Pretence and Counterfactual Reasoning: What is the nature of the relationship?

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Declaration

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Abstract

This study aims to explore the theoretical assertion that pretence and counterfactual reasoning involve the same cognitive mechanisms. However, there is little empirical evidence concerning the nature of the association between pretence and counterfactual reasoning (CFR), and the associations of these constructs with other cognitive abilities. This study investigated shared cognitive skills proposed to link pretence to counterfactual reasoning and explored whether an underlying cognitive capacity might explain the associations shared between the two.

This study uses a large-scale observational design to test the relationship between pretence and counterfactual reasoning at a structural level. 189 typically developing children (M_{age} = 58 mths, *SD* = 4) completed measures of pretend play, counterfactual reasoning, executive functions (EFs) and receptive language. Confirmatory Factor Analysis (CFA) was used to assess whether pretence and CFR measures each loaded on to latent factors. Hierarchical multiple repression analyses were used to assess predictors of scores on these factors. Structural equation modelling (SEM) was used to explore whether a second order ability explained common variance in CFR and Pretence latent variables.

CFA results confirmed the latent pretence and CFR constructs emerged as predicted. Further these factors were significantly correlated with each other. The hierarchical multiple regression analyses identified inhibition as commonly accounting for unique variance in both latent constructs. SEM supported that a second-order factor, predicted by inhibition, accounted for the unique variance shared between pretence and counterfactual reasoning.

The findings are discussed with reference to the theoretical supposition that pretence and counterfactual reasoning share cognitive mechanisms. Based on the results of this first study to model empirically a unifying theory of pretence and counterfactual reasoning, a tentative new theoretical model is proposed which is based on the idea of a general mental state model of an imaginary representational capacity influenced by inhibitory control.

Key Words: Pretence, Counterfactual Reasoning, Imagination, Hypothetical Thinking, Cognitive Models

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Dedication

For mama…

The sunset behind this new dawn.

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List of Abbreviations

BCQ(s)	Before Control Question(s)
EF(s)	Executive Function(s)
CELF	Clinical Evaluation for Language Fundamentals
CI	Confidence Intervals
CFA	Confirmatory Factor Analysis
CFR	Counterfactual Reasoning
CHIPPA	Child Initiated Pretend Play Assessment
CIpretence	Child Initiated Pretence
HTKS	Head Toes Knees and Shoulders task
ICC	Intraclass Correlation Coefficient
IR	Imaginary Representation
NIA	Number of Imitative Action
NIA-CV	Number of Imitative Action in conventional-imaginative play
NIA-SY	Number of Imitative Action in symbolic play
NCQ(s)	Now Control Question(s)
NOS	Number of Object Substitution
NOS-CV	Number of Object Substitution in conventional imaginative play
NOS-SY	Number of Object Substitution in symbolic play
PAT	Pretend Action Task
PEPA	Percentage of Elaborate Pretend Play
PEPA-CV	Percentage of Elaborate Pretend Play in conventional imaginative play
PEPA-SY	Percentage of Elaborate Pretend Play in symbolic play
SEM	Structural Equation Modelling
WM	Working Memory

Imagination is the only weapon in the war against reality

(Lewis Caroll – Alice in Wonderland)

Chapter 1 Introduction

1.1.0 Background

A remarkably interesting parallel has been observed between the naïve thinking that underpins young children's engagement in pretence and the more sophisticated form of thinking called counterfactual reasoning. The similarities between pretence and counterfactual reasoning have been described as important, fascinating and puzzling because they both share the quality of disengaging from the real world and moving into the realm of imagination (Weisberg & Gopnik, 2013). For instance, a child who acts as if a banana is a telephone or observes someone performing this action and can accurately tell the true identity of the telephone from the banana in both real and pretence contexts is said to be engaging in pretend play or has the capacity to recognize pretence in others (Leslie, 1987). Alternately, a student who upon failing a test imagines that if they had more time to study; they would have surely succeeded is engaging in counterfactual reasoning (Byrne, 2016). In counterfactual reasoning, the student conjures up alternative versions of their experience and possible resulting outcomes, essentially reasoning from the false premise. What is common to both pretence and counterfactual reasoning is the ability to disengage with current reality, make inferences about an alternative representation of reality, and keep this inference representation separate from reality (Weisberg, 2015; Weisberg & Gopnik, 2013). These three characteristics are the basis for the theoretical proposition that the tendency to transition between the real and imaginary suggests that both pretence and counterfactual reasoning share similar underlying cognitive processes.

The study of pretence and counterfactual reasoning is relevant and potentially makes an important contribution to understanding learning and development in the early years. For one thing pretend play is ubiquitous for children across diverse cultures although it is perceived as an innate and mysterious development (Lillard, Pinkham, & Smith, 2011). Developmental and cognitive psychologists view pretence as a prevailing enigma of child development and question why children spend such a prolonged period of their formative years of development participating in pretend play when it does not appear to serve any obvious survival function (Lillard et al., 2011). Notwithstanding, symbolic pretend play has come to be looked upon as one of the most significant cognitive developments in young children and as the mature or developmentally appropriate play of the preschool child (Stagnitti et al., 2000).

Despite the well-established claim that pretend play is crucial to development; according to Lillard, Lerner, Hopkins, Dore, Smith, & Palmquist (2013) current evidence does not support strong causal claims about the unique importance of pretend play for development and suggested that much more and better research is imperative for clarifying its possible role. In other words, it is widely agreed that pretend play is important but there is little evidence explaining precisely which aspects of development it directly facilitates. In response, Walker and Gopnik (2013) and Weisberg and Gopnik (2013) argued that the way forward for researching the relationship between play and development lies with developing an explanatory theory of the cognitive mechanisms that underlie pretence which can then be used to generate testable predictions about the role of pretend play in development. The researchers proposed a unifying theory of imaginative processes whereby pretence and counterfactual reasoning share an underlying capacity that explains how both cognitive skills inherently involve the practice of generating false premises and reasoning from them (Weisberg & Gopnik, 2016). The researchers' premise is that given the early emergence of pretend play in development then pretending functions as an opportunity to practice important cognitive skills associated with planning causal models, including counterfactual reasoning and Bayesian learning. This is possible because children like adults possess intuitive theories of learning which are used to reason about causal relationships by actively generating hypothetical causal models (if X then Y; if not X then not Y) about possible worlds, assess the fit of the alternative models, and select the most likely causal model (Walker & Gopnik, 2013b). Albeit precociously, through pretending children practice generating and keeping in mind imaginary models (counterfactuals) of the real world (factuals) to make sense of causal relationships. Thus, pretending may actual serve the function of helping children to begin learning about psychological causal relationships.

This present study is important as it sets out to test the prediction that an underlying imaginative representational capacity might be the nexus linking pretence and counterfactual reasoning. I believed that in response to the proposed unifying theoretical framework of pretence and counterfactual reasoning, the first logical step was to design a study that aimed to test the link between pretence and counterfactual reasoning, that is, whether imaginative processes are at the heart of generating mental causal structures of the world; before tackling the question about the role of pretence, that is, does early years pretence predict performance in causal and counterfactual reasoning? It is my take that the results from this present study, in its own right, can respond to the proposal by Walker and Gopnik (2013) and Weisberg and Gopnik (2013)

that a unifying theory of pretence might provide a new wave of evidence for considering the role of pretence in development.

As a consequence, a powerful implication from this study is its potential to contribute to the conversation about the best practices for the structure of early years education, as well as, for the role of play in education more generally. Schooling in the early years are designed around variations of pretend play, for example, role-play, socio-dramatic play, object play, et. cetera., which mimic how young children naturally learn whilst also making learning engaging and fun. From my experience of teaching primary school for over ten years, I observed that the practice of including different forms of imaginative play in general education as children got older usually dissipated, eventually, being relegated to the confines of a specialist theatre, arts, and drama classroom. This practice tends to stem from a philosophy that the concept of play detracts from the seriousness required to succeed at general education and assessment; hence, the two must be separated. I contend that if this unifying theory that pretence is linked to causal models of learning like counterfactual reasoning holds true, then the findings from this present study can contribute evidence and make recommendations for integrating opportunities for imaginative thinking into the school curricula and teaching, as well as, for greater advocacy for learning through play.

To date, evidence that the ability to transition between the real world and an imaginary world is a shared characteristic of both pretence and counterfactual reasoning comes mostly from separate, independent studies of the two phenomena (Amsel & Smalley, 2000; Beck, Riggs & Gorniak, 2009; Beck, Weisberg, Burns, & Riggs, 2014; Bergen, 2002; Byrne, 2016; Friedmam & Leslie, 2007; Harris, German, & Mills, 1996; Perner, 1991). What is known in relation to pretence is that the tendency to engage with an imaginative world or fantasy occurs quite overtly in young children and is seen when they begin to engage in pretend play early in development (Leslie, 1987). Pretence can be considered as referring to the cognitive construct of pretend play and pretend play is considered the behavioural manifestation of pretence. In other words, pretence is the premise of pretend play and it manifests in young children in the form of playful behaviours like object substitutions, role playing or acting out make believe scenarios that are typically drawn from children's actual real-world observations and experiences. Consequently, a researcher's inferences about a child's capacity for pretence are indexed from observing children's actions in natural, playful or simulated pretend play settings.

Counterfactual reasoning is somewhat different, as it takes the form of reflecting on how the world might have been under different circumstances rather than how it is immediately presented (Amsel & Smalley, 2000; Riggs & Peterson, 2000). Thinking about how the world *might* have been seduces individuals to create imaginary versions of their world or the world presented to them. (Roese & Morrison, 2009) described spontaneous adult-like counterfactual reasoning as ruminating about how things might have turned out differently. In children, counterfactual reasoning is typically elicited by presenting children with cause and effect scenarios and getting them to imagine how a change in the event antecedent could lead to an alternative consequent or vice versa (Guajardo & Turley-Ames, 2004). Consistent in studies of pretence and counterfactual reasoning is the tendency for children as well as adults to generate imaginary or make-believe representations.

Particularly noteworthy about pretence and counterfactual reasoning is the difference in the developmental trajectory of these two similar yet distinct cognitive skills. The ability to pretend seems to emerge naturally during the early years of development so much so that its absence is usually indicative of a developmental disorder (Jarrold, 2003). While different cultures and subcultures differ in the extent to which children engage in [pretend] play by their cultural values about childhood, gender, religious beliefs, social structures, cultural attitudes transmitted to children through the behaviours of their parents and so on; there is a clear and consistent manifestation of child [pretend] play in all cultures (Whitebread et al., 2012). The emergence of pretence results initially as: object-substitute pretence by imitating adults, imitating actions with objects that are dissimilar in either form or function and being able to produce (child-initiated) object substitutions without modelling. As children get older, they: display and comprehend child-initiated object substitutions with objects similar or dissimilar in form or function, as well as begin to understand object substitution action in others. Some difficulty with understanding object substitution actions in others persist but improves with age until engagement in overt pretend play atrophies as children get into middle childhood.

On the other hand, researchers are less inclined to attribute counterfactual reasoning competencies to children until the age of three to four years. The developmental trajectory of counterfactual reasoning in young children follows a slow progression probably because it does not show off as overtly as pretend play which appears early in development and must be directly elicited from children in order for it to be measured. In sum, general indicators include children showing they have an understanding of the concept of almost, the ability to answer questions

about future hypotheticals before past hypotheticals, imagining an event could occur in the past using the strategies of basic conditional reasoning or reasoning from general assumptions about the world, being able to hold dual possibilities in mind by keeping in mind what happened and could have happened, and being able to hold multiple possibilities in mind which includes what happened and multiple possibilities of what could have happened (Beck, Robinson, Carroll, & Apperly, 2006; Byrne, 2016; Harris, 2000; Rafetseder, Schwitalla, & Perner, 2013). As a result, counterfactual reasoning is thought to have a prolonged period of development with adult-like counterfactual reasoning appearing after the preschool years and gradually becoming stable as children mature into adulthood (Beck & Riggs, 2014; Rafetseder et al., 2013).

Overt pretence and pretend play in children emerges from eighteen months with children experiencing what is often referred to as a high season of pretence from two to five years, followed by a visible decline in routine, spontaneous engagement in pretend play (Friedman & Leslie, 2007; Leslie, 1987; Weisberg, 2015). It is important to emphasize that less overt engagement in pretend play does not suggest the disappearance of a pretence ability, as children, to a greater or lesser extent depending on cultural orientations, continue to engage in pretence well into middle childhood (Harris & Jalloul, 2013). There is even evidence to suggest that for some people pretence dispositions persist in adulthood in the form of fantasy proneness[1]. Fantasy proneness is a tendency to imagine fictitious situations, often to escape reality (Bacon, Walsh, & Martin, 2013). The point is that a pretence stance can be adopted at any time even during later development but very rarely does it resemble the preoccupation with imaginary worlds that is seen during the early years of development.

Around the time that spontaneous, explicit engagement in pretend play (the behavioural indicator of pretence) show signs of decline in children; counterfactual reasoning is becoming matured, explicit and spontaneous. This contrast between pretence and counterfactual reasoning raises a number of interesting questions. For example; Why is it that as overt, spontaneous child-driven pretence behaviours (pretend play) show signs of decline in children, the more thoughtful skill of counterfactual thinking begins to mature? Does the transition imply that overt, explicit pretence or pretend play gives way to a more explicit, spontaneous

[1] Fantasy prone-ness can be seen as normally distributed within the general population (Eisen & Lynn, 2001) with various degrees of daydreaming a fairly universal part of normal emotional functioning (Mason et al., 2007), (cited in Bacon, Walsh & Martin, 2013).

counterfactual reasoning ability? Another more general but related and relevant question posed by Lillard, Lerner, Hopkins, Dore, Smith and Palmquist (2013)[2] asked, "What contribution does pretend play (or pretence) make to child development?'. In the context of this paper, Lillard et al.'s (2013) question can be rephrased to ask, what role does pretend play have in children's development of counterfactual reasoning? These are a selected few general questions of many questions which can be raised in relation to the theoretical claim that pretence and counterfactual reasoning engage the same component cognitive abilities (Weisberg, 2015; Weisberg & Gopnik, 2013).

1.2.0 Rationale for Study

There is currently a dearth of empirical research which has aimed to unpack claims of a relationship between pretence and counterfactual reasoning. Hence, I think that research endeavours need to begin to answer fundamental questions which attempt to detangle issues like; what are the specific 'cognitive abilities' or 'shared cognitive dimensions or mechanisms' that researchers are proposing links pretence and counterfactual reasoning? To what extent do pretence and counterfactual reasoning share underlying cognitive dimensions? This thesis seeks to fill the gap in the literature and state of knowledge about pretence and counterfactual reasoning by addressing these questions. The intention is to contribute empirical evidence by testing the theoretical claims that pretence and CFR are linked, and to evaluate and extend if possible, this growing theory.

In acknowledging the need for such goals, Weisberg and Gopnik (2013) have stated there is need for large scale studies that use multivariate analyses to get at the unique variance that pretend play contributes to other abilities like counterfactual reasoning and causal reasoning, above and beyond other explanatory factors. Similarly, in their meta-analysis Lillard et al. (2013) recommended further research using correlational and training paradigms to explore whether pretending affects logical reasoning (of which counterfactual reasoning is a form) more generally. Given the limited empirical evidence available, the use of correlational studies aimed at understanding the relationship between pretence and counterfactual reasoning is necessary and timely especially since correlational studies are useful investigative procedures,

[2] Lilliard et al (2013) conducted a meta-analysis of pretend literature to answer the question what is the impact of pretend play on child development.

generally used first, before attempting to discover whether relationships are causal (Gall et al., 2007). Furthermore, if this study finds evidence that pretence and counterfactual reasoning are indeed complementary skills; then the findings from this investigation can clarify and add to the theoretical principles needed for building a robust theory of pretence and counterfactual reasoning as well as contribute to discussions about the role of pretence or pretend play in child development. More importantly, I believe that the answers to these fundamental questions set the stage for further experimental, intervention or training studies involving pretence, pretend play and counterfactual reasoning.

1.3.0 Overview of Thesis

This thesis reports on how two seemingly distinct cognitive processes share similar characteristics. The thesis itself is divided into eight chapters including this first introductory chapter.

Chapter two, which is the Literature Review, holds up to critical scrutiny the lines of arguments which inform suggestions that pretence and counterfactual reasoning are associated cognitive processes. The literature review begins by delineating the definitions, defining features, cognitive mechanisms, developmental trajectory and measures of pretence and counterfactual reasoning, separately. Next, this information is used to compare and contrast pretence and counterfactual reasoning primarily by looking at their cognitive mechanisms and the fact that both skills involve a capacity to represent real and non-literal aspects of the world, and to maintain, as well as transition successfully between both representations. Parallels between pretence and counterfactual reasoning are highlighted by taking into account links to other cognitive factors like, Language, and Executive Functions (EFs) which are believed to influence children's abilities to engage in both pretence and counterfactual reasoning. Empirical evidence alluding to a relationship between pretence and counterfactual reasoning are also reviewed. The review of literature culminates with a discussion aimed at contributing to the theoretical claims about pretence and counterfactual reasoning and with a framework of the proposed study undertaken.

Chapter Three and Chapter Four cover the Research Design and Research Methodology, respectively. Chapter Three explains why an observational research design study was the most appropriate for investigating the extent to which pretence and counterfactual reasoning share

cognitive mechanisms. The research questions are delineated, study variables are operationalized, sampling decisions are explained, and the process of piloting the study is described. Chapter Four presents the research methods employed in conducting this investigation including the selection of participants, study measures, data collection procedures, ethical considerations, the data analyses plans, and the treatment of missing data.

Chapter Five and Chapter Six outline the results from the data analyses which addressed the four main research questions posed in this study. These two chapters are referred to as results A and results B, respectively. Chapter Five begins by describing the demographic background of the sample and the reports the findings to the first two research questions which unpack the characteristics of the constructs of pretence and counterfactual reasoning. Chapter Six reports on the relationship among the variables with the goal of determining the nature of relationships which exists between pretence, counterfactual reasoning, language and executive functions.

Chapter Seven is the discussion chapter and Chapter eight is the conclusion. In Chapter Seven, the study findings are summarised and discussed in relation to relevant literature. In addition, the theoretical claims about pretence and counterfactual reasoning are appraised in light of the empirical evidence from the current research. Furthermore, the strengths and limitations of this study are considered and implications for further research are proposed. Chapter eight serves to conclude the thesis by overviewing the research project including a general discussion about the contributions of this thesis to the study of the theory of pretence and counterfactual reasoning.

Chapter 2 Literature Review

2.1.0 Introduction

The relevant literature relating to pretence, counterfactual reasoning and the relationship between the two are examined in this chapter. In the first half of the chapter, the literature on pretence and counterfactual reasoning are reviewed separately. The intention is to give a broad over view of the representational qualities of pretence and counterfactual reasoning to elucidate why researchers think the two share cognitive mechanisms. In the second half of the chapter, the relationship between pretence and counterfactual reasoning is appraised by describing their cognitive mechanisms, the influence of other related cognitive skills like executive functions and language on the development and functioning of pretence and counterfactual reasoning are explained, and empirical evidence which have investigated the connection between the two are presented. A theoretical framework is put forward to explain how these two cognitive skills might be related and the framework of the thesis is explained.

2.2.0 Pretence

The study of pretence, its defining features, and characteristics are particularly interesting to cognitive-developmental researchers since pretence has been observed to be a unique attribute that separates human beings from other animate beings (Mitchell, 2002; Woolley, 2002). 'Pretend play', 'make believe', 'fantasy play', 'symbolic play' and 'acting as-if' are all terms used to refer to pretence. According to Perner (1991, p.51):

> "'make believe,' interpreted literally, carries a deceptive connotation: "She makes her father believe she is sleeping." 'Fantasy' suggests detachment from reality: "She imagines herself sleeping." 'Symbolic' suggests a representational function: "She represents herself as sleeping." 'Acting-as-if' suggests, "Although she is awake, she acts as if she were asleep."

Common across these different interpretations of pretence is that they involve representations of an alternative world which at the time is not real (Perner, 1991).

It is this deviation from normality, whereby an individual entertains imaginary worlds that differ from reality that is the focus of the ensuing discussion. Hence, pretence is the projecting of a supposed or imaginary situation onto an actual one in the spirit of fun or play (Lillard,

1993). Imaginary play is also referred to as pretend play. In the context of cognitive research, a discussion of pretence begins with an acknowledgement of the representational nature of the mind, that is, its capacity to generate mental representations. What this means to the study of cognitive psychology is that human beings make sense of the world by forming mental representations (cognitive structures) that stand for aspects of the world encountered throughout one's life time. In its simplest sense, mental representations are our cognitive representations of reality. Pretence, then, is a distortion of that reality, or a deviation from normality (Leslie, 1987; Perner, 1991). As a consequence, when we pretend, real world representations are substituted by an imaginary (representational) version.

The earliest indicator of the capacity for pretence is seen in children from around eighteen months of age in the behavioural manifestation of pretend play (Weisberg, 2015). What makes children's pretend actions remarkable is the fact that they are aware that the situation they are enacting is imaginary (Lillard, 1993; Perner, 1991). This is deduced from the child's ability to keep separate, real world references from pretence representations. For example, in pretending that a block is a cookie a child would stop short of actually trying to eat the block (Lillard, 1993). However, while pretend play may dominate young children's play behaviours; it is not a necessary criterion for pretence (Lillard, 1993). It is quite plausible for one to formulate pretence scenarios without acting it out. In such a case, the pretence thought can be written down e.g. story writing, spoken aloud or shared e.g. story telling or simply kept in the recesses of the pretender's mind.

Moreover, pretence and pretend play comprise a variety of different types and distinguishable actions. Researchers tend to describe pretence based on the aims of their study (Frahsek et al., 2010). One way of describing pretence involves identifying how the pretence is initiated, as in whether the pretence is self-directed/initiated or other-directed/initiated. Self-directed pretence emerges during the second year of life; whereas, other-directed pretence develops latter from actions directed towards another person to pretence involving a fictional character that grows incrementally in quality, for example: a child may act as if she was eating from an empty plate around her first birthday, show signs of awareness, such as exaggerated sounds around eighteen months of age, in her second year of life feed her mother with an empty spoon, sometime later she may pretend to feed her doll, later start to talking to her doll, and during her third year of life, even treat the doll as if it was an independent agent (Frahsek, et al., 2010). Self-directed/initiated pretence may also look like solitary pretend play and other-directed/initiated

as joint pretend play with peers or an adult. For this reason, when assessing pretend play the social context must be taken into account (Frahsek, et. al., 2010).

Pretence can also be described by the form of representational substitution that it takes on. Two forms of representational substitutions, symbolic substitutions and hypothetical substitutions, are identified by (Perner, 1991). According to Perner (1991), symbolic substitution involves a referent which is used to represent something else, for example, pretending that a stick is a soldier. Put simply, in symbolic play one thing or object is playfully treated as if it were something else (Russ & Dillon, 2011). Hypothetical substitution involves *acting as if* something were something else for example, acting on Monday as if it were Sunday (Perner, 1991). These categories are further elucidated by Stagnitti, Unsworth, & Rodger (2000) who argue that pretend play includes symbolic play as well as imaginative play with functional toys, for example, a child pretending that 'the doll is *sitting* at the table' or 'putting the doll to *sleep*'. An element of *acting as if* seems to underpin Stagnitti, Unsworth, & Rodger's (2000) description of children's imaginative play and is closely aligned to Perner's (1991) definition of hypothetical substitution. In addition, Stagnitti, Unsworth, and Rodger (2000) listed several forms of symbolic substitution done in pretence:

(a) substituting one object to represent another, for example, using a box as a car, using an action to represent a property e.g. rubbing the head to feign sickness,
(b) the substitution of symbolic action to represent an absent object, for example, waving the hand as act of closing the door.
(c) Symbolic play can be observed when a child uses an inanimate object or a conventional object, for example, a stick or shoe, respectively, in an unconventional way by pretending the object is something else.

However, it must be pointed out that symbolic pretend play is distinct from other forms of object play such as exploratory play with objects seen when children arrange, sort, classify, construct with objects or participate in functional play where an object is used in accordance with its conventional purpose without any imaginative or elaborative element (Frahsek, et al., 2010). In order to distinguish pretence from functional play, some researchers observe additional signs of awareness that accompany the action, such as exaggerations, sound effects, comments, or 'knowing' laughter (Frahsek, et al., 2010).

Given that pretence can manifest in different ways, there is a need for identifying all the attributes of pretence with the view of establishing valid common constructs of pretence that can be used to guide pretend play research across multiple contexts. An attempt of establishing a common theoretical framework for conceptualizing pretence is reported by Thompson and Goldstein (2019) who reviewed one hundred and ninety-nine empirical articles measuring pretend play and proposed that pretend play behaviours are likely to develop additively from least to most psychologically complex in the order of object substitutions, attribution of pretend properties, social interactions within pretend, role enactment, and pretence-related metacommunication. This organisation is meant to provide a theoretical framework to facilitate a more coherent, valid, and holistic approach to studying pretend play across different contexts (Thompson & Goldstein, 2019). Going forward, it would be useful to explore whether all these pretend attributes are correlated with each other or if they could be used to proxy a general construct of pretence.

2.2.1 Defining Features of Pretence

How is pretence conceptualized at a cognitive level and what are the cognitive mechanisms involved in pretending? Several researchers like Leslie (1987), Lillard (1993), Nichols and Stich (2000), and Perner (1991) have delineated the defining features of pretence. Their ideas are presented and compared in this section.

(Leslie, 1987) is most succinct in his identification of two characteristics of pretence. The first, is the ability to quarantine or keep pretence separate from normal reference, truth, and existence relationships about the world such that representational abuse is avoided. For example, a toddler driving a car as part of his pretend play does not necessary translate to him thinking himself capable to drive his parents' car nor would he expect that his toy car should be filled up with gas at a petrol station. To quarantine is the ability to transition between pretence and reality without getting confused between the two and being able to quarantine successfully is necessary for true pretence. The second, is the ability to also recognize pretence in others. According to Leslie (1987), understanding pretence in others is part and parcel of being able to pretend oneself. Often, children engage in pretend play with another (parent, sibling or friend). The understanding of others pretence is commonly seen when young infants engage in joint-pretence.

The essential feature of pretence according to Perner (1991) is that it is a deviation from normality. Children deviate from reality to create imaginary situations as part of their play. However, for play engagement to be considered pretence, the child must be aware that their actions deviate from the normal, and of the fact that the situation is imaginary. Without an element of awareness, the child's play may be merely functional, that is, object interaction where actions done on objects match the appropriate use of the objects for example, combing a doll's hair (Zelazo & Kearsley, 1980).

The features of pretence proposed by Lillard (1993) and Nichols and Stich (2000) draw from the contributions of previous play researchers including Leslie (1987) and Perner (1991). Lillard (1993) listed six features as necessary and sufficient for pretence[3]. Firstly, there must be a pretender. In other words, some mindful being has to do the pretending. Secondly, there is a reality to which the pretence contrasts. Thirdly, there is a mental representation different from reality for example, one cannot pretend to type while they are typing. Fourthly, there is a layering of the pretence representation over the reality, such that they exist within the same space and time. In other words, an imaginary scenario is imposed on a real state for example, pretending a stick is a horse such that the top of the stick is treated as if it were the head of the horse and the bottom as if it were the legs. Fifthly, there is awareness on the part of the pretender through features two, three and four. Hence, pretending is done knowingly and intentionally for example, the pretender knows the difference between a stick, a horse and pretending that a stick is horse. Sixthly, pretence is frequently accompanied by some external manifestation for example, activities or bodily movements that are in accord with the pretence. However, the pretence action is one of potentiality and may not always be present in a pretence episode. An additional aspect of pretence, although not specifically identified as a feature but included in Lillard's (1993) discussion is that the real and pretend situations are kept separate. The pretend world does not seep into the real world, nor is the real world expected to adopt features of the pretence for example, after pretending a block is a cookie one does not expect the block to become a cookie in real life or expect that a bag of blocks newly purchased would contain a cookie (Lillard, 1993a).

[3] Examples used in this paragraph were extracted from the paper Lilliard (1993a)

Another set of defining features are proposed by Nichols and Stich (2000)[4]. Firstly, typical pretence episodes begin with an initial premise or set of premises where the pretender either produces the initial premise, that is, if he or she was the one who initiated the pretence. Otherwise, he or she figures out what the initial premise is and whether or not he or she will proceed with the premise if someone else initiated the pretence. The initial premise is what that gets the pretence started. An understanding of the pretence premise is the basis for generating appropriate thoughts and actions. Secondly, the details of what is happening in the pretence are filled out through a process called inferential elaboration. For example, for a child to answer a question about which cup is full after watching an experimenter pretend to fill up two empty cups and then turn one upside down; the child must infer that the cup which was turned upside down is empty. Thirdly, the details of what is happening in the pretence can also be elaborated in non-inferential ways where the pretence inference radically departs from what one might typically expect to unfold in a known setting. For example, in a fantasy restaurant pretence scenario, a waiter pretends to decapitate a diner. Fourthly, the actions that individuals engage in during pretence are appropriate to the pretence, for example, holding one's arm rigidly to imitate the rigidity of a cat's body after rigor mortis has set in. Fifthly, the ability to keep what is really believed separate from what is pretended through a process called cognitive quarantine where the pretence has limited effects on the later cognitive state of the pretender.

The preceding discussion about the defining features of pretence shows that some researchers emphasize different aspects of pretence more than others. Hence, there is a degree of overlap across the researchers. Notwithstanding, it stands to reason that there can be no pretence without a pretender. Whereas, Lillard (1993), makes direct mention of a pretender, one can infer that the presence of a pretender is implicitly implied in the accounts of Leslie (1987) and Perner (1991). There must also be a pretender who generates the premise identified by Nichols and Stich (2000). Consistent among all four researchers is the ability of the pretender to avoid becoming confused as they manoeuvre between real world representations and representations formulated for the purpose of pretence. Leslie (1987) called this skill 'quarantine', Perner (1991) refers to it as awareness of the discrepancy between the real and imagined, Nichols and Stich (2000) calls it 'cognitive quarantine', and Lillard (1993) identifies the presence of two representations, the real world and pretence representation. Further parallels can be drawn by

[4] Examples used in this paragraph were extracted from the paper Nichols & Stich (2000)

comparing the two pretence elaborations (inferential and non-inferential) identified by Nichols & Stich (2000) to Lillard (1993) explanations about 'the layering of the pretence over the reality'. I would say that both relate to the details included in the pretence scenario and suggests that the pretender can extend his or her imaginary world as he or she deems fit. Lastly, Leslie (1987), Lillard (1993), and Perner (1991) all stated that it is important that the pretender knows he is pretending. Leslie (1987) in his paper, extends this idea to the ability of the pretender to understand pretence in others however, there is contention among play researchers about whether this characteristic is necessary for pretence. Lastly, pretence actions are a feature of pretence that all three researchers make reference to. The defining features of pretence discussed are summarised in Figure 2.1.

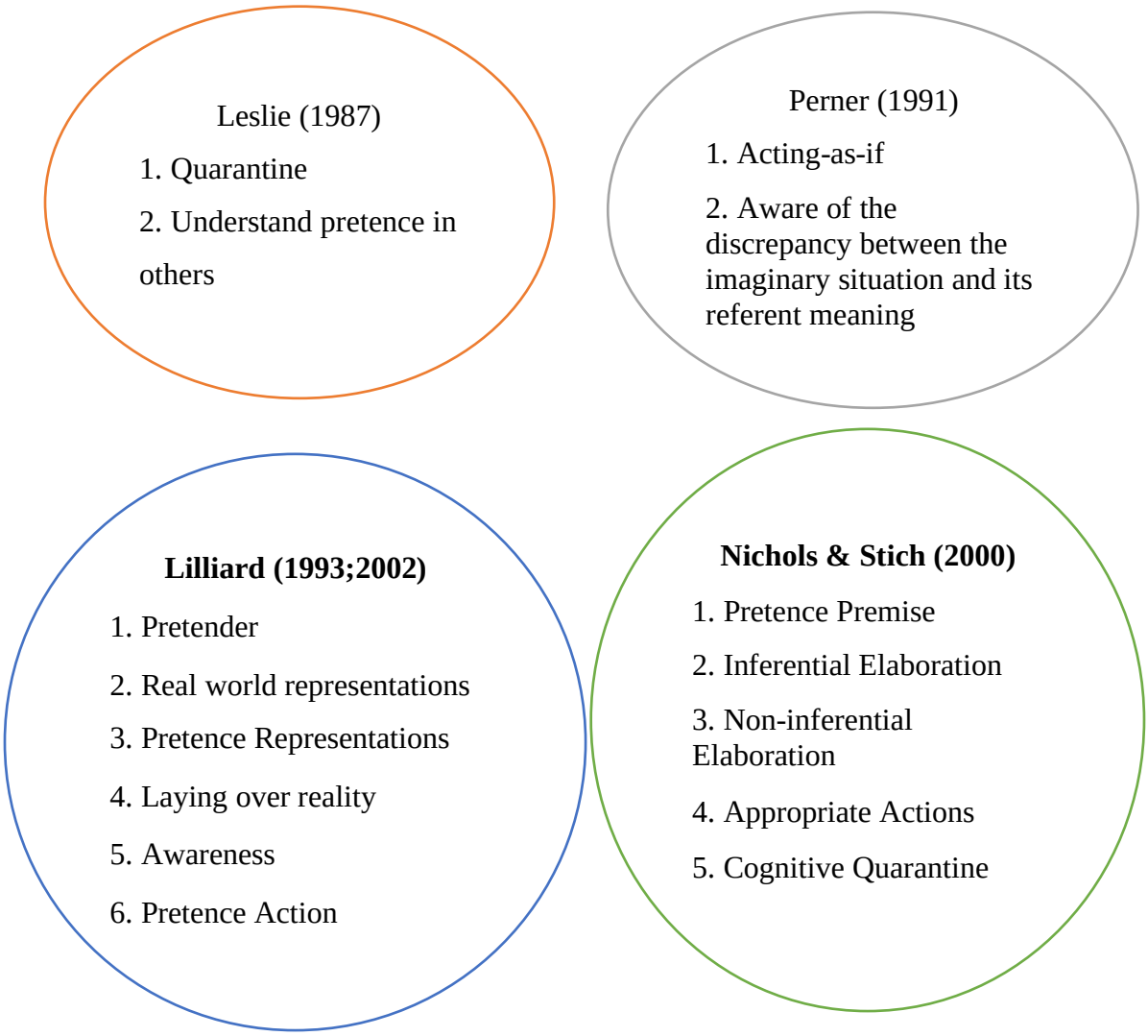

Figure 2.1 Defining Features of Pretence

2.2.2 Cognitive Mechanisms of Pretence

In complement to the defining features of pretence researchers have gone further to outline the mechanisms which make the features of pretence possible. The main cognitive theories that give an account of the cognitive mechanisms of pretence include; 'The Metarepresentational Theory of Pretence' by Leslie (1987), 'The Multiple Model Theory' by Perner (1991) and 'The Possible World Box Theory' by Nichols & Stich (2000).

The most influential mechanistic account of pretence was put forward by Leslie (1987) in his 'Metarepresentational Theory of Pretence'. Leslie's description of the mechanisms underlying pretence was represented using what he referred to as the 'decoupling model of pretence' (see Figure 2.2).

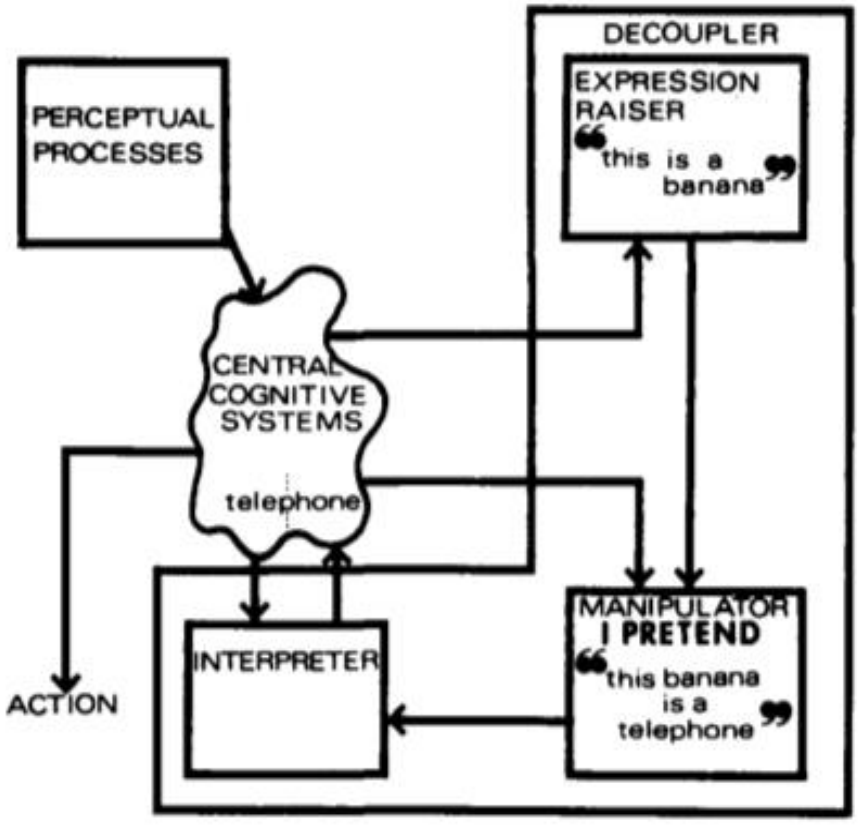

Figure 2. The decoupler model of pretense.

Figure 2.2 The decoupler model of pretence (from Leslie, 1987)

‘The Decoupler Model’ comprised three main components namely; perceptual processes, a central cognitive system and the decoupler; all of which form the cognitive architecture that facilitates pretence. Perceptual processes are responsible for taking in information about the world and represent our current situations. This information is transferred to the central cognitive system. The central cognitive system has structures corresponding to perceived situations, memory systems (including, for example, general knowledge) and systems for planning action. The idea of a central cognitive system (central executive) is widely purported as critical to cognitive processing as a whole and is discussed further when other cognitive factors that can likely influence one’s capacity for pretence are explored later in this chapter (see section 2.4.0 which discusses evidence for the link between pretence and counterfactual reasoning).

According to Leslie’s mechanistic account, information about the world collected by the perceptual process goes to the central cognitive system and together they form primary representations of the world. Pretence expressions are formed when primary representations are raised to a second order representation or metarepresentation, by ‘the decoupler’. The ‘Decoupler’ achieves this by engaging three separate processes, ‘the expression raiser’, ‘the manipulator’ and ‘the interpreter’. The ‘expression raiser’ does the following: (a) copies primary representations from the central system, and (b) removes the primary representation from its normal input-output relations and normal computational consequences through a process referred to as decoupling. ‘The manipulator’ then transforms the decoupled expression to a second order representation or metarepresentation. Lastly, the interpreter performs anchoring functions by; (a) accessing primary representations in central systems, (b) relating decoupled expressions to their current perceptual representation, (c) accessing inference rules and other information for passing to the manipulator for further cycle, and (d) passing metarepresentations to the central cognitive systems for storage. Thus, the feature of quarantining primary and metarepresentations are achieved.

Moreover, Leslie (1987) argued in his paper that pretence is a fundamental ability in typically developing children which once having emerged does not develop any further. This leads to the following conclusions about pretence:

1. Pretence is sophisticated in and of itself
2. The qualitative changes in pretence are not necessarily due to a change in the ability to pretend as opposed to the influence of maturation in other cognitive structures and

abilities e.g. perceptual abilities, conceptual understanding, memory functions, social rules.

To support this perspective, Leslie (1987) used the analogy that growth in a child's 'encyclopaedic' knowledge leads to changes in the contents of the child's pretence. Hence, Leslie likened pretence to an early manifestation of Theory of Mind and at its core is the perspective that a child's ability to pretend means that they can understand their own pretence as well as that of others. It is this aspect of Leslie's theory that is most often criticized. A review of empirical evidence by Lillard (2001) has suggested that there is little evidence to support Leslie's metarepresentational theory of pretence.

In contrast to Leslie (1987), Perner (1991) proposed a 'Multiple Model of Pretence' where child pretence is described as 'acting-as-if' and is made possible by the child's ability to switch between reality and imaginary situations. Unlike Leslie (1987), Perner (1991) purports that the ability to switch is sufficient for meeting the condition of being 'aware' of the difference between reality and pretence. According to Perner (1991), the cognitive mechanism which underpins pretence is facilitated by an ability to entertain two mental models: a 'Reality' model and an 'As-If' model. The two models simply represent two different situations: the real situation and a hypothetical situation that may not be and probably never was real. The two models are simply representations of two different situations or contexts and meet the following three assumptions:

1. The representation controlling play action is contained in a different model than information about the real world controlling serious action; otherwise, the child would be confused about what is real and what is pretend.
2. The models are labelled in a way that enables it to pick the right one for playful enjoyment and for serious action.
3. In order that the pretend model can govern pretend action in the real world, the two models are about the same entities. This is ensured by the fact that expressions like "this object," "is," "piece of cloth," "my pillow," and so on, in the two mental models represent the same entities and relations.

According to Perner (1991) his 'Multiple Model' offers a more parsimonious explanation of the mechanisms of pretence than Leslie's (1987). I think Leslie's model is more technical because it ventures to explain the specific mechanisms which facilitate decoupling of pretence information from the real world to make hypothetical imaginary representations possible.

Another cognitive theory of pretence fairly recently developed by Nichols and Stich (2000) proposed that the capacity for pretence rests on a mental workspace embedded in our cognitive architecture called the 'Possible World Box' (see Figure 2.3).

Illustration of Nichol's & Stich (2000) 'Cognitive Model of Pretence' removed for copyright reasons. Copyright holder is Elsevier

Figure 2.3 Cognitive Model of Pretence (from Nichols & Stich, 2000)

Nichols and Stich (2000) described their 'Possible World Box Pretence Theory' as a highly eclectic one which borrows many ideas from other theorists like Leslie (1987) and Perner (1991). However, Nichols and Stich (2000) theory differ in its design of specifying a mechanistic account of pretence where the Possible World Box is a mental workspace where our cognitive systems build and temporarily store representations of one or another possible world. In addition, other mental state capacities are held in a separate box to pretence for example, beliefs are held in a Belief Box. Nicholas and Stich (2000) posited that the original evolutionary function of the Possible World Box may be to facilitate reasoning about hypothetical situations, thus the Possible World Box acquires a central role in pretence. The Possible World Box interacts with other cognitive systems to influence to varying degrees the contents of our pretence representations.

Similar to Leslie (1987), Nichols and Stich (2000) agreed that pretence mechanisms require quarantining and decoupling of mental representations. However, Nichols and Stich (2000) aligned with Perner (1991) to conclude that Leslie's (1987) assertion that pretence is a primitive manifestation of the ability to conceptualize mental states and therefore an early manifestation of Theory of Mind is flawed. Friedman and Leslie (2007) have given a rebuttal arguing why the metarepresentational theory of pretence provides a better account than theories which view pretence as behaving as-if. In Leslie's defence he argued that it is not the representational capacity to pretend that changes but qualitative changes in pretence are the influence of maturation in other cognitive structures. Allowing for maturation based on connections with other cognitive connections may explain why children's ability to understand pretence in others develops over time. Like Perner (1991), Nichols and Stich (2000) argued that in principle pretence could proceed perfectly well even if the subject did not hold a concept of pretence, as is often seen during the emergent stages of pretence in young children. By extension, it is entirely possible that young children have lots of beliefs and desires though they have no theory of mind at all and are entirely incapable of conceptualizing mental states Nichols and Stich (2000, p. 138). Both Nichols and Stich (2000) and Perner (1991) view pretence as a distinguishing between the real world and hypothetical world whereas, Leslie (1987) added the acquisition of a pretence concept by the pretender as a dimension. Nichols and Stich (2000), however, disagreed with Perner (1991) Multiple Models theory ('Reality' model and 'As-if' Model), to suggest that pretending draws upon a single code for interpreting pretence representations and its representational content (beliefs) by a process of updating.

Conclusion. The commonalities observed across all the mechanistic theories of pretence suggest that; (a) knowledge of the world from observations or real experiences are foundational to pretence; (b) children use their imagination to recreate realities in similar ways or new and original ways to their understanding of reality; and (c) children can transition between their knowledge of their real world and their recreated versions without getting confused or getting them mixed up. The difference across the theories are in the descriptions of the cognitive architecture that facilitate these processes. Some points of contention include: (a) When does a child have a representational understanding of pretence? (b) How is a child able to prevent their imaginative pretence ideas from interfering with their concept of the world? – Leslie (1987) suggests a method of 'decoupling', Perner (1991) updated 'codes', and Nichols and Stich (2000) 'Other World Box'; and (c) When do children begin to understand pretence in others?

This present study is explicitly interested in unpacking the cognitive mechanisms of pretence in relation to counterfactual reasoning. For pretence, Leslie's (1987) 'Theory of Mind Mechanism' account is seminal in the field. Its principles of decoupling and quarantine are foundational to explaining the cognitive mechanisms of pretence today and have become the tenet of subsequent theories including that of Nichols and Stich 'Possible World Box and Perner's 'Multiple Model of Pretence'. For this study, I primarily adopted Leslie's metarepresentational theory because according to this theory, from the onset of the appearance of pretence in development, children have a 'mental concept' of pretence; hence, pretence can be construed as a mental representation. In contrast, the other two theories begin from the premise that pretence begins from a non-representational behaviour model which is sometimes referred to as 'behaving as if' before being construed as representational (Friedman & Leslie, 2007; Friedman et al., 2010). This would imply that in the early stages of its appearance, pretence could be not be classified as a mental state and would be independent from other mental state capacities relating to thinking, believing or remembering. The next obvious question would then be 'when do children come to represent pretence as representational?' - which is not the focus of this study. As discussed in the introduction, this study aims to address the suggestion that pretence and counterfactual reasoning are related constructs sharing similar representational qualities. Leslie's theoretical account of pretence is therefore more aligned with the premise of this investigation, that is, both pretence and counterfactual reasoning are representational constructs.

2.2.3 Development Trajectory of Pretence

In this section, developmental markers of pretence are discussed with reference to the discussion on the defining features of pretence in section 2.2.1. Acknowledgement is given to the fact that pretence is a component of a broader capacity for imagination or fantasy. In addition, there is a brief discussion on what those developmental milestones might mean for child-development in general.

The first indication of an imaginative capacity in humans is observed from when children begin engaging in pretend play (Woolley, 2002). The general consensus is that pretence emerges from eighteen to twenty-four months, becomes consolidated into the child's play repertoire by their third year of development, by the fourth year children's pretence capacities evolve into the creation of elaborate fantasies that involve imaginary characters and animals, and it atrophies by middle childhood although people continue to have an appreciation for the imaginary as adults (Nielsen & Dissanayake, 2000; Smith, 2009; Woolley, 2002). Between the ages of three to five, children begin to make clear reality and non-reality distinctions of pretence and understand that in comparison to knowledge, imagination reflects reality less accurately (Woolley, 2002). This is supported by the observation that children as young as three years are aware of different properties that distinguish mental entities from real physical objects. For example, a child imagining a pair of scissors and thinking about making them open and close does not mean that this same process will make real scissors open and close (Woolley, 2002). According to Woolley (2002) imagining and pretending are similar in that both involve: maintaining a conscious awareness of the real world, engaging in a mental event, and deliberate, planning, constructing, and controlled processing. The difference between the two is that imagination is non-propositional whilst one must always pretend that one thing is something else. For example, one can imagine owning a new car but that is different from imagining that their new car is a 'batman mobile'. There is a general expectation that when children engage in pretend play they have the knowledge that: pretence is fictional, someone can pretend to do things that they in actual fact cannot, pretending something does not make it really happen, and something pretended can be different from what really exists (Woolley, 2002).

Although the disposition for pretend play emerges before the second year of life, peaks during the late preschool years, and declines during the primary school years; an ability to consistently recognize when another person is pretending is sustained after the age of two (Smith,

Englander, Lillard, & Morris, 2013). However, recognizing when another person is pretending is qualitatively different from acquiring a representational understanding of pretence or an understanding of pretence as a mental state. The evidence suggests that during the early years of development, young children's representational understanding of pretence is fragile (Amsel & Smalley, 2000). Lillard (2002) argued that although children appreciate that pretence situations are framed separately from reality, most young children do not generally appreciate that those frames emanate from minds, or that pretence require a mental representation of a pretence scenario. An assessment by Lillard (1993), resulted in the conclusion that children do not understand that pretending requires mental representation. They used several scenarios, for example; children were shown a doll named George and told that he knows what a bird is, he is pretending to be a bird, and then George was made to move around with his feet on the ground and his hands outstretched. In contrast, they were shown a troll-doll named Moe and told that Moe doesn't know what a bird is, has never seen a bird, has never heard of one. Moe was then made to move in the same manner as George. Afterwards, children were asked: "Moe doesn't know what a bird is, does he?" and "Is he pretending he is a bird". Majority of children responded that Moe was pretending leading Lillard (1993) to conclude that children did not understand mental representations in pretence although they succeeded on false belief tasks which were indicative of understanding mental representations of belief. Lillard (1993) repeated several similar experiments and concluded from the experiments that children's ability to understand pretence in others appeared to be very limited before elementary school. According to (Lillard, 1993a) children's earliest understanding of pretence is as 'acting-as-if' because they do not appreciate the role of mental representations in pretence. It is not until from about the age of six that Lillard (1993) ascribes to children the understanding that when people are pretending, they are mentally representing.

Woolley (2002) critiqued Lillard's (1993) claim that children entirely lack an understanding or pretence as a mental state on the basis that the action component of the characters' pretence from the scenarios used may have been more accessible to the children than the mental state component. Woolley (2002) reported setting out studies to address the perceived limitations from (Angeline S. Lillard, 1993) by using scenarios to equate the salience of action and mental state by using drawings of characters instead of dolls and depicting characters thoughts in speech bubbles. In a one-animal task, children were shown a character said to be from another planet, a Gleep, with a bunny rabbit depicted next to the Gleep. The Gleep was described to be hopping like a bunny rabbit hops but does not know what a bunny rabbit is as he is from another

planet. Children were then they asked “So, what’s Gleep doing, is he pretending to be a bunny rabbit, or is he just hopping?”. The children were also shown a comparable two-animal task - this time accompanying the Gleep was a creature called a Mins which resided on the same planet as the Gleep. Children were told that the Gleep was wriggling his nose like Mins and bunny rabbits wriggle their nose but the Gleep knew what a Mins was but did not know what a bunny rabbit was. The test question asked, “What would you say Gleep is pretending to be, a Min or a bunny rabbit?”. The results showed that for the one-animal task only four to five years performed significantly above chance but for the two-animals task all children, three, four, and five-year olds, performed above chance. Woolley (2002) suggested that the results revealed that children actually have a high level of understanding of the mental component of pretence and that the lack of alternatives in the task by Lillard (1993) is responsible for children’s poor performance.

The contrasting findings by Woolley (2002) and Lillard (1993) indicated that, on one hand, there is the perception that children struggle to understand that pretence involves mental representation. On the hand, the argument is made that children can actually understand mental representations in pretence if the tasks are simplified such that the linguistic demands are minimized and the salience of actions and mental state actions are balanced. Sobel and Lillard, (2001) also showed that when the pretence involves fantasy characters children’s understanding of the mind may be more advanced. One of way of looking at it, is that it may be that children’s understanding of the mind is less stable than adults and this variable characteristic may actually be reflecting different levels of understanding such that different studies may be tapping into different aspects of the phenomenon (Woolley, 2002). Notwithstanding, the general conclusion is that children’s ability to recognize and take part in pretence is independent of (and precedes) their capacity to represent mental states in pretence (Smith, 2002).

Another key question about pretence posed by child development researchers is the question of its contribution to individual child development. Three models for explaining the likely role of pretend play posited by Smith (2002) are detailed below (see Figure 2.4):

(a) Pretend play may be a by-product of other aspect(s) of development, with no important developmental consequence(s) of its own (Figure 2.4a).

(b) Pretend play is a facilitator of developmental consequence(s); it can help bring about important developmental consequence(s) but it is not essential for this if other expected developmental pathways are present (Figure 2.4b).

(c) Pretend play is necessary for important developmental consequence(s); in the absence of pretend play, these developmental consequences will not happen or will at least be significantly held back (Figure 2.4c).

Smith (2002) posited that evolutionary influences might have led shifts from one model to another but generally favours model 2.4b. In their review of evidence to substantiate the role of pretend play in child development Lillard, Hopkins, Dore, and Smith (2013) purported that the current state of empirical evidence favour models 2.4a and 2.4b but further and better research is required for clarifying its role.

Illustration of Smith (2002) 'Three Models of the Role of Pretend Play in Development' removed for copyright reasons. Copy right holder is Cambridge University Press

Figure 2.4 Three Models of the Role of Pretend Play in Development (from Smith, 2002)

Some predictions have been proposed about the possible role of pretend play based on the observation that the simultaneous naturally occurring observation that overt pretend play begins to decline just when children seem to begin to acquire an understanding of the mental representational qualities of pretence. A suggestion put forward by Lillard (2001) is that when children come to appreciate mental representations in pretence; they eventually apply their understanding of mental representations outside of pretence domains. Drawing from the results from numerous experiments that concluded that children's meta-representational understanding of pretence is acquired sometime after the emergent ability to engage in pretend play; Lillard (2001) proposed the 'Twin Earth Model' of pretence (see Figure 2.4) which distinguished pretence as pretend play from pretence as metarepresentational to suggest that the coinciding of a representational understanding of pretence with success on false belief tasks imply that the role of pretend play in development is to facilitate over time children's theory of mind understanding. Theory of mind is a mental state concept which involves appreciating the distinction between the mind and the world and one of the ways it is determined is by assessing a child's understanding that a person can have a false-belief - a belief which contradicts reality (Wellman et al., 2001).

Illustration of Lillard (2001) 'Twin Earth Model of Pretence Theory of Mind Relations' removed for copyright reasons. Copyright holder is Elsevier.

Figure 2.5 Twin Earth Model of Pretence Theory of Mind Relations (from Lillard, 2001)

Another similar association with pretence has been observed with counterfactual reasoning. Counterfactual reasoning is just as intricately linked to theory of mind because thinking about events that contrast with reality is central to false belief tasks. For this reason, Riggs & Peterson (2000) have argued that the false belief tasks actually tap into counterfactual reasoning skills not belief, and children's poor performance on the task is indicative of them being poor counterfactual reasoners. Success at mature counterfactual reasoning also coincides with children's acquisition of a representational understanding of pretence. Additionally, the unifying theory of pretence and counterfactual reasoning investigated in this present study argued that early years may very well function as an opportunity to practice the cognitive skills associated with counterfactual reasoning (Walker & Gopnik, 2013b, 2013a; Weisberg & Gopnik, 2013). The nature of this relationship is explored further in this thesis.

Conclusion. This section delineated the developmental markers of pretence by drawing on empirical evidence from the literature. It appears that pretence milestones culminate in an understanding of pretence as a mental concept. The sudden decline in overt pretence by middle childhood has raised queries about the role of pretence in child development.

2.2.4 Measuring Pretence

This present study focuses on the cognitive representation of pretence but without some manifestation or report of pretending it is impossible for cognitive researchers to say anything about pretence. In early-years studies, which is the focus of this thesis, children's engagement in pretend play provides a reliable index of a child's cognitive capacity for pretence. Part of the difficulty with gathering evidence on the quality of child pretence comes from limited rigorous, standardised measures of pretend play. Also, there is a limited consensus on the multiple components of pretence, how such multiple components could be measured in tandem for a comprehensive picture of a child's pretend abilities, and how these components aid in understanding the developmental progression of pretend play itself across different studies (Thompson & Goldstein, 2019). Most pretence investigations use observational methods, studying children in simulated pretend play settings, and assessing the frequency with which children exhibit specific pretend play behaviours within the wider frame of play(fullness).

For instance, the Affect in Play-scale is used to assess both affective and cognitive play processes (Fehr & Russ, 2014). In this assessment cognitive processes refer to pretend play skills of: *imagination* which assess fantasy; *elaboration* which assesses the amount of variety and complexity in story themes, toys used, character development; *organization* which assesses the coherence of the play narrative, and *comfort* in play which assesses the child's ability to engage in the play task. Alternately, the Test of Pretend Play focuses explicitly on object substitution in symbolic play by assessing substituting one object for another, making reference to an absent object as if it was present, and attributing an imaginary property to an object (Clift, Stagnitti, & DeMello, 1998). Seldom are all the components of pretence measured together in one study (Thompson & Goldstein, 2019) and there has been little emphasis on targeting primarily only the cognitive components of pretence.

A concern for measuring pretend play is the degree to which the assessment context reflects children's naturalistic play contexts. Pretend play assessments may take the form of lab-based, task-based or naturalistic methods. A question raised is whether the context for assessing pretend play would matter if a common cognitive construct is being and measured. Would it be that only a pretence mental state is needed then regardless of the pretend play behaviours in which children are engaged (Thompson & Goldstein, 2019)? Having clearly defined measures of pretence is necessary for drawing robust inferences about the cognitive characteristics of pretence and would go a long way towards generating replicable studies explaining the links pretence has with other cognitive constructs; as well as its role in child development more generally.

2.3.0 Counterfactual Reasoning

The model governing pretence has been referred to as hypothetical because it is more often than not a counterfactual reasoning situation, that may not be and probably never was real (Perner, 1991). The idea that during pretence leads to the creation of hypothetical worlds is the basis for suggesting that pretence bears resemblance to counterfactual reasoning, and by the same token, that they each utilize similar cognitive processes. Counterfactual thoughts refer to mental representations that are explicitly contrary to facts or beliefs (Roese & Morrison, 2009). The paradox is that while pretence is attributed to children very early in their development and even in the absence of a stable understanding of the representational capacity of the mind, counterfactual reasoning is generally viewed as a more sophisticated form of reasoning. As a result, the similarities between pretence and counterfactual reasoning have led researchers to inquire whether pretence is a training ground for developing more sophisticated, higher order reasoning skills like counterfactual reasoning (Lillard, 1993; Weisberg & Gopnik, 2013).

Counterfactual reasoning has been linked to a range of complex human behaviours, making it an area that is widely researched. For instance, in social psychology counterfactual reasoning has been linked to the study of emotions like regret and remorse; in clinical psychology it has been linked to pathological processes of depression, social anxiety, and schizophrenia; and in cognitive psychology the role of counterfactual in understanding causality has been explored (Harris et al., 1996; Rafetseder & Perner, 2014). This section of the review presents the defining features of counterfactual reasoning with a focus on child counterfactual reasoning, the cognitive mechanisms involved, its developmental trajectory, and how it is measured.

2.3.1 Defining Features of Counterfactual Reasoning

The process of reflecting on how the world might have been under different circumstances rather than how it is immediately presented to us is a powerful feature of human thinking known as counterfactual reasoning (Riggs & Peterson, 2000). Counterfactuals are diverse and can range from imagined alternatives that entertain and amuse as in that found in fantasy, fiction, literature, film and theatre to imagined alternatives that support logical, mathematical and scientific reasoning (Byrne, 2016). In everyday life, counterfactuals are spontaneously generated and generally serve four broad functions; (1) to explain the past, (2) prepare for the future, (3) modulate emotional experiences and (4) support moral judgments (Byrne, 2016).

The defining features of a counterfactual thought have been summarised by Roese & Morrison, (2009) as follows:

1. Counterfactuals are usually grounded in some aspect of reality with the counterfactual itself being a juxtaposition against this reality
2. Counterfactuals are typically triggered by negative or unusual events from which a resultant counterfactual concentrate on how the event might have been different
3. A counterfactual is generated from a conditional statement or premise comprising of:
    - an antecedent, an action or decision by an individual e.g. If only Bob had kept his eyes on the road, and
    - a consequent, a state of being often framed in evaluative terms e.g. he would have avoided the accident.
4. The counterfactual itself may be
    - An upward counterfactual, an alternative outcome that is better than the actuality e.g. If only Bob had kept his eyes on the road, he would have avoided the accident.
    - A downward counterfactual, an alternative outcome that is worse than actuality e.g. If Bob had not acted quickly, more people could have been injured
    - Additive whereby a behaviour or event is added to the situation e.g. If only Mary had accompanied Bob, he would not have fallen asleep and he would have avoided the accident.
    - Subtractive whereby some event or behaviour is removed e.g. If only Bob had not gone to the party, he would have avoided the accident

2.3.2 Cognitive Mechanisms of Counterfactual Reasoning

According to Byrne (2016) the underlying mechanisms of counterfactual reasoning maintain and update two representations, the imagined alternative and the known or presupposed reality. Byrne (2016) proposes that an algorithm to specify the mental representations and cognitive processes that create counterfactuals would involve the following:

- take as input the relevant facts of actual events (grounded in reality)
- produce as output a counterfactual alternative (an alternative to reality)
- intervening processes would change aspects of the mental representation of the facts to create a second mental representation, the counterfactual alternative
- A goal to produce counterfactuals that are plausible, that is reasonable, believable and acceptable. This makes the counterfactual thought dynamic as it can be challenged and changed by the discovery of further information or by others with different opinions

Byrne (2016) further posits that generally people imagine similar sorts of counterfactuals and the decisions they make to change mental representations of the facts of an event are influenced by following factors:

1. **Exceptionality effect:** the tendency to imagine an alternative by changing exceptional events to be normal

2. **Controllability effect:** the tendency to imagine an alternative by changing a controllable event rather than an uncontrollable one

3. **Action effect:** the tendency to imagine an alternative by changing an action rather than an inaction

4. **Temporal order effect:** the tendency to imagine an alternative by changing the most recent event rather than earlier events.

These factors are invoked under different circumstances and depend on the function of the counterfactual thought being generated. In child studies using counterfactual reasoning scenarios, the action effect tends to be most prevalent because the scenarios are usually centered around physical actions in the child's environment that they are likely to be familiar with.

2.3.3 Developmental Trajectory of Counterfactual Reasoning

If we are to understand fully the cognitive processes that underpin the acquisition and use of counterfactual thoughts by children and adults then knowing how counterfactual thoughts develop and when children begin to reasoning counterfactually is critical (Beck & Riggs, 2014). From all accounts, it appears that counterfactual reasoning emerges in early childhood and becomes an essential skill in adult life. Extensive research has inquired whether young children can engage in adult-like counterfactual reasoning and at what age does this ability emerge. As a result, several fundamental cognitive developmental milestones believed to evidence counterfactual reasoning have been observed in children.

An understanding of 'almost' is one of the earliest developmental markers of counterfactual reasoning. A study by Harris (1995) reported in Robinson and Beck (2000) showing two and three-year olds scenes of two horses galloping across a table, one stopping well before the edge, but the other stopping short of it. Most children were able to identify correctly which horse 'almost' or 'nearly' fell off the table before their third birthday (Harris, 2000). The finding from this investigation indicated that children are able to describe what actually happened in relation to what might have happened, (Harris, 2000). Therefore, when alternate outcomes are not shown directly to young children; they show an understanding that observed outcomes (actualities) might have turned out differently (Harris, 2000). This indicates that young children have an awareness of the outcome of a sequence of events as well as alternate outcomes from a sequence of events.

Asking children to generate likely outcomes for alternative antecedents is presumably a more taxing task. Children must set aside the actual antecedent plus the outcome observed, to imagine the antecedent being replaced by a different antecedent and to predict new outcomes for the new antecedent (Harris, 2000). Some researchers propose that by age three and four children are able to interpret both positive and negative outcomes to counterfactuals. One such scenario dramatized for children involved a tower of bricks which naughty Teddy comes along and hits with a stick (Harris, German & Mills, 1996). Follow up questions first check children's recall of the scenario for example, 'Are the bricks standing up now?' and 'Were the bricks standing up before?'; followed by counterfactual questions; 'If Teddy hadn't hit the bricks with his stick, would they be standing up now?', and 'If Teddy had hit the bricks with his hand instead, would they be standing up now?'. Children were able to identify alternative

antecedents that lead to different outcomes and antecedents that lead to the same outcome (Harris, German & Mills, 1996).

Additional questions posed about children's development of counterfactual reasoning asked whether children recognized that different causal factors play a role depending on the counterfactual antecedent brought to mind and can they go beyond the structure of experimental stories to generate counterfactual possibilities for themselves. To answer this question, Harris, German, and Mills (1996) presented three and four-year olds an experimental and control version of the following story;

> Experiment: 'One day, Sally wanted to do a drawing. Her Mum said she could draw with a pencil or with a black pen. Sally said she didn't want to draw with a pencil, she wanted to draw with a black pen. Guess what! When Sally was drawing with the black pen, she touched her drawing, and her fingers all inky'.
>
> Control: Sally wants to do a drawing. Her Mum said she could draw with a blue pen or a black pen. Sally said she didn't want to draw with a blue pen, she wanted to draw with a black pen. Guess what! When Sally was drawing with the black pen, she touched her drawing, and made her fingers all inky.

These two questions were posed to the children, "why did Sally's fingers get all inky?", and "what should Sally have done instead so that her fingers wouldn't get inky?". The children's responses to both versions of the story referenced alternative antecedents, the pencil and blue pen, but the children responding to the control version did so less than the children responding to the experimental version. The children listening to the control stories imagined for themselves alternatives not mentioned in the story that might have led to a different outcome for Sally (that is not getting her hands inky). This experiment showed that children do recognize that different antecedents influence the process of selecting a causal factor and that by the age of four children can generate counterfactual possibilities outside of those presented in experimental scenarios. This finding was supported Guajardo and Turley-Ames (2004) who found that four and five-year olds were better than three year olds at spontaneously generating multiple counterfactual possibilities for set counterfactual antecedents.

One observation is that before the age of three children tend to make 'reality errors' by using what was actually stated in the story to answer the counterfactual question otherwise referred to as reasoning with the current state of affairs (Rafetseder et al., 2010; Rafetseder & Perner, 2010; Robinson & Beck, 2000). Children, however, tend to overcome the predilection for

realist errors between the ages of three and five (Rafetseder, Cristi-Vargas & Perner, 2010). Additionally, students' success on counterfactual tasks are frequently held up to scrutiny by counterfactual reasoning researchers resulting in conclusions drawn from seminal studies being critiqued. For example, Beck and Guthrie (2011) posited that Harris's (1997) suggestion that children can reason about 'almost' from about the age of two is a false positive because in their studies three to four year olds identified a character who 'almost' completed an action when the comparison character also did not complete the action but children performed poorly when the comparison character completed the action. At age five to six children consistently passed the tasks indicating they made appropriate counterfactual interpretations of 'almost' leading to the conclusion that understanding almost was more challenging than standard counterfactuals (Beck & Guthrie, 2011).

Standard counterfactuals have also come under scrutiny. The suggestion is that children's success may be attributed to basic conditional reasoning, that is, where real world plausible answers are the default response as opposed to mature counterfactual reasoning where the details of the counterfactual premise is integrated into the counterfactual response to arrive at the correct answer. Distinguishing between basic conditional reasoning and mature counterfactual reasoning on standard counterfactual tasks is difficult for researchers because both yield correct answers. To understand children's preferred reasoning strategy standard counterfactual tasks have been revised by designing stories in which counterfactual reasoning results in different answers from basic conditional reasoning. For example, Rafetseder, Cristi-Vargas, and Perner (2010) designed a sweet story involving a mother who regularly puts sweets on either a top shelf or a bottom shelf and either a tall boy or short girl comes looking for the sweets to take them into their room. For different locations of the sweets (top and bottom shelf) the counterfactual question asked is, "what if not the tall boy but the short girl had come looking for the sweets, where would the sweets be (and vice versa)?". Basic conditional reasoning could be distinguished from counterfactual reasoning by comparing when both characters have an equal chance of getting the sweets to when only one character could take the sweet so a default answer would yield an incorrect response (when the sweet is on the top shelf). Children were less likely to provide correct answers in situations where basic conditional reasoning yielded the wrong response. The conclusion was that children were most likely to give correct counterfactual responses around the age of six (Rafetseder et al., 2010). Similar findings were replicated in different studies by Rafetseder and Perner (2010, 2012), and Rafetseder, Schwitalla, & Perner (2013).

Other study designs have varied counterfactual scenarios by using physical causal tasks to determine if children were more likely to integrate the contents of counterfactual premises into their counterfactual responses using different paradigms. For instance, McCormack, Ho, Gribben, O'Connor, and Hoerl (2018) used the paradigm of doubly-determined outcomes which compared scenarios where an outcome would still have occurred even in the absence of its actual cause to singly-determined outcomes where only one possible outcome could occur using a novel causal structure. The structure used by McCormack, et al. (2018) comprised two runways of unequal length and two distinct heavy metal discs (one with a picture of red bird and one with a picture of a yellow bird) used to roll down the two runways and knock over an object (a green pig) located in the centre of the runway. Both objects had an equal chance of knocking over the green pig but the object on the shorter side would always have the advantage of knocking down the green pig first. Children were shown doubly-determined trials where both discs rolled down the runway all the way to the bottom and singly-determined trials where only one of the discs rolled all the way to the bottom because a peg was used to stop the descent of the other disc. The counterfactual question involved undoing the descent of one of the metal discs. This task aimed to reduce the complexities of tasks aimed at differentiating basic conditional reasoning from counterfactual reasoning like those used by Rafetseder, Cristi-Vargas, and Perner (2010), Rafetseder and Perner (2010, 2012), and Rafetseder, Schwitalla, & Perner (2013). The perception was that using a novel causal, physical structure would remove the bias of familiarity with real world contexts which generally underpin the inclination to apply basic conditional reasoning to counterfactual questions and allow children to focus expressly on the counterfactual premise presented to them. However, the conclusion was that four to five year olds performed below chance, six to seven year olds were above chance, and eight to nine year olds were at ceiling (McCormack et al., 2018). These findings were replicated by Nyhout, Henke, and Ganea (2019) using modified versions of Rafetseder, Schwitalla, and Perner (2013) social-causal task involving the characters Susie and Max walking into the room with their muddy boots. The results were consistent with McCormack, et al. (2018) finding that children could reason in doubly-determined events, otherwise termed as causally overdetermined events in this study, between the ages of six and eight years.

Notwithstanding, the ability of four to five year olds to engage in counterfactual reasoning still has scope for exploration due to the suggestion that children's lack of success at applying counterfactual reasoning stems from issues of task complexity and tasks may have underestimated children's performance (Beck & Riggs, 2014). Nyhout and Ganea (2019)

reopened the discussion in their study which reported that given a clear and novel causal structure four to five-year olds can reason about causally-over determined events and display adult-like counterfactual reasoning. Causally-over determined scenarios being the same as a doubly-determined scenarios – children are essentially presented with two antecedent actions where both will result in the same causal outcomes. The researchers use a physical-causal paradigm and ague that tasks like those used in Rafetseder, Schwitalla, and Perner (2013) may have mischaracterized the causal structure of the events children were representing. In their study, the researchers used a blicket-detector machine which is a box with four light bulbs and four blocks that are causally linked to the bulbs being lighted. Four differently coloured blocks were placed in front of the box, two of the blocks cause all the light bulbs to be switched on and two of the blocks caused nothing to happen – none of the light bulbs get switched on. Children were shown over-determined and single-determined trials and four to five year olds answered all the different types of counterfactual questions with a high degree of accuracy which led the researchers to conclude that children could over-ride prepotent basic conditional reasoning in favour of counterfactual reasoning (Nyhout & Ganea, 2019).

Conclusion. The evidence shows that although children are generally able to reason from false premises, in recent times research has focused on when children can use adult-like or mature counterfactual reasoning. The benchmark for successful mature counterfactual reasoning is to hold in mind and contrast two worlds – the real and possible world and integrate the contents of the counterfactual premise into the possible world to arrive at the correct answer to the counterfactual question posed. Merely showing that children are able to reason with premises that are known to be false has been criticised on the basis that children's success can be equally attributed to basic conditional reasoning that is where real world plausible answers result in the same answer as the counterfactual response (Beck & Riggs, 2014; Rafetseder et al., 2010; Rafetseder & Perner, 2010). In such contexts, it becomes hard to distinguish whether children have actually taken into account the counterfactual premise or simply relied on a plausible answer. For children to reason counterfactually, they must appreciate that at a specific point in the past two possible worlds diverged because of a single causal event. Hence, one possible world is understanding the causal relation between a specific past event and its subsequent outcome, and the other possible world is understanding that had that specific past event been different, another outcome would have ensued (the counterfactual) (Beck & Riggs, 2014). This is also referred to as the application of the nearest possible world constraint. Rafetseder, Schwitalla, and Perner (2013) aptly describes it as one assuming that the counterfactual world

is exactly like the real world except for the facts that are incompatible with the false premise and changing only the facts that depend causally on the counterfactual premise. According to Beck and Riggs (2014), it is relating these two possible worlds that children find challenging.

2.3.4 Levels of Counterfactual Thinking

The contrasts in studies from the counterfactual reasoning literature make it clear that mature counterfactual reasoning is a complex higher order thinking skill with multi-tiered layers of development. In response to the complexities of counterfactual reasoning, Beck, Riggs, and Burns (2011) argue that there is not one critical development that should be thought of as marking children's ability to engage in counterfactual reasoning, but rather a sequence of (at least) four developments or types of thinking taking place from early to middle childhood which include: generating alternative worlds, representing falsity as if it were true, representing multiple possibilities, and comparing multiple possibilities. Beck, Riggs, and Burns (2011) describes these types of thinking in the following way:

1. *Generating alternative worlds*. According to Beck, Riggs, and Burns (2011) children can think about future hypotheticals by ignoring the current state of affairs and imagining an alternative. The researchers refer to the example from Riggs, Peterson, Robinson, and Mitchell (1998) which involved a sorting game where pieces of paper with pictures on them were sorted into one tray and blank papers went into another tray. Three and four year old children were asked counterfactual questions after a picture had been drawn on a piece of paper and it had been sorted, 'If I had not drawn on the piece of paper, which box would it be in?' and they were asked future hypothetical questions before a picture had been drawn, 'If I draw on this piece of paper, which box will it go into?' In both cases the child has to ignore the current state of affairs (whether or not the paper has a picture on it) and imagine an alternative. Three and four-year-old children found it much easier to answer the future hypothetical question than the counterfactual. The onset of pretend play precedes when we know that children can entertain future hypotheticals and is the earliest sign of an ability to entertain alternative, non-real worlds or of an imaginative capacity in general.

2. *Representing falsity as if it were true*. Beck, Riggs, and Burns (2011) explain that the difference between thinking about a counterfactual event and a future hypothetical

event is that the counterfactual event imagined is known to be false. In a counterfactual condition the child thinks about something that contradicts what they know to be true but in the future hypotheticals the child does not know the true state of affairs. We know that children start to answer explicit counterfactual conditional questions correctly at around three to four years of age. Children start to make reference to counterfactual worlds in their spontaneous speech at about the same time and begin describing 'what if' something had happened (Kuczaj & Daly, 1979). Beck, Riggs, and Burns (2011) refer to the experiments by Riggs, Peterson, Robinson, and Mitchell (1998) and Guajardo and Turley-Ames (2004). For example, in Riggs, et al.'s (1998) paper, in one of their stories, Peter is at home in bed when he receives a phone call asking him to go help put out a fire at the Post Office. Once he is there the counterfactual conditional question is, 'If there had been no fire, where would Peter be?' Riggs et al. found substantial improvements between three and four years on these types of tasks. Children stopped giving realist answers, that Peter would be in the Post Office, and instead began to give counterfactual answers, that he would still be in bed. Children are also successful at generating new alternatives for example, Guajardo and Turley-Ames (2004) found similar developments occurred between the ages of three and five as children in their study were able to answer consequent counterfactual conditional questions, such as the one above about Peter and the fire, which require generating multiple counterfactual antecedents. For example, if a character walks through mud, comes in to the house, and makes the floor dirty it is possible to imagine many different answers to the question "What could you have done so the kitchen floor would not have gotten dirty?" such as not walking through the mud, taking the boots off, wiping her feet. Most studies find that children's performance on these types of questions improved between three and five years. Pretence is also a case of 'what is being imagined is known to be false' in that a false representation is knowingly imposed on a real-world object by pretending that an object is something else.

3. *Representing multiple possibilities.* Beyond, children being able to answer explicit questions about counterfactual worlds prompted both by counterfactual antecedents (Riggs et al., 1998) and counterfactual consequents (Guajardo & Turley-Ames, 2004); there is good evidence that at least two further developments occur. According to their reasoning, Beck, Riggs, and Burns (2011) argue that there is no evidence that four year-olds who answer counterfactual conditionals such as those used by Riggs et. al. (1998)

are thinking about two possibilities in the manner of 'dual possibilities' that is, hold in mind both the counterfactual possibility and the actual possibility as described by Byrne (2016). A similar proposal is presented by Rafetseder and Perner (2010) who argue that four-year olds who answer counterfactual conditionals correctly may only be using hypothetical reasoning and unlike adults, may not be constraining their thinking based on the real world. For example, in a game used by Beck, Robinson, Carrol, and Apperly (2006) children saw a toy mouse run down a slide that split in two halfway down. Once the mouse was at the bottom of the slide children were asked the counterfactual questions, either 'What if he had gone the other way, where would he be?' (standard counterfactual conditional) or 'Could he have gone anywhere else?' (the new open counterfactual). On undetermined trials the mouse waited at the top of the slide and children were asked to put out mats to ensure that he was caught at the bottom. The correct cautious response was to put out two mats, implicitly acknowledging that the mouse could go either way. The common incorrect response was to place only one mat. Children found the counterfactual conditional questions significantly easier to answer than the open counterfactuals. What's more, they found it relatively difficult to use two mats to cover the two possible outcomes in the undetermined trials. For both younger (three and four-year-olds) and older (five and six-year olds), performance on open counterfactuals and undetermined trials were not different to each other, but both were significantly worse than performance on the standard trials. The results imply that in standard counterfactual conditions children's reasoning may not incorporate actively holding in mind as possibilities what happened and what could have happened (Beck, Riggs, et al., 2011). Dual possibilities can be looked at as a constraint which forms part of the counterfactual scenario which dictates the parameters of the likely possibilities within a given counterfactual. Pretence may observe similar constraints, especially, in social contexts where the pretender applies rules to set boundaries for the imaginative adventure which may involve some negotiation among the agents participating in the play. The difference is that within a specified counterfactual reasoning context the boundaries are more often fixed (given there are correct and incorrect responses) that are not tenable for negotiation. In solitary pretence, when the premise of the pretence is not shared there is an impression that the imaginary possibilities are unconstrained.

4. *Comparing multiple possibilities.* These refer to not only holding multiple possibilities in mind, but also making a comparison between reality and what could have happened

(Beck, Riggs, et al., 2011). An example used by Beck, Riggs, and Burns (2011) presents a scenario of given a choice between two envelopes and the one chosen contains ten pounds then you will be pleased. However, it is likely the choice would be re-evaluated upon learning that the unchosen envelope contained one hundred pounds. Beck, Riggs, and Burns (2011) suggest that this comparison between the actual and counterfactual world suggests that understanding counterfactual emotions may more cognitively demanding that thinking about counterfactuals as possibilities. In one study, Weisberg and Beck (2010) used a task in which children chose between one of two boxes and won a number of stickers. They found that children as young as five showed some evidence of regret, but relief was not seen until the age of seven. When children watched another person play the game; they did not attribute counterfactual emotions.

Additionally, alongside counterfactual emotion tasks, reasoning from holding multiple possibilities as alternatives to the real-world in other contexts is generally challenging. An example is from Rafetseder, Crisit-Vargas, and Perner (2010) sweet-story task explained in the section 2.3.3 on developmental trajectory of counterfactual reasoning on page 47. Children must keep in mind the real world – where mother places the sweets, and compare the real world to multiple possibilities in the counterfactual world – if the sweets are on the top shelf the little girl cannot reach the sweet so it remains on the top shelf as she cannot take it to her room, if the sweets are on the bottom shelf the little girl can reach the sweet and can therefore take it to her room, or if the tall boy came first he would be able to reach the sweets irrespective of their location so he could carry the sweets to his room, hence the little girl would not be able to take the sweets to her room. Children struggled with answering correctly in the final condition.

Generally, children are in control of the hypothetical possibilities in their imaginary worlds and they are not usually asked to compare and reason across the multiple possibilities that they generate. According to Amsel & Smalley (2000) children specify the true and pretend identities of objects noncontingently, asymmetrically, and do not necessarily form and retrieve a counterfactual proposition.

Conclusion. From Beck, Riggs, and Burns (2011) account of levels of counterfactual reasoning, children between the ages of three to five are generally able to ‘generate alternative worlds’ and ‘represent falsity as true’. They begin to show success at ‘representing multiple

possibilities' and 'comparing multiple possibilities' but the results are tenuous at best. The suggestion is that children show mastery on representing and comparing multiple possibilities after the age of six.

From the preceding discussion in this section, it is clear that counterfactual reasoning is a broad construct inferred from specific milestones or levels of counterfactual thinking observed in development. In recent times, researchers like Rafetseder and Perner (2010) contend that these early developmental milestones differ from mature adult-like counterfactual reasoning and question whether they should count as true counterfactual reasoning. This argument makes a valuable contribution to our understanding of the construct of counterfactual reasoning and makes a strong case for thinking carefully about inferences made about counterfactual reasoning throughout (lifespan) development and across different measures used to help us define the construct. Given our understanding of child development and for the purpose of this study which aims to contrast counterfactual reasoning to pretence during the early years of child development; early years milestones or levels of counterfactual reasoning need to be studied in order to allow appropriate comparisons across the two constructs. For these reasons, in this study, I view counterfactual reasoning as a broad construct and whichever levels of counterfactual thinking that are measured (potentially inclusive of basic conditional reasoning and matured counterfactual reasoning) can be conceptualised as dimensions of that construct.

2.3.5 Measuring Counterfactual Reasoning

To elicit counterfactual reasoning in young children, researchers have generally used two types of tasks – social-causal tasks which are heavily narrated and physical-causal tasks which require children to act on objects within a causal sequence paradigm. The narrative element of social-causal tasks are criticised for not being fully transparent leading children to make unwarranted inferences about the events in question (Nyhout & Ganea, 2019). The concern is whether counterfactual tasks using social-causal structures do enough to ensure children's comprehension of the causal structure is correct and sufficient to answer counterfactual questions if children possessed the ability to do so (Nyhout & Ganea, 2019). Similar criticisms have been levied at physical-causal tasks like that of McCormack, Ho, Gribben, O'Connor, and Hoerl (2018) for the learning demands from having to learn a number of rules about how a device functioned on the basis that having to learn too many rules might equally affect children's representation of a causal structure.

Notwithstanding, the short stories use in social-causal tasks may describe events occurring in the physical environment or be about emotions rather than having an environmental component (Guajardo, Parker, & Turley-Ames, 2009). One thing common across these tasks is that counterfactual scenarios present a conflict between the stated premise and the actual state of affairs (Rafetseder et al., 2010). Participants are generally required to respond to a subjunctive question which is usually close-ended for which the likely answer is known or as is typically done with adults an open-ended question to encourage divergent responses. The responses on counterfactual reasoning tasks are assessed by looking at the respondents' ability to produce a counterfactual response. Further evaluation may take into account the structure (upward or downward) and direction (additive or subtractive) of the counterfactual response (Guajardo et al., 2009).

Counterfactual reasoning tasks which were used in early counterfactual reasoning studies are now referred to as tasks of basic conditional reasoning, for example, a scenario where a child is asked "If Carol *were* walking with dirty shoes on the clean floor, *would* the floor be dirty or clean?". Such tasks are referred to as tasks of basic conditional reasoning because it has been found that such counterfactual reasoning questions may be answered using basic conditional reasoning, that is, ignoring the subjunctive premise and simply providing plausible answers. The criticism of tasks of basic conditional reasoning is they demonstrate an ability to entertain counterfactual states but often the tasks do not require the respondent to take into account a

nearest possible world option where the conditional contradicts a corresponding fact, like "if before Carol entered the room with her dirty shoes her brother had already messed up the floor with his dirty shoes, would the floor be dirty or clean?". Basic conditional tasks can be answered correctly without requiring the respondent to keep in mind the real sequence of events when considering alternative possibilities (Rafetseder et al., 2010). The point is in basic conditional reasoning children may arrive at the correct response by relying on what they typically know about the world.

There has also been focus on real-world counterfactual tasks designed to encourage children to integrate the reality of the given scenario into their counterfactual assumptions. Such tasks are pitched to determine whether children apply the levels of counterfactual thinking previously described in section 2.3.4 – dual thinking and holding multiple possibilities in mind. One example is an open counterfactual task which checked whether children could pinpoint when in a given scenario an alternative possibility could have occurred, that is, keep dual possibilities in mind (Beck et al., 2006). The open counterfactual task assesses whether children think about counterfactual and actual events as two separate possibilities, dual possibilities, that could once have happened such that the counterfactual was a possibility that could have replaced an actual event. Open counterfactuals require children to directly compare between the actual and counterfactual outcomes in a given scenario (Beck & Crilly, 2009). According to Beck, Robinson, Carrol, and Apperly (2006) children find standard counterfactual questions easier than the open.

Other counterfactual tasks include nearest possible world tasks which go one step further by checking whether children can answer a counterfactual subjunctive question about a past event correctly when a basic conditional reasoning approach will produce a wrong answer. Nearest possible world tasks are designed to ensure that respondents keep active the real sequence of events that is being counterfactually altered (Rafetseder et al., 2010). These counterfactual tasks are based on the Lewis (1973) nearest possible world constraint argument that in reasoning counterfactually the alternative needs to be maximally similar to the real scenario and stay logically consistent or else everything would follow from the premise (Rafetseder & Perner, 2010). This is a basis of adult-like counterfactual reasoning; hence such tasks are used to assess the extent to which children's early years counterfactual reasoning reflect adult-like counterfactual reasoning. Nearest possible world tasks require the respondent to make only logically or causally necessary changes to the actual event to arrive at the counterfactual

alternative (Rafetseder et al., 2010). The researchers assessed variations of conditional reasoning including whether linking the counterfactual information to actual events is of critical difficulty for children (Perner et al., 2004). Such tasks are a response to the argument that counterfactual tasks should require children to remember or know the contents of the counterfactual scenario to answer a counterfactual question and not rely on their own empirical knowledge of the world. A result is that children younger than six years old find nearest possible world tasks the most difficult. One explanation is that the increased complexity requires greater processing and memory capacity which may exceed that of young children (Case, 1992; Gordon & Olson, 1998 in Perner, Sprung, & Steinkogler, 2004).

2.4.0 Evidencing the Link Between Pretence and Counterfactual Reasoning

In this section, the previous independent descriptions of pretence and counterfactual reasoning will be used to show how the two concepts are related, why they should be studied in tandem and the factors that should be taken into consideration towards this goal. The researcher will illustrate the similarities and differences between pretence and counterfactual reasoning as a way of clarifying the proposal that the two are related cognitive processes. The subsequent comparisons between pretence and counterfactual reasoning are drawn from the preceding discussions of the defining features, cognitive mechanisms, developmental trajectory and assessment approaches of each.

2.4.1 Mental Representations of Reality

At the core of the ability to engage in either pretence or counterfactual reasoning is the basic cognitive capability to generate mental representations of the world. Mental representations are cognitive structures that both represent one's general knowledge about a given concept or stimulus domain and one's memory for specific experiences (Fiske & Taylor, 2013). Pretence involves mental representation of behaviours or actions that are not meant to literally reflect reality (Weisberg, 2015). Counterfactual reasoning is the mental simulation of alternatives to reality (Bacon et al., 2013). According to cognitive psychology information processing theory, all cognitive understandings of the world are a collection of mental representations that we form to depict our interactions with the world. Leslie (1987) explained that the mental representations that underpin our pretence are built through our perceptual processes, and Byrne (2016) proposed that during counterfactual reasoning we take as input the relevant facts of actual events. Both are grounded in reality; hence, mental representations are definitional to both pretence and counterfactual reasoning.

2.4.2 Alternative Representations of Reality

When pretence is observed in its action form, pretend play, it has been called an 'as-if' orientation to actions, objects and verbalization (Smith, 2009). During pretend play an 'as-if' orientation would manifest as actions that are not meant to literally represent reality, for example pretending that a doll is drinking tea. People also represent reality in alternate ways during counterfactual reasoning when they consider inaccessible things by focusing on 'what-ifs and comparing what they know to be true with what might have been for example, a child wondering what they would play with if their doll was taken away (Beck & Riggs, 2014; Riggs

& Peterson, 2000). The 'as-if', imaginative process of pretend play, is thought to be similar to 'what-if' tendencies generated during counterfactual reasoning. It is this similarity that is the crux of postulations that pretence and counterfactual reasoning are similar cognitive processes because during both pretence and counterfactual reasoning an agent conjures up an imaginary or hypothetical version of the world (Perner, 1991).

Grounded in a Premise. As part of this process, both pretence and counterfactual reasoning theorists make clear that the process of generating hypotheticals is preceded by establishing a premise about the world. Nichols and Stich (2000) stressed that all typical joint-pretend play scenarios begin with a premise (or premises) which gets the pretence started and is the basis by which appropriate thoughts and actions are generated. Similarly, a counterfactual thought emanates from a premise, or what is sometimes termed a conditional statement for example, "What if Tom hadn't called his dad, would Tom be happy or sad? (Amsel & Smalley, 2000; Roese & Morrison, 2009). In typical assessments of pretend play and counterfactual reasoning, researchers set up the premise.

In naturalistic settings and for typically developing children, pretend play is a spontaneous enterprise involving; (a) elaborate scripts, (b) themes that change often, and its playful aspect is characterized by; (a) flexibility, (b) positive affect and (c) long-term, intense, intrinsic motivation, and (d) meta-communicative behaviours (Bergen, 2013; Lillard et al., 2013). On this basis, investigations of children's pretend play are criticized for being simulated, and by virtue, are considered inadequate representation of children's natural, spontaneous pretend play interactions. According to Bergen (2013), laboratory simulated pretend play is a far cry from adults' recollection of their memorable pretend play engagements when they were young which; (a) were often private and occurred outside the knowledge and influence of adults, (b) had few restrictions on the materials used (c) had flexibility in theme direction, (d) gave them an intrinsic feeling of player control and motivation. Further criticism levelled includes: (a) adults are highly visible and directive of the pretend play, (b) children are unfamiliar with the researcher and do not feel like pretending, and (c) limited time or objects are made available for pretence (Bergen, 2013).

These are legitimate criticisms but are often practically impossible to overcome using theory driven research paradigms since objective and replicable assessments of pretend play require that researchers set up the pretence premise or play frame. To some extent, some standardised

assessments overcome such criticisms by (a) lessening the role of the researcher, (b) providing reasonable lengths of child initiated pretend play encounters will range from fifteen to thirty minutes, (c) tap into children's motivation by encouraging them to initiate the pretend, (d) use of conventional toys and unstructured play materials to encourage diverse themes in pretence, and (e) offer diverse play materials (Stagnitti, 2007 based on the CHIPPA manual).

On the other hand, counterfactual reasoning researchers agree that children's counterfactual thoughts are by and large different from real world, adult-like counterfactual reasoning because real world counterfactual reasoning skills are advanced cognitive skills used to learn from past mistakes and regulate emotions like regret; skills which are slow to develop during the early years of development. In contrast to pretence, counterfactual reasoning researchers are more focused on interpretations of the processing demands of the task (refer to the discussion on levels of counterfactual reasoning) hence, counterfactual reasoning tasks are highly structured.

Hypothetical or Imaginary Ideas. Premises are the platform from which hypothetical ideas are generated. When children engage in pretence or counterfactual reasoning, they construct non-literal mental representations, that is, imaginary worlds that differ from what holds in reality. Some researchers posit that any alternative to a reality is actually a counterfactual and children in pretend contexts reason counterfactually by virtue of creating a reality that is an alternative to the one known or believed to be true (Amsel & Smalley, 2000; Perner, 1991). In a book chapter entitled, 'Beyond really and truly: Children's counterfactual thinking about pretend and possible worlds', Amsel & Smalley (2000) argued, playing pretend and pondering possibilities (counterfactual reasoning) are close relatives in the reasoning family like siblings who may be different but nonetheless share a common underlying nature. According to Amsel and Smalley (2000) two distinct levels of cognitive processing can explain how children reason counterfactually in pretend contexts:

1. Low-level processing of pretend information – the manner by which information regarding true and false states of affairs is represented and managed.
2. Higher-level understanding of pretence – when or if young children conceive of pretence in terms of thoughts of a pretender.

This classification reiterates that pretence and counterfactual reasoning develop along a continuum of representational ability and representational understanding (refer section 2.2.3 on developmental trajectory of pretence and section 2.3.3 on developmental trajectory of counterfactual reasoning). What's more, Amsel and Smalley (2000) proposal is also quite

similar to Beck, Riggs, and Burns (2011) multiple development of counterfactual reasoning (see Table 2.2). However, the difference between pretence and counterfactual reasoning may lie in that, when children play pretend, false states of affairs are created from true ones as playful alternatives, but when they ponder possibilities (counterfactuals), the false state of affairs are copied and edited versions of true ones which are seriously compared to and contrasted with true ones (Amsel & Smalley, 2000).

Table 2.1 A Comparison of the Levels of Cognitive Processing in Pretence and CFR

Amsel and Smalley (2000) Beyond really and truly: Children's counterfactual thinking about pretend and possible worlds	Beck, Riggs, and Burns (2011) Multiple developments in counterfactual thinking
Low level processing of pretend information	generate alternative worlds
	represent falsity as true
Higher Level understanding of pretence	representing multiple possibilities
	comparing multiple possibilities

Conclusion. Pretence and counterfactual reasoning are comparable cognitive skills. Both are mental state concepts that involve generating alternative representations of reality. To achieve this cognitive feat, an alternative representation is grounded in a real-world premise from which becomes foundational to the imaginary, hypothetical ideas generated. Children's ability to reason between true and false state of affairs develop progressively as they develop. There is also the expectation that other general cognitive abilities like language and domain-general skills like executive functions might influence the progression.

2.3.3 Links with Language

In order to make inferences about children's hypothetical world, cognitive researchers must be able to observe it. In child development research, inferences about a child's capacity for pretence are indexed from their pretend play behaviours which are usually punctuated with a lot of talk and decisions about a child's capacity for counterfactual reasoning is elicited through oral means (sometimes older participants are asked to write out their counterfactual thoughts)[5]. Language also involves mental representation and is critical aspect of child development. Therefore, language is an inherent factor in assessments of pretend play and counterfactual reasoning, and it should be accounted for in statistical analyses of pretence and counterfactual reasoning because differences in children's language ability are found to affect how children perform on measures of pretence and counterfactual reasoning.

Receptive language, the ability to understand or comprehend language heard or read and expressive language, being able to put thoughts into words and sentences, in a way that makes sense and is grammatically accurate, are important to pretence and counterfactual reasoning. In a validation study which assessed children's symbolic ability during pretend play (Test of Pretend Play-TOPP), when age was partial out, the partial correlation between ToPP scores and language scores remained statistically significant $r(56) = 0.36$, $p = 0.003$. (Language scores were derived from the language subtest of the FirstSTEP Miller (1993) which is a screening assessment, used to identify children who may be at risk of developmental delay).

The influence of language on pretence is substantiated by (Lewis et al., 2000) who examined the relationships between functional play, symbolic play, non-verbal ability, and expressive and receptive language in normally developing children aged between one and six years using standardized assessment procedures and found that when effects of chronological age were partialled out, symbolic play remained significantly correlated with both expressive and receptive language, but not with functional play or non-verbal ability; and functional play was only correlated significantly with expressive language. Similarly, Beck et al. (2010) found children with low receptive vocabulary find counterfactual reasoning tasks difficult.

[5] Bauchsbaum et al. (2012) children are engaged in a pretend play manipulation and then asked counterfactual questions; Bacon, Walsh & Martin (2013) asked participants to write a free narrative of their thoughts

2.4.4 Links with Executive Functions

Domain-general Executive Function skills also share strong links with both pretence and counterfactual reasoning. Executive Functions (EFs) are higher order, self-regulatory cognitive processes that aid in the monitoring and control of thought and action by enabling individuals to override more automatic or established responses (Beck, Carroll, Brunsdon, & Gryg, 2011; Garon, Bryson, & Smith, 2008). Executive Functions comprises several cognitive dimensions but the most common skills, identified from confirmatory factor analysis techniques were working memory, inhibition, and cognitive-flexibility. Working Memory (WM) require holding information in mind, updating and manipulating that information; inhibition involves withholding or restraint of a motor response; and cognitive-flexibility involves shifting from one 'mental set' to another (Garon et al., 2008). Research using confirmatory factor analysis found all three executive functions to be consistently, partially independent but still correlated with each other over separate age groups (Beck, Carroll, et al., 2011; Garon et al., 2008).

2.4.5 Overview of Research Involving Pretence, Counterfactual Reasoning, Theory of Mind, Language and Executive Functions

Several researchers have investigated the relationship between pretence or counterfactual reasoning with theory of mind, language, and executive functions. A correlational study by Nielsen and Dissanayake (2000) which aimed to investigate the association between false belief comprehension, the exhibition of pretend play, and the use of mental state terms in pre-school children found that for three to four-year olds certain components of pretence, like object substitution and role assignment, were related to false belief understanding. A limitation of the study, however, is that the researchers did not control for language when general language development have been found to be associated with false belief. Another study by Schwebel, Rosen, and Singer (1999) who observed children during naturalistic spontaneous play and tested their ability to differentiate appearance and reality, and to understand false belief concluded that make-believe play develops concurrently with children's understanding of multiple representational tasks.

Guajardo and Turley-Ames (2004) examined associations between theory of mind and counterfactual reasoning using both antecedent and consequent tasks among three, four and five-year-old children. They found that the generation of specific types of counterfactual

reasoning statements and overall counterfactual reasoning as a whole accounted for significant variance in children's theory of mind performance beyond age and language. In another study aimed at clarifying their previous work on associations between counterfactual reasoning and false belief, Guajardo, Parker, and Turley-Ames (2009) determined whether these two variables are related and if so, if executive function skills mediate the relationship. The researchers tested three, four, and five-year-old children and concluded that counterfactual reason accounted for limited unique variance in false belief, both working memory and representational flexibility mediated the relationship between counterfactual reasoning and false belief, and language partially accounts for the relationship between counterfactual reasoning and false belief. Additionally, Beck, Riggs, and Gorniak (2009) tested three and four-year old children and found; that inhibitory control predicted performance on counterfactual reasoning tasks, suggesting that the difficulty three to four-year olds have with counterfactual reasoning is ignoring what they know to be true. There was no evidence that working memory was related to the development of counterfactual reasoning, and there was a strong relationship between language (receptive vocabulary) and counterfactual reasoning. Despite Beck, Riggs, and Gorniak's (2009) findings about working memory, the argument that representing a counterfactual alongside the true state of affairs stretches the mental resources of many preschool children to their limits and the demands on working memory during a counterfactual reasoning task could be too great for a young child, even though a matched hypothetical can be within their capacity is quite plausible (Byrne, 2016; Robinson & Beck, 2000).

It is not uncommon to also consider whether there are gender differences in children's abilities across these different variables. Some studies report that girls engage in pretend play more than boys whereas others studies report that there is no effect of gender (Jing & Li, 2015). A study by Carlson, White, & Davis-Unger (2014) exploring the relationship between executive function and pretence representation in preschool children reported no gender differences on these measures. Similarly, studies of counterfactual reasoning have also reported no effect of gender (Beck, Schaefer, Pang, & Carlson, 2011; Beck, Riggs, & Gorniak, 2009). It would be interesting, to check whether this trend continues in this study.

2.4.6 Empirical Studies of Pretence and Counterfactual Reasoning

There are several notable observations and findings from the study of pretence and counterfactual reasoning to date. Firstly, the study of pretence predates the study of counterfactual reasoning in young children, as a consequence, most of the research in the two areas has proceeded independently. Counterfactual reasoning research has largely explored the structure of counterfactuals, under what conditions different types of counterfactuals are generated and when are children able to generate and reason from counterfactuals. In psychology, the study of pretence and pretend play has a longer history but a recent review by Lillard, Lerner, Hopkins, Dore, Smith, & Palmquist (2013) raised a call for better research exploring the role of pretence or pretend play in children's development. A result from the call is a proposal purporting a possible developmental link between pretence and counterfactual reasoning and the suggestion that since pretend play may function as an opportunity to practice the cognitive skills associated with counterfactual reasoning (refer to the discussion on the role of pretence in section 2.2.3 developmental trajectory of pretence). A few theoretical papers have been written expounding on the theory of a unified framework of pretence (Gopnik & Walker, 2013; Walker & Gopnik, 2013b, 2013a; D.S. Weisberg & Gopnik, 2013) but there is only one empirical paper that reports an investigation of the direct relationship between pretence and counterfactual reasoning (Buchsbaum, Bridgers, Weisberg, & Gopnik, 2012). This present study, therefore, aims to explore the potential relationship observed between pretence and counterfactual reasoning further.

The study by Buchsbaum et al. (2012) entitled "The power of possibility: causal learning, counterfactual reasoning and pretend play" investigated the correlational link between pretend play and counterfactual reasoning by asking three to four-year-old children to reason about a causal model. The researchers reported that to their knowledge there had been no previous empirical demonstration that pretence and counterfactual reasoning were specifically related in development. The children were taught a novel causal relationship and were then encouraged to engage in a pretend game to see if they would maintain and act on this relationship in the context of an imaginary world. The researchers found that children's pretence scores significantly correlated with their counterfactual scores and remained significant even when controlling for age. Seventy-one percent of the children engaged in spontaneous elaboration and forty-four percent engaged in extended pretence. Since, the experiment was aimed at drawing conclusions about children's causal reasoning; it was replicated with the Piagetian conservation task included along with an executive function (EF) - Stroop task (day-night task)

to assess inhibition. The findings from the second experiment were consistent with the first. However, no correlations were found between children's performance on the conservation task with age, pretence or counterfactuals. Children's performance on the day-night task correlated their age but not with pretence or counterfactual reasoning. The relationship between counterfactual reasoning and pretence remained significant after controlling for EF, age and conservation. Buchsbaum, Bridgers, Weisberg, and Gopnik (2012) concluded that their findings suggested: (a) a link between pretence and counterfactual thinking, (b) that pretence provides an opportunity for children to practice and perfect the skills of reasoning, and (c) that when children are given new information about a causal system, they made similar inferences when they considered counterfactuals about the system and when they engaged in pretend play with the system. The findings from Buchsbaum, et al.'s (2012) study provided valuable preliminary evidence for further testing the relationship between pretence and counterfactual reasoning at a latent level to determine whether an underlying capacity might underpin this observed relationship.

Conclusion. Much of the research into pretence has focused on children's engagement in pretend play versus when they develop a meta-representational understanding of pretence. There is now conclusive evidence that engagement in pretend play precedes having a meta-representational understanding of pretence. Towards affirming the distinction between pretence as representational and meta-representational, it is interesting that there seems to be consensus that children's early pretend play behaviours are pretence in and of itself as long as it meets the criterion of contrasting reality. It might therefore be appropriate to conclude that both naïve pretence and sophisticated counterfactual reasoning are achieved by alternatively representing reality. Children begin to pretend from eighteen months but the capacity for counterfactual reasoning is not ascribed to them until later (over three years old at least). It appears that the quality of a child's pretence representations and counterfactual reasoning skills are dependent on their cognitive maturation. Moreover, it would seem that counterfactual reasoning mirrors the cognitive skill of pretence and that both depend on a capacity mentally represent true worlds as false. However, at this point the theoretical trail runs cold as empirical evidence is required before more can be said about the extent and nature of the links shared by pretence and counterfactual reasoning.

2.5.0 Theory of Pretence and Counterfactual reasoning

The preceding sections of this chapter have laid the foundation for explaining the basis upon which claims have been made that pretence and counterfactual reasoning are associated cognitive skills. The discussion delved into the cognitive structure of pretence and counterfactual reasoning separately to observe commonalities between the two and used the common features identified to justify why pretence and counterfactual reasoning may be associated cognitive skills. This section responds to the claims proposed in the unified theory of pretence and counterfactual reasonings. Several researchers like Amsel and Smalley (2000), Buchsbaum, Bridgers, Weisberg, and Gopnik (2012), Walker and Gopnik (2013), Weisberg (2015), and Weisberg and Gopnik (2013) have suggested that a shared underlying cognitive mechanism might be responsible for the observed associations shared by pretence and counterfactual reasoning but they provide little explanation of what this underlying cognitive mechanism might be or what form it might take.

In this section, I draw on information processing and computational theories of cognition to outline a theoretical argument that specifies what could be meant by the idea that an underlying cognitive representational ability underpins pretence and counterfactual reasoning or that the two may share cognitive mechanisms. I draw on a cognitive model developed by Amsel & Smalley (2000) that outlines a model of counterfactual reasoning about possibilities which involve processes of representing the real world as a false premise, holding dual representations in mind, reasoning from false premises. Discrepancies in children's success at reasoning from false premises are influenced by children's developmental understanding of the representational mind. I contend that current explanations of dual representations in pretence and counterfactual reasoning can be applied across all contexts of hypothetical thinking, including, pretence and counterfactual reasoning. I suggest that the common underlying mechanism attributed to pretence and counterfactual reasoning may be a general capacity for imaginary representations which is relied on to evoke the kinds of representations involved in hypothetical thinking about imaginary worlds. This imaginative capacity links with other domain general executive control cognitive skills. I propose that a connectionist view of the computational mind provides the best explanation for the developmental differences between pretence and counterfactual reasoning.

2.5.1 Dual Representation System

An initial proposal conceptualizing the link between pretence and counterfactual reasoning by showing how true and false state of affairs are mentally represented is proposed by Amsel & Smalley (2000). The researchers gave a developmental account of the qualitative differences observed in children's successes and challenges when mentally manipulating false premises about the real world. Amsel & Smalley (2000) presented a model of thinking about counterfactual possibilities which explained that information in counterfactual contexts are represented in dual mental models where information is represented as true state of affairs and false state of affairs (see Figure 2.6).

Illustration of Amsel & Smalley (2000) 'Model of counterfactual reasoning about possibilities' removed for copyright reasons. The copyright holder is Psychology Press.

Figure 2.6 A model of counterfactual reasoning about possibilities (from Amsel & Smalley, 2000)

According to Amsel and Smalley (2000) a mental representation of an event sequence is marked as 'true state of affairs' (event 1 – 4 based on the model), and a copied and edited version of that representation is generated such that a particular node is altered to become the representation of the 'false state of affairs' paralleling the true event sequence except for the altered event node (labelled 'E' in the diagram for edited). However, beyond editing a change in an event sequence, the consequences of the edited change must be imagined (depicted by a broken arrow to an event node labelled 'I' for imagined) and the imagined node is compared and contrasted with the corresponding event node in the true state of affairs such that the assessment of an actual state of affairs can be evaluated for a possible one (depicted by an arrow going from a false state of affairs to a true one). For both pre-schoolers or adults, the

representational format is assumed to be the same and to involve copying an actual sequence of events, editing it by altering a specific event, then imagining the consequences of the edited change. However, pre-schoolers are unable to bring bear the evaluation (comparing and contrasting) from the false state of affairs on to the true state of affairs (Amsel & Smalley, 2000). In other words, although the mechanism by which children and adults create alternative worlds in pretence and counterfactual reasoning contexts are similar; they are dissimilar in how information about the false state of affairs which could have occurred are used to evaluate the true state of affairs.

Amsel and Smalley (2000) attribute children's difficulty with reasoning from false premises to them having low-level pretend processing skills in the early years which eventually develops to higher-level understanding of pretence later in development. What this means is that children: (a) are able to encode an object's true and pretend identity as separate representations; (b) are able to activate representations in memory but the two representations are unequally activated; (c) are able to link the two representations but the more salient or more strongly activated representation can be the most influential; (d) are not always successful at retrieving representations if they are decoupled and acted upon independently of each other (Amsel & Smalley, 2000). These levels of processing are similar to the related component cognitive skills that Weisberg and Gopnik (2013) identified – disengaging with current reality, making inferences about an alternative representation of reality, keeping this representation separate from reality. The discrepancy lies with children's ability to successfully reason from the false premise and this is the key expectation of mature counterfactual reasoning. Specifically, children's low-level processing appears as a difficulty in remembering both states of affairs in order to reason from the false premise. When children come to understand meta-representations or have the knowledge that false states are representational – intentionally created mental representations of false states of affairs instead of actions which simulate false states - the transition in children's understanding that the false state of affairs is false, marks a shift towards a higher-order understanding of mental representations.

This transition between low-level processing and higher-level understanding may explain why during their early years of development children struggle with understanding imagination as a representational state of mind across different contexts. For instance, the difficulty that children have at first with conceptualizing pretence as a mental representational state (Lillard, 1993b); with overcoming basic conditional reasoning (Rafetseder & Perner, 2010); or even with

understanding false beliefs (Lillard, 2001; Lillard & Flavell, 1992). Across these different contexts children generally begin to show mental state understanding from four years. In their arguments, Amsel and Smalley (2000) suggested that as children develop more powerful cognitive capacities and control systems more complex forms of counterfactual reasoning become possible while children's spontaneous or naïve form of engaging in pretend play begins to dwindle. The development of more powerful cognitive capacities is attributed to maturation and control systems refer to domain general executive function skills like inhibition and working memory. Mental imagery is central to hypothetical thinking but the extent to it is required to integrate information between real and imagined worlds varies according to the reasoning demands of the task (Kulakova et al., 2013). I think Amsel and Smalley's model does a good job of modelling how specific cognitive processes work together to generate alternatives to reality.

2.5.2 Proposal for a General Underlying Imaginary Representative Capacity

In Amsel and Smalley's (2000) model of counterfactual reasoning about possibilities, the dual representation system identified that the false state of affairs is really an edited version of the true state of affairs that is imagined. The notion that pretence and counterfactual reasoning requires one to venture into an imaginative cognitive workspace is implicitly implied in the definitions of the two concepts discussed in sections 2.2.0 and 2.3.0. Pretence was defined as having to do with projecting an imaginary situation unto an real-world situation (Lillard, 1993a) and counterfactual reasoning as imagined alternatives to reality (Byrne, 2016). Both pretence and counterfactual reasoning involve conjuring non-literal representations of the world which are essentially 'imaginative representations' of the world as it is perceived or experienced; making the 'imagination' the nucleus from which pretend play or counterfactual reasoning emanates.

In this present study, I propose that the 'imagination' should have a more central feature in any discussion that involves generating alternatives to reality. One might argue that 'imagining' is an implicit feature given the references to 'other possible worlds', 'hypothetical worlds', or even 'impossible worlds' and in this context, what is important, is the juxtaposing of the real world to the imagined world. However, I think the 'imagination' needs to be more explicitly attended to in discussions like this one because it is the basis of all hypothetical thought. In

early conceptions of the imagination by David Hume in his writing Treatise of Human Nature he described the imagination as being free to join ideas together in any way it pleases but that it does not always join ideas at random and so implying that there were limitations on how free the imagination is (Warnock, 1976). Hume identified three defining features of the imagination – resemblance, contiguity in time or space and causal connexion. According to Warnock's (1976) descriptions of Hume's work, the imagination collects impressions of the world from memory to fill the gaps in our experiences and to bring lively and vivid ideas of our experiences to mind. Therein, the representational power of the imagination to allow us to form images, ideas, and likenesses in the mind contributes to our awareness of the world (Warnock, 1976). Clearly, the imagination has long been perceived as a hallmark of human cognition. In this present study, imagination is defined as a dynamic process by which one "'leaves' the here and now of a proximal experience to explore a distal experience in the past, future, or any alternative reality before 'coming back' to the here and now" (Zittoun & Gillespie, 2016). This definition of imagination captures how pretence and counterfactual reasoning have been described in the literature review thus far; furthering the argument that the imagination plays a central role in our ability to think about alternatives to realities, more than has been acknowledged in discussions of concepts involved in generating possible worlds that are counterfactual to reality. In his book 'Understanding Children's worlds: The Work of the Imagination' Harris (2000, p. xi) laid out an ontogenetic description of the human imagination and argued that "the capacity to imagine alternative possibilities and to work out their implications emerges early in the course of children's development and lasts a lifetime". Similarly, I am putting forward for consideration that the ability to imagine is the common denominator that comes up in all descriptions of hypothetical thinking and is the nexus underpinning our ability to represent true states of affairs as false ones.

2.5.2.1 Contributions of Connectionist Perspective

In section 2.4.2, I established that mental representations are definitional to understanding the cognitive mechanisms of pretence and counterfactual reasoning. This implies that imagination is a type of mental representation. One way of thinking about how representations work, that might be applicable to thinking about how an imaginary representative capacity might function, comes from a description of representations provided by Smith and Conrey (2007) who described how representations operate in connectionist memory system. To make this

argument, I first provide a brief explanation of connectionism, then explain Smith and Conrey's (2007) descriptions of 'mental representations' in a connectionist system, and then comment on how a connectionist network might shed light on the idea that the link between pretence and counterfactual reasoning might be facilitated by an underlying capacity to generate imaginary representations. Alternatives different from connectionism are also attended to briefly. The discussion here will be revisited in the Chapter 7 Discussion section 7.3.3 when the applicability of connectionist theories will be considered in light of the empirical evidenced generated from this study.

Connectionist theories broadly conceive the brain as a network of units or nodes, each with a degree of activation that are connected to each other and the connections are weighted so that the extent of activation of a unit along with the weight of its connections to others will excite or inhibit those other units (MacDonald, 1995). According to Smith and Conrey (20017), representations, therefore, function as richly connected units sending signals to each other, whereby, each unit has an activation level which can change from one moment to another in response to signals that the unit receives from its connections. These include incoming input connections from outside the network, for example, sensory information, as well as, unit outputs sent to other units through its outgoing connections. What makes a connectionist network view of representations interesting is the perception that learning takes place through the strengthening and weakening of interconnections in response to examples encountered in the input (McLaughlin, 1990). Weighted connections are thought to change slowly with time and the weights are assumed to be shaped by a learning process where each weight is incrementally adjusted as the network processes stimuli (Smith & Conrey, 2007). Smith and Conrey (2007) used the analogy of a computer screen to explain how network connections work in a connectionist system works. A computer screen operates on a fixed number of pixels to facilitate different colour and brightness levels which generate very large numbers of different but meaningful images, more than the number of pixels that exist, but no individual pixel has meaning by itself, as the unit meaning is the pattern of states from combining many different pixels. In the same way, the number of states represented in a connectionist system is constrained by the number of unique patterns that can be activated and the unit of meaning is the pattern of nodes and links that it is activated (Smith & Conrey, 2007). Three characteristics stand out in how connectionist systems operate: (a) cognitive skills occur by sharing processes across a distributed network; (b) representations require that relevant weights become activated whilst non-relevant weights are inhibited; and (c) the interaction across network systems with

the environment facilitates learning. Based on these characteristics, I think the dynamism of network systems as that explained by connectionist theory has the potential for explaining how an imaginative workspace facilitates different forms of hypothetical thinking, including pretence and counterfactual reasoning, that rely on a capacity to imagine other possible worlds. Further to describing how connectionist systems work, Smith and Conrey (2007) explained that 'mental representations' in a connectionist system have the following defining features:

- Representations are dynamic in that as a representation is maintained in memory it is changed by learning due to other stimuli the network is processing
- Representations that are currently active states exist in a different representational format from those that are currently inactive.
- A representation is constructed by flows of activation in the network given appropriate inputs so to find a desired representation does not require to search through a number of other irrelevant representations.
- Representation construction is an ongoing process, qualitatively the same as representational change and both are solely due to incremental change in the network's connection weights and not constructed at a specific point in time, going from non-existence to existence.
- If people's responses demonstrate context sensitivity or change over time, it could be because the same focal inputs (e.g., a target stimulus) result in the elicitation of different reconstructed representations, due to (a) intervening learning, or (b) effects of other inputs representing nonfocal or contextual elements of the overall situation.

Essentially, in a connectionist system, representations can be broad, have multiple, contextual versions of a concept each of which can have distinct, and even unrelated sets of attributes (Smith & Conrey, 2007). On this premise, I propose that a capacity that uses 'imaginary representations' would adhere to general descriptions of how 'mental representations' work and connectionist theory provides a framework for understanding the cognitive architecture of a mental imaginary workspace.

One way of determining the adequacy of connectionist theory as a model for describing the cognitive architecture of an imaginary representational workspace is whether it can address questions about the nature of the associations between pretence and counterfactual reasoning, and, by extension, other forms of hypothetical thinking in this context. For instance, can a general underlying capacity explain the differences in the appearance of pretence and

counterfactual reasoning in development? How would a general imaginary representational cognitive workspace facilitate different forms of hypothetical thinking over the course of development? How can we explain the differences in the constraints placed on the imagination from pretending as oppose to reasoning counterfactually? Can the connectionist model account for Amsel and Smalley (2000) observation that maturation and links with other cognitive processes influence children's ability to compare and contrast true and false premises and reason from a false premise? How might domain-general executive function skills interact with both pretence and counterfactual reasoning? Are domain-general executive function skills equally important to both pretence and counterfactual reasoning? Essentially, a theory explaining a general cognitive imaginary representational workspace needs to account for the qualitative differences in the development of pretence and counterfactual reasoning and their timing in appearing in development, as well as, the similarities in their cognitive mechanisms. In other words, a theory of a general imaginary representational process should explain the process by which the representations are generated and must be dynamic enough to explain the similarities and differences of the concepts being compared.

A starting point for thinking about how a connectionist network might illuminate the questions raised is to consider the characteristics of 'imaginary mental representations' in a connectionist system. The description of representations discussed by Smith and Conrey (2007) may provide a good account of describing how a general 'imaginary representational' capacity might operate across the two conceptual domains and perhaps other contexts which depend on hypothetical thinking. If Smith and Conrey's (2007) descriptions of representations are upheld then the contents of imaginary representations being held in memory would be influenced by other stimuli the network is processing. Other stimuli may come from the environment, physiological reactions or from being activated as the mind engages in other cognitive activities, for example asking one to consider an analogy requires some level of imaginative thought. In a connectionist system, variations in the extent to which imaginary representations are unconstrained is possible as representations in active states exist in a different format from those in a current state. So, only imaginary representations relevant to a specific context are attended to while other unrelated imaginary representations can be suppressed. Additionally, previous imaginary representations can be mutually exclusive from each other given that a representation is constructed by flows of activation in a neural network given appropriate inputs and does not depend on a search through irrelevant representations. In connectionist systems differences in how imaginary representations are constructed are influenced by maturation

because representation construction is an ongoing process solely due to incremental change in the network's connection. Also, connectionist systems are influenced by context and environmental factors; similarly, imaginative representations are grounded in a real-world premise and this suggests that they are context sensitive. Moreover, developments in the quality of the contents of the imaginative representation would change over time owing to different reconstructed representations in a connectionist system being elicited from intervening learning or the effects of other inputs representing nonfocal or contextual elements of the overall situation.

Connectionism is considered, although speculatively, because it overviews a structural as well as functional characteristic of the brain (Herberle, 1998) that can perhaps illuminate questions about the cognitive mechanisms that facilitate imaginary representations for thinking skills like pretence and counterfactual reasoning which depend on them. This is only one possible perspective proposed here. To provide an analogy, the proposed suggestion is that humans may have an innate capacity to imagine possible worlds represented as different types of imaginary representations, for example, pretence, counterfactual reasoning, thinking about future hypotheticals, et cetera; the real world, and other properties that may be relevant to what is being represented but each having their own representative cluster. Say someone is pretending that a banana is telephone then the object, banana, comes to be represented as a unit in the pretence cluster. It is activated as two-way weighted connections, activated across units within a cluster and between units across clusters. Excitatory connections are activated within and between clusters and weights are used to form inhibitory connections among units within a cluster such that activation of one property tends to suppress the activity of other properties in its cluster (Bechtel & Abrahamsen, 2002). Over time, learning occurs by changing the connection weights between units not by adding or modifying propositions (Bechtel & Abrahamsen, 2002). So, the relevant attributes of the banana necessary for the pretence context are activated and the irrelevant attributes are inhibited. The strengthening of weighted connections over the course of development would explain the process of how children come to understand pretence representations as meta-representations. Connectionism, therefore, gives a broad explanation of; (a) how units are connected to one another; (b) how the activations of individual units are determined, (c) the nature of the learning procedures which change connections between units; and (d) the ways in which systems are interpreted semantically" (Bechtel & Abrahamsen, 2002).

Connectionists attempt to explain cognition by describing how information is represented in the brain. Similar use of connectionism to explain mental states have been applied to social psychology and thinking about how attitudes are mentally represented (Conrey & Smith, 2007; Smith, 1996). By using a connectionist paradigm, the aim was to explain how imaginary representations could vary across different contexts which rely on hypothetical thinking about possible worlds and how domain-general cognitive processes might interact to influence the component processes involved in pretending or reasoning counterfactually. Criticisms of connectionism are from rival classical and modular theories of cognition (Fodor & Pylyshyn, 1988). Classical computational theories follow the traditional symbolic paradigm of construing cognition as involving symbol manipulation and transforming of symbols according to rules; whereas, connectionists do not provide for either stored symbols or rules that govern their manipulations (Bechtel & Abrahamsen, 2002). Connectionists generally account for domain general as well as domain specific skills in contrast to classical, modular theories of cognition. For instance, according to Herberle, (1998) modular theorists like Fodor (1983) claim that global processes like those arising from the imagination are less understood as compared to domain-specific processes (like mathematics, science, language) which use specific, localized, and structured neural systems operating through the manipulation of symbols much like a computer. According to Herberle (1998) modular cognitive systems are domain-specific, computational autonomous, innately specified and associated with specific, localized, and elaborately structured neural systems; whereas, nonmodular cognitive systems are not content specific, for example, memory, attention, imagination, perception et. cetera, involving creative, interactive, problem solving thinking skills that cross content domains.

Conclusions. In this section, an argument was made for considering connectionist theory as a model for explaining the mental representations involved in thinking about alternative imaginary worlds to reality. It must be acknowledged that considering a connectionist paradigm moves away from traditional approaches which usually compares modularity theories and simulation theories to explain how the mind computes mental state representations; typically from research of pretend play (Lillard, 2001). I suggest, that in light of the proposal, that mental state representations involving alternate versions of reality have something in common by way of shared cognitive mechanisms; then theories of connectionism and parallel distributed processes might give a better account of how previously perceived distinct cognitive skills may be associated.

2.5.2.2 Neuroscience Evidence

There is some evidence from neuroscience research that the cognitive processes involving mental imaginative representations share neural correlates in similar components of the brain. A study investigating neural correlates from observing pretend play where one object is pretended as another found observing pretend play activated additional areas previously associated with theory of mind tasks and listening to narrative, including medial prefrontal cortex, posterior superior temporal sulcus and temporal poles (Whitehead et al., 2009). Similarly, counterfactual thought has been found to depend on an integrative network of systems with coordinated interaction between three networks: (1) mental simulation in the medial temporal lobe and prefrontal cortex region; (2) cognitive control in the frontoparietal and cingulo-opercular network; and (3) affective processing including motivation and valuation in limbic regions and ventral medial prefrontal cortex regions (Van Hoeck et al., 2015). These findings overlap with neural links relating to theory of mind. A meta-analysis of neuroimaging theory of mind studies reported support for a specialised mechanism for mental attributions where all sorts of theory of mind tasks engaged a particular brain network including the medial prefrontal cortex region and bilateral temporal parietal junction (Schurz et al., 2014). The neural networks engaged in different mental state abilities have neural correlates in specialised components of the broad which generate from general related cortical regions in the brain. The findings from the neuroscience research makes a case for thinking about related cognitive processes as connections in a cognitive network system. Connectionism is greatly influenced by neuroscience research for providing neural support that sheds light on the cognitive architecture of the mind. Evidence that pretence and counterfactual reasoning overlap and may activate similar cognitive components in the brain amplifies support for thinking about these constructs as related cognitive skills.

2.5.3 Conclusion

A suggestion was proposed in response to the question of whether pretence and counterfactual reasoning share cognitive mechanisms. Amsel and Smalley's (2000) model of counterfactual reasoning about possibilities was used as starting point to explain the process of generating alternatives to reality and reasoning from false premises. The ability to imagine was identified as integral to forming a false premise of a real-world premise. Additionally, being able to compare and contrast real and counterfactual worlds is influenced by maturation made apparent

by the transition in low-level processing skills which gives way to higher-level understanding over the course of development. The evidence from reviewing the literature seem to suggest that mature counterfactual reasoning relies on an imaginary representational capacity, along with help from other domain-general skills. For this reason, a connectionist model was used to show how a network of cognitive processes might explain how imaginary representations facilitate pretending and counterfactual reasoning. Evidence drawn from neuroscience research supports the idea of an interconnected neural network at play in similar cognitive skills as related cognitive processes appear to emanate from similar locations in the brain. Overall, this section makes a case for considering that an explanation for a unified theory of pretence may come from evidence that the two rely on a shared capacity that evokes imaginary representations.

2.6.0 Thesis Framework

The aim of this present thesis is to clarify claims that pretence and counterfactual reasoning share cognitive mechanisms and that a shared underlying capacity underpins the relationship between the two. The evidence proposing a joint theory of pretence and counterfactual reasoning were reviewed by examining what is known about the cognitive structure, development, and cognitive mechanisms of these two cognitive skills during the early years of child development, independently and jointly. One thing which is clear from this review is that there is a dearth of empirical evidence which has examined the extent to which pretence and counterfactual reasoning are related cognitive skills. For this reason, the goal of this research is to test theoretical claims made about pretence and counterfactual reasoning by addressing the following questions:

RQ 1. Is there evidence that observed pretence behaviours depend on a common underlying ability in this domain?

RQ 2. Is there evidence that observed counterfactual reasoning behaviours depend on a common underlying ability in this domain?

RQ3. How are pretence, counterfactual reasoning, executive functions, and receptive language associated?

RQ4. Is there support for the idea that the constructs from the domain of the pretence and counterfactual reasoning are underpinned by a general imaginative ability?

This research endeavour is theory driven because it aims to provide explanations to clarify the nature of the relationship between pretence and counterfactual reasoning. At the end of the thesis an attempt will be made to: organize the knowledge already known and the knowledge generated about pretence and counterfactual reasoning into statements that describe the relationships among the study variables for the purpose of proposing a coherent explanation of the nature of the relationship between the two, and also to discuss predictions about the behavioural manifestations expected if pretence and counterfactual reasoning are associated (Goodwin & Goodwin, 2014). The expectation is to contribute to the current body of knowledge about pretence and counterfactual reasoning in a parsimonious way with the understanding that the findings are open to being falsifiable.

2.7.0 Chapter Summary

The literature reviewed in this chapter surveyed the state of knowledge about pretence and counterfactual reasoning in early childhood from a cognitive psychology perspective. The discussion covered five main topics. The first and second section overviewed pretence and counterfactual reasoning separately by outlining the defining features, cognitive mechanisms, developmental trajectory, and general approaches to how each construct is measured in research with children. The third section presented evidence to explain assertions that pretence and counterfactual reasoning are related cognitive skills. The tenets on which claims about associations between pretence and counterfactual reasoning rest come from observations that both take mental representations of reality and re-represent them as alternate representations that are contrary to fact. Additional evidence is pooled from reports showing links between pretence and counterfactual reasoning shared with language, and executive functions, as well as, empirical evidence directly testing the two cognitive skills. The fourth section developed a theoretical argument providing support for the claim that pretence and counterfactual reasoning are associated potentially because both cognitive skills rely on an imaginary representational capacity responsible for conjuring up non-literal versions of the real world. The last section overlays the framework of the thesis. The thesis goal is to test theoretical claims that that pretence and counterfactual reasoning share cognitive mechanisms and that an underlying cognitive dimension might explain associations shared by the two constructs. The outcome of this study should shed light on the nature of the relationship between pretence and counterfactual reasoning.

Chapter 3 Research Design

3.1.0 Introduction

In response to the theoretical propositions outlined in the literature review about the potential contribution of early years pretend play to the development of counterfactual reasoning; a large-scale empirical study was designed. This chapter outlines the research design of the study by presenting the statement of problem, purpose of the research, and the research paradigm which influenced the study design. The research questions are stated, key constructs are operationalized, and the pilot study which was conducted is reported. A chapter summary is included at the end.

3.2.0 Statement of the Problem

The literature review delineated a theoretical perspective that suggests that the cognitive processes activated during pretend play reflects the cognitive processes of counterfactual reasoning; therefore, the two may share similar cognitive mechanisms (Weisberg & Gopnik, 2013). In response to this theoretical proposal, this study was designed to investigate the extent of the relationship between pretence and counterfactual reasoning as related cognitive skills. A hypothetical model was specified to test the theoretically proposed links between counterfactual reasoning and pretence both at an observable level and at the level of latent constructs (see Figure 3.1). The boxes identify the observed variables measured and the circles indicate the latent constructs being inferred. The goal was to explore whether the variance in the data might support a general factor, described as a cognitive capacity to generate imaginary representations (IR), to be extracted which would imply that pretence and counterfactual reasoning represent the same component skill and there would be remaining variance sufficient to extract specific latent factors of pretence and counterfactual reasoning (Eid et al., 2018). The implication of a shared cognitive association between pretence and counterfactual reasoning opens the possibility for future explorations of a causal relationship between pretence and counterfactual reasoning and the proposal that early years pretence is an opportunity to practice and perhaps scaffold counterfactual reasoning in later development (Weisberg, 2015). Hence, it is important that claims in this field be opened to tentative speculation.

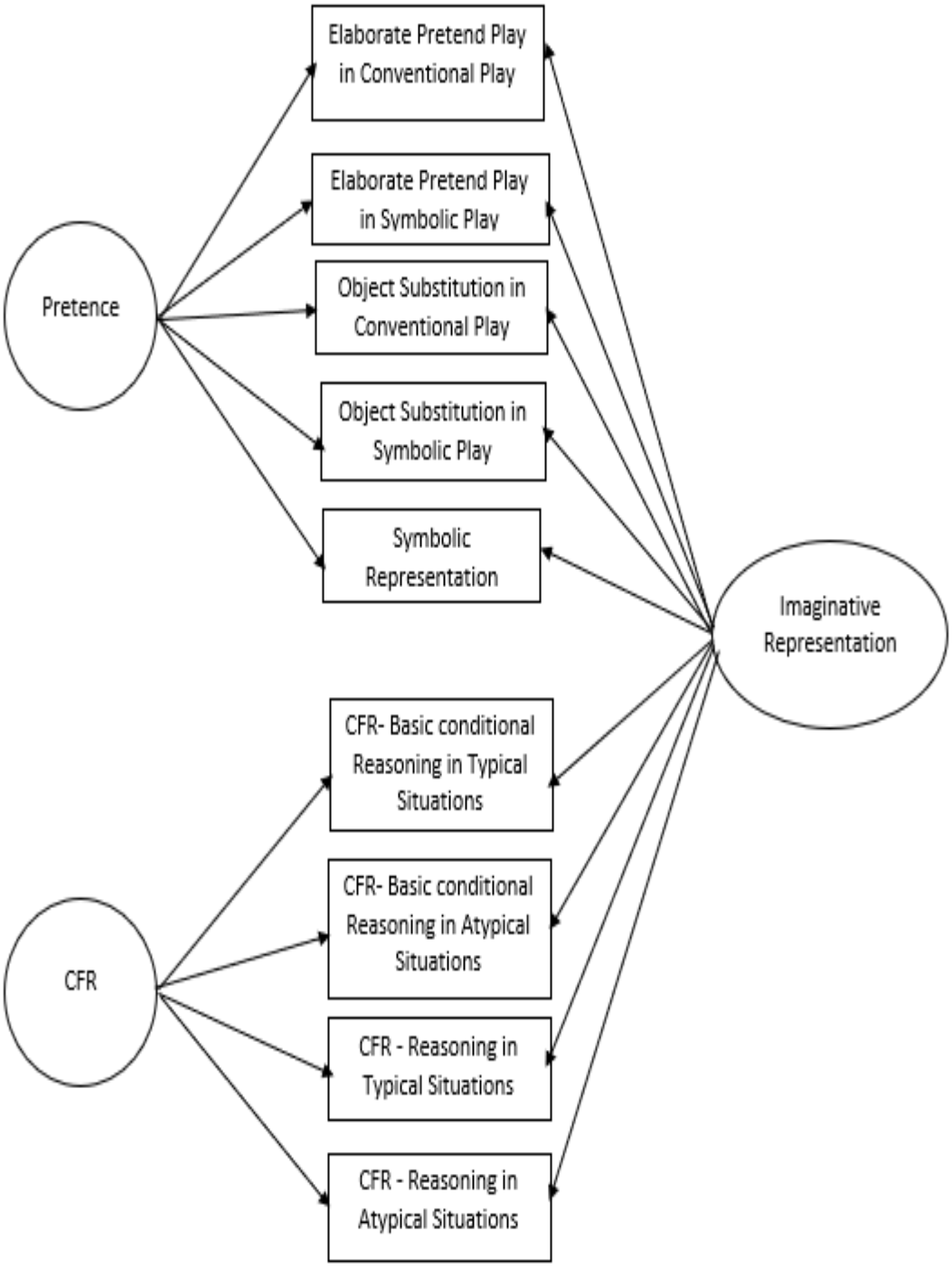

Figure 3.1 Hypothesized Model of CFR and Pretence

3.3.0 Research Paradigm

In undertaking this research, I adopted a post-positivist paradigm as my world view because it involves an understanding that observations are subject to critical evaluation given that there may be multiple, co-relating explanations (Cohen, Manion, & Morrison, & Bell, 2018). Such a stance was especially important since this study aimed to generate empirical evidence to test what is still an inchoate theoretical proposal of the associations between counterfactual reasoning and pretence. Post-positivism ideologies retains the positivists perspective that the strength of theories are contingent on their ability to withstand 'severe tests' of their falsifiability and that their discoveries are subject to future falsification in the light of the new evidence (Cohen, Manion, & Morrison, Bell, 2018). As consequence, confirmatory and non-confirmatory findings of proposed hypotheses are reported.

3.3.0 Aim

The aim of this study is to explore the theoretical claim that counterfactual reasoning and pretence are associated cognitive skills.

3.4.0 Research Questions

RQ 1. Is there evidence that observed pretence behaviours depend on a common underlying ability in this domain?

RQ 2. Is there evidence that observed counterfactual reasoning behaviours depend on a common underlying ability in this domain?

RQ3. How are pretence, counterfactual reasoning, executive functions, and receptive language associated?

RQ4. Is there support for the idea that the constructs from the domain of the pretence and counterfactual reasoning are underpinned by a general imaginative ability?

3.5.0 Operationalization of Variables

The concepts in this study are operationalized within a cognitive psychology domain. The operational definitions of the main study variables are drawn from the literature but are also aligned to how each variable was measured and subsequently interpreted to answer the research questions. The operational definitions of the variables in the study are stated in Table 3.1 below.

Table 3.1 Operational Definition of Study Constructs

Variables	Operational Definitions
Pretence	Pretend play behaviours involving fantasy or imagination with functional and symbolic toys or objects inferred from: elaborate imaginative actions and objects, verbally attributing properties to objects, using one object to represent another, and referring to an absent object as if it were present. It also involves representing objects or ideas symbolically or in a non-literal manner.
Counterfactual Thinking	It is a process of generating alternative antecedents or consequents to a counterfactual sequence
Receptive Language	Involves both receptive language ability, listening and auditory comprehension.
Executive Functions – inferred from working memory, inhibitory control	*Working memory* - the number of units of verbal information a child can hold and manipulate in their minds. *Inhibitory control* - the ability to resist the urge to engage in an enticing behaviour or stop oneself from engaging in automatic behaviours.

3.6.0 Cross-sectional Research Design

A cross-sectional research design framed the development of this study. Cross-sectional research takes a snapshot of multiple variables at a single point in time with the aim of understanding the relationships among the variables (Cohen, Manion, Morrison, & Bell, 2018; Field, 2016; Thomas, 2013). The research here collects data from children at a single timepoint to understand how the variables pretence and counterfactual reasoning are related. Cross-sectional studies are quantitative in nature, applying correlational analyses methods based on multi-subject designs in which participants are not randomly assigned to experimental groups (Thompson, Diamond, McWilliam, Snyder, & Snyder, 2005).

A cross-sectional research design was selected for this study because it is ideal when state of knowledge in a field is still immature as they reveal whether there is a relationship among the variables of interest before committing resources to complex experimental designs (Howitt & Cramer, 2011). At the time of writing this thesis, only one empirical study reporting on associations between pretence and counterfactual reasoning was found indicating that there is little published research about how pretence and counterfactual reasoning are related. Counterfactual reasoning research with children dates back to the past two decades beginning with Harris, German, and Mills (1996) seminal paper which showed children's capacity to reason counterfactually. Whilst pretend play has been researched extensively; empirical research focused on the intersection between pretence and counterfactual is only attributed to Buchsbaum, Bridgers, Weisberg, and Gopnik (2012). Hence, if the findings from further correlational research methods corroborates a robust relationship between pretence and counterfactual reasoning; then this provides justification for undertaking longitudinal and/or experimental designs. This is prudent as longitudinal and experimental designs tend to require a longer timeline to complete the research cycle resulting in a knock-on effect of increased cost to complete the research.

The limitations and strengths of cross-sectional studies were critically considered when making decisions about this study. A drawback of cross-sectional designs is that they do not provide evidence that variables are causally related (Thompson et al., 2005). However, establishing and understanding how variables are correlated is a critical first step before attempting to detangle predicted causal links. It provides a basis from which predictions about the relationship between variables can be tested in related sectional samples. In this vein, this investigation does not aim to assert unequivocally the direction of the relationship between pretence and

counterfactual reasoning but to only explore how they might be associated. Hence, a cross-sectional design was deemed suitable for this study as cross-sectional research is a type of explanatory research that is appropriate for investigating theories about a phenomenon like that specified in Figure 3.1 (Gall et al., 2007; Howitt & Cramer, 2011). A strength of cross-sectional research is that it is a type of observational research which takes a naturalistic view of the question being researched while ensuring that the findings are not biased by the presence of the researcher (Field, 2016).

3.7.0 Sampling

A critical aspect to designing cross-sectional studies is drawing an adequate sample so that the information from which inferences are based are comprehensive (Cohen, Manion, Morrison, & Bell, 2018). Three factors influenced determining the sample size for this study; effect sizes and post-hoc power analyses from a previous study which found counterfactual reasoning and pretend play to be correlated, an a-priori power analyses to predict sample size by taking into consideration statistical power given the number of variables being measured in this study, and consideration of the sampling criteria to facilitate advanced quantitative analyses like factor analyses to tests latent variable models.

In the one reported study that shows that pretence and counterfactual reasoning are correlated, the researchers found a medium to large effect size (r = .44) in a sample fifty-eight 3-4-year-old typically developing children (Buchsbaum, Bridgers, Weisberg, & Gopnik, 2012). Subsequently, a post-hoc power analysis with the program *G*Power* (Faul et al., 2007) was conducted to determine the statistical power of Buchsbaum et al.'s (2012) study and it revealed, based on a two-tailed correlation bivariate normal model, the power to detect an effect of this size was determined to be .94. Given the high statistical power and medium effect size, an a-priori power analysis to predict an adequate sample size was conducted based on a linear multiple regression with 6 predictors – pretence (2 variables), working memory, inhibition (2 variables), and receptive language – with counterfactual reasoning as the dependent variable. The a-priori analyses indicated that with a power of .95 the chance of finding a significantly large (.35), medium (.15) or small (.02) effect size exists with sample sizes of 67, 146 and 1050 participants, respectively (Faul et al., 2007).

Given Buchsbaum et. al.'s (2012) finding of a medium to large effect size in their study and the aim of this study to undertake latent variable modelling which typically requires large datasets, it was assumed that a sample size greater than one hundred and forty six but approximating two hundred would meet the minimum criterion of a large dataset with adequate statistical power to run analyses like confirmatory factor analysis (CFA) or structural equation models (SEM). Some researchers argue that SEM models can be robust with varying sample sizes (Kline, 2015; Wolf et al., 2013).

3.8.0 Pilot

This section discusses the piloting phase of the research. A pilot is small-scale testing of the procedures intended for use in the main study and informs the revising of procedures based on what the testing reveals (Gall et al., 2007). The goal of this pilot was to check the suitability of measures used with 3-5-year-old children. A lot of care went into selecting measures that: were age-appropriate, could be administered within a reasonable time frame, and had a record of being reliable and valid measures of the constructs in the study. These factors were crucial because the inferences made in any study are only as good as the measures upon which these inferences are based. All the measures considered have been reported in published research and include experimental tasks and tasks standardized and/or published by their developers. Standardised assessments are formal assessments that have been designed to measure a child's abilities compared to other children of their own age. They are norm-referenced by a period of trialling on large samples of a representative population and children's score can be compared to the average score of other children of similar ages. In contrast experimental tasks are usually research developed, designed to carefully manipulate a particular variable of interest by controlling for confounding variables (Purser & Van Herwegen, 2016).

3.8.1 Measures Piloted

The variables measured in the study were pretend play, counterfactual reasoning, inhibition, working memory and language. A range of tasks were considered but after piloting a final selection of measures were selected for inclusion in the main study. The study measures considered are detailed in Table 3.2.

Table 3.2 List of Study Measures Trialled

Variables	Measures	Task Description
Pretence	Child Initiated Pretend Play Assessment - CHIPPA (Stagnitti et al., 2000)	a norm-referenced standardised assessment designed to measure children's cognitive skills in pretend play by assessing the child's ability to self-initiate pretend play.
	Pretend Action Task – PAT (Overton & Jackson, 1973)	A measure of symbolic representation in pretence
Counterfactual Reasoning	Antecedent and Consequent Task (Guajardo & Turley-Ames, 2004)	A comparison of counterfactual responses to antecedent and consequent counterfactual questions.
	Travel Scenario Task (Perner et al., 2004)	Lends itself to simulating different types of counterfactual questions in one task
	Road Task (Beck & Crilly, 2009)	assesses the influence of considering dual possibilities
	Sweet Story (Rafetseder et al., 2010)	considers the nearest possible world where respondents keep active the real sequence of events that is being counterfactually altered
	Location Change Task (Rafetseder & Perner, 2010)	Task aimed at differentiating basic conditional reasoning from adult-like CFR
Inhibition	Head Toes Knees and Shoulders Task – HTKS (McClelland, Cameron, Duncan, Bowles, Acock, Miao & Pratt, 2014)	A measure of behavioural self-regulation and a general measure of EFs known for tapping response inhibition

	Delay of Self-Gratification Task (Mischel & Underwood, 1974; Thompson, Barresi, & Moore, 1997)	A measure of the initial choice for a delayed reward in preference to a current reward
Working Memory	Spin the Pots (Hughes, 1998)	A WM task assessing skills for mentally acquiring and retrieving information
Language	Clinical Evaluation of Language Fundamentals -CELF (Wigg et al., 2006)	A norm-referenced standardized language test including a test of receptive language measuring listening and auditory comprehension.

The purpose for doing a pilot study was to trial the measures in my research context, check that they yielded appropriate data and for the researcher to become familiar with procedures for administering the measures accurately and efficiently. There were two phases of piloting. In the first pilot all the measures initially selected were piloted. However, a second pilot study was needed because the counterfactual reasoning measure, the Antecedent and Consequent counterfactual reasoning task, initially selected was revised since the results from the first pilot study did not yield satisfactory results. Four other counterfactual reasoning measures were trialled in a second pilot and are also included in Table 3.2 as part of the total list of the measures trialled in this present study. The result from both pilots are discussed at length in the subsequent sections - Piloting Phase One and Piloting Phase Two.

3.8.2 Piloting Phase One

Participants. The first pilot took place at the Observation Laboratory at the Faculty of Education with ten 3-5-year old children who lived in the city of Cambridge.

Procedures. Children participated in two consecutive testing sessions each lasting approximately thirty minutes with a break between the two sessions. In session one the pretend play task (CHIPPA) was administered whilst the remaining tasks were administered in session

two (Antecedent & Consequent CFR Task, Spin the Pots, HTKS, CELF receptive language tests).

Results. Except for the counterfactual reasoning task, all other tasks showed good variability across the age-ranges of children sampled, that is, generally older children performed better than their younger peers. The variability in the scores across age groups suggested the tasks were functioning satisfactorily so no further adjustments were made (refer to Appendix A for children's scores on the tasks performed during phase one pilot).

In the case of the counterfactual reasoning task while the Antecedent Task showed good variability across participants of different ages, children performed at ceiling on the Consequent Task. Essentially, six of ten participants scored at ceiling on the Consequent Task and of the six children their ages ranged from 3-5 years old which suggested all ages had a good chance of obtaining the maximum score on this task. It is worth mentioning that 1st and 2nd Order False Belief tasks were trialled in the first pilot but are not reported on as they were eliminated from the study because it became necessary to reduce the number of variables measured so as to reduce the length of time taken to administer the measures. No further report is given about false belief tasks being used in this study.

Given that children had good performances on the Antecedent task but performed poorly on the Consequent counterfactual reasoning task; additional counterfactual reasoning tasks were piloted to select an appropriate task for the study. The other measures trialled in the phase one pilot, except the Antecedent and Consequent counterfactual reasoning task, were included in the main study. They are described in detail in Chapter Four Research Methods in section 4.3.0 which describes all the measures used in the main study.

Four other counterfactual reasoning tasks were trialled in the second phase of piloting. Before reporting on the phase two piloting, all the counterfactual reasoning tasks trialled are described together beginning with the Antecedent and Consequent task used in the first pilot. The purpose is to provide an over-view and contextual background on all the different counterfactual reasoning tasks trialled. A brief description of the counterfactual reasoning task trialled is presented first. Afterwards, the results of the phase two pilot are presented. The counterfactual reasoning task selected for inclusion in the main study is identified and the rationale for selecting the task is explained.

3.8.3 Piloting Phase Two

The purpose of the second phase of pilot testing was to trial other counterfactual reasoning tasks to select a suitable task for the study. Counterfactual reasoning is multi-dimensional, so there are differences in the difficulty and complexity of different tasks. The core of these differences arises from researchers wanting to understand how counterfactual reasoning develops in children in relation to what constitutes adult-like counterfactual reasoning. The background of each of the counterfactual reasoning tasks are described first. To provide context to the battery of counterfactual reasoning task trialled; the counterfactual reasoning task trialled in the first pilot is described here followed by the other four counterfactual reasoning tasks trialled in the second pilot. Afterwards, the procedures and results from the trialling are discussed and the final measure selected is justified. This is to elucidate the decision-making process undergone to arrive at the final counterfactual reasoning measure selected for this present study.

3.8.3.1 Background of the Counterfactual Reasoning Tasks Trialled

The five counterfactual reasoning tasks trialled are listed below:

1. The Antecedent & Consequent Task by Guajardo and Turley-Ames (2004)
2. The Travel Scenario Task by Perner, Sprung, and Steinkogler (2004)
3. The 'Road Task' by Beck & Crilly (2009)
4. The Sweet Story by Rafetseder, Cristi-Vargas, and Perner (2010)
5. Location Change Story Rafetseder and Perner (2010)

3.8.3.1.1 Antecedent & Consequent Task Counterfactual Reasoning Task

The task used was developed by Guajardo and Turley-Ames (2004) and designed for participants to identify alternative antecedents and consequents to counterfactual reasoning questions. In a given counterfactual scenario; an antecedent – is an action or decision, and a consequent – is the outcome resulting from the action or decision. An Antecedent Task gets the respondent to generate as many different antecedents as they can different to the antecedent stated in the task with the goal of providing an alternative response to change the outcome of the sequence of events presented. For example, "What could you have done so that the kitchen floor would not get dirty?" A Consequent Task gets the respondent to come up with an alternative consequent or outcome given a stated change in the story antecedent (the changed antecedent forms the counterfactual reasoning question). In a Consequent Task the response

leads to an altered consequent because respondents identify a different outcome given a specific change to an antecedent. For example, "If the wind had not blown, where would Jenny's picture be?" An example of a Consequent Task and Antecedent Task taken from Guajardo and Turley-Ames (2004) is illustrated in Figure 3.2 below. Participants listened to the researcher read counterfactual reasoning scenarios whilst watching accompanying pictures on an android tablet before responding to the antecedent and consequent counterfactual reasoning questions.

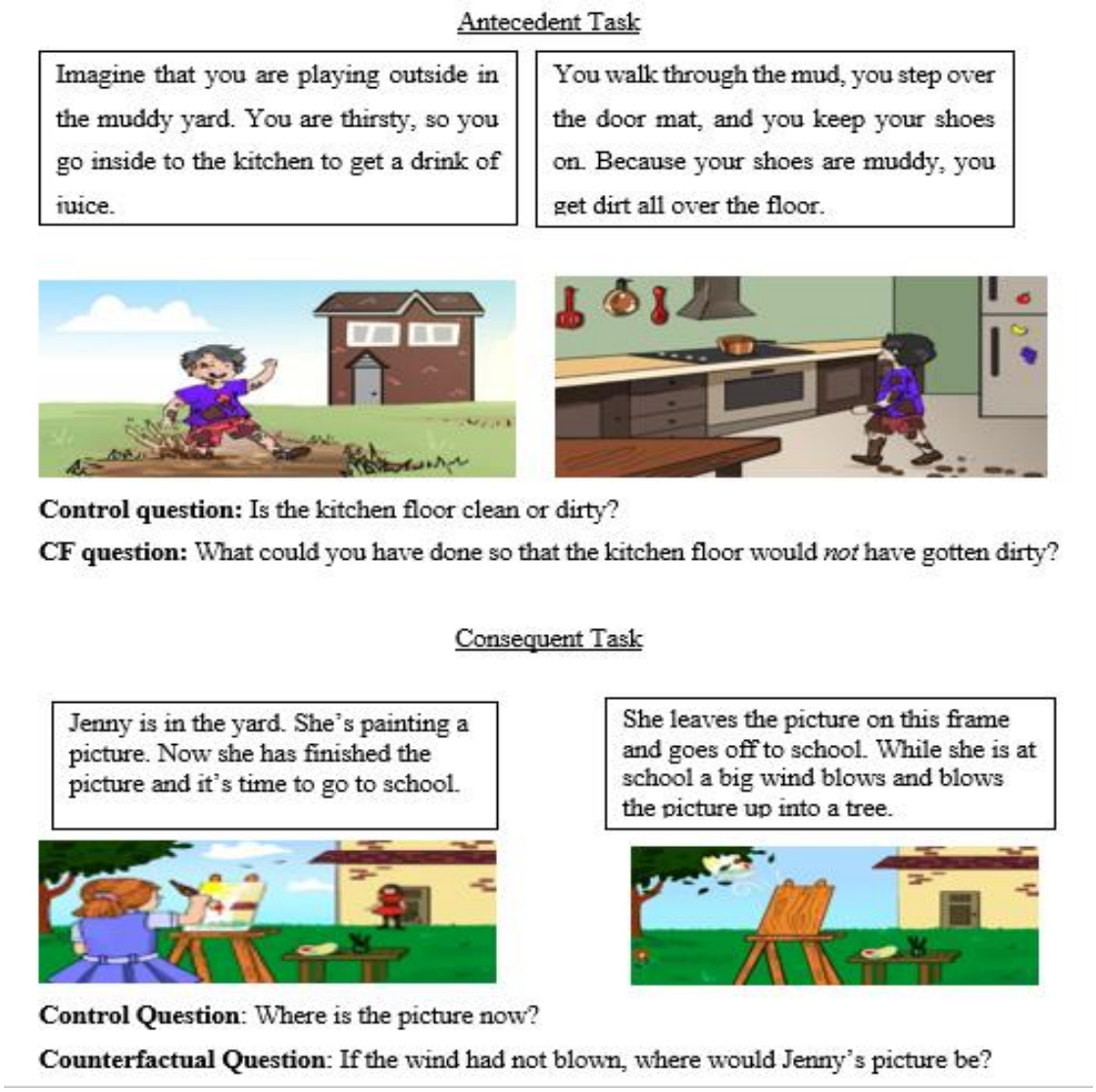

Figure 3.2 Antecedent & Consequent Task (Guajardo & Turley-Ames, 2004)

This counterfactual reasoning task can be classified as a task of basic conditional reasoning. Children from as young as three perform successfully on tasks like the Consequent Tasks by applying basic conditional reasoning – the application of general knowledge to answer a question independent of the actual content of the question. The pattern of children's responses – ceiling on Antecedent task but variable on Consequent task is consistent with Beck, Robinson, Carroll, and Apperly's (2006) suggestion that children who correctly answer questions to Consequent Tasks could more than likely also generate correct answers to questions on Antecedent Tasks. However, I made the decision to not use this counterfactual reasoning task because the ceiling effects on the Consequent Task raised concerns that the task would produce limited variability in children's scores if it was used with the intended participants of the main study, 4-5-year-old children. The age of participants for this present study was more restricted than those from the original paper where these tasks were used where the ages of children were reported to range from 3-years to 5.9-years (Guajardo & Turley-Ames, 2004).

3.8.3.1.2 The 'Road Task' (Beck & Crilly, 2009)

This task involves the following scenario: A car drives to a fork in the road and children are told, 'Sam had decided to go for a drive in his car. He could either go down this road to the swimming pool or he could go down this road to the sweet shop. The character takes one of the roads and the children are told, "Today Sam decided to drive down this road to the sweet shop". Then the children are asked a standard counterfactual question, "What if he had gone the other way, where would he be?" or an open counterfactual question, "Could he have gone anywhere else?" Thereafter follows three further trials each using a different car and driver. Standard and open counterfactual questions are counterbalanced, and each child has two standard questions and two open questions. This task is classified as an open counterfactual reasoning task and assesses whether children think about counterfactuals and actual events as two separate possibilities, dual possibilities, that could once have happened (Beck & Crilly, 2009).

3.8.3.1.3 The Travel Scenario Task by (Perner et al., 2004)

The task is a modified version of the task developed by Perner, Sprung, & Steinkogler (2004). It is based on the following scenario depicted in Figure 3.3.

Equidistant from Peter's house are two train and bus stations. From the green station, a bus leaves for the lake and a train for the mountains, and from the blue station a bus leaves for the mountains and a train for the lake. "Peter gets up and walks to the green station and takes the train to the Mountain. The children are asked a control question: Where is Peter now? [correct answer: "at the mountain"]. Then they are asked alternative departure counterfactual question, "If Peter had gone to the blue station and had taken the train, where would he have ended up?" [correct answer "at the lake"]. Afterwards, they are asked an alternative transport counterfactual question, "If Peter had taken the bus instead, where would he have ended up?" [correct answer "at the lake"]. There after follows three additional trials accounting for the different routes which could be travelled. For the purpose of this study only complete counterfactual questions were posed as possible variations to the path that Peter travelled although the task can simulate variations of counterfactual reasoning questions including future hypothetical counterfactual questions which are questions that ask children to predict outcomes to possible journeys that could be taken.

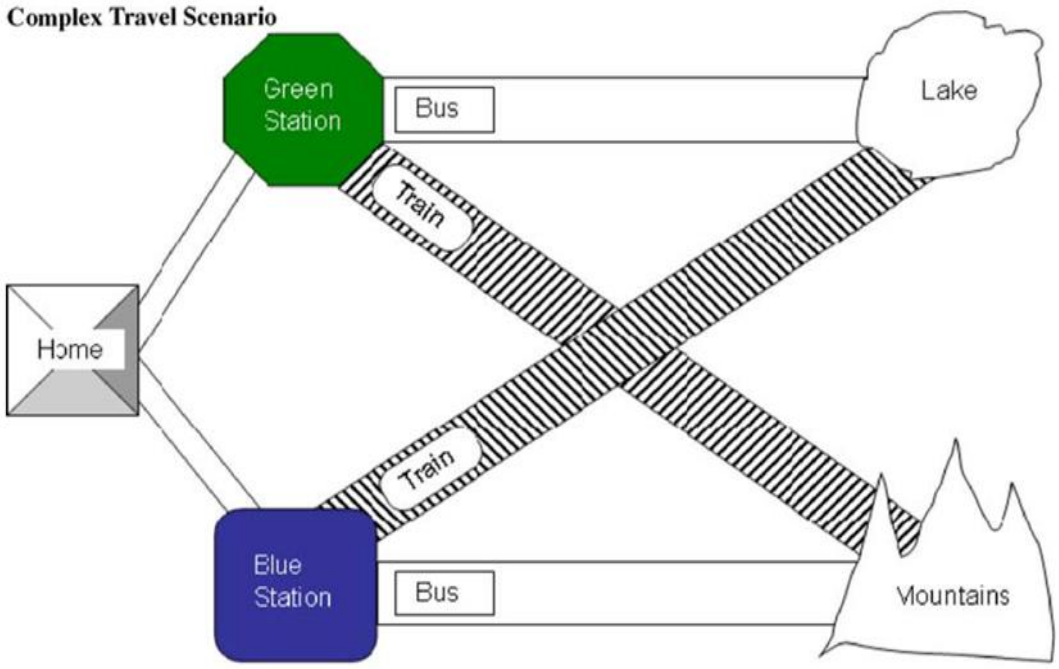

Figure 3.3 Travel Scenario Task (Perner, Sprung, & Steinkogler, 2004)

3.8.3.1.4 Sweet Story (Rafetseder, Cristi-Vargas & Perner, 2010)

In the sweet story four different sequences of events could take place, each sequence comprised two transformations of an object's location. The scenario explains that mother puts sweets regularly on either the top shelf or the bottom shelf (the first transformation) and then either the tall boy or the little girl comes looking for the sweets and takes them into his or her room (the second transformation). The tall boy can reach both shelves, so he takes the sweets into his room regardless where mother puts them. The little girl can only reach the bottom shelf so if she comes looking for sweets either they will remain on the top shelf or she will take them from the bottom shelf into her room. A subjunctive past question would be, "If not the little girl but the tall boy had come along looking for sweets, where would the sweets be?" could give a basic conditional reasoning answer "his room" because whenever the boy comes looking for the sweets they end up in his room, but when the subjunctive past questions are about the girl, given the girl can only reach the bottom shelf children must consider the 'nearest possible' answers 'either she went without sweets or took the sweets to her room. This task assesses whether children can hold multiple possibilities in mind.

3.8.3.1.5 Location Change Story (Rafetseder & Perner, 2010)

Task Administration Location Change Story. This task involves four stories involving protagonists – doctor, teacher, firefighter, and police officer engaged in sequences of events but only two scenarios were included in the pilot (see Figure 3.5). For example, the Doctor Story involves: a doctor, sitting in the park reading a book, is called to an emergency at the swimming pool. The question, ''If there had been no emergency, where would the doctor be?'' should counterfactually be answered ''in the park''. But by ignoring the doctor's intentions, and just reasoning from premises about the default location of a hospital and the doctor who has been called out to an emergency, one might answer: ''in the hospital''. Each story has four variations, in two stories the protagonist moves between two locations – from a typical and atypical antecedent location to the consequent location and in the other two stories the protagonist moves between three locations – between the typical and atypical locations (vice versa) before moving to the consequent location. The task is described more fully in Chapter Four Research Methods. In section 4.3.2. The Sweet Story and Location Change tasks can be referred to as nearest possible world tasks because they are designed to ensure that respondents keep active the real sequence of events that is being counterfactually altered (Rafetseder et al., 2010).

Firefighter Story

Policeman Story

Doctor Story

Teacher Story

Figure 3.4 Location Change Task (from Rafetseder & Perner, 2010)

3.8.3.2 Administration and Results from Trialling the Counterfactual Reasoning Tasks

Participants. Ten participants were recruited from a nursery in Cambridge. Parents were invited to opt their child out of the study. Children took part in the tasks, but no participant data was solicited from the school or parents because of the nature of the consent requested. An opt-out consent was suitable as the goal of the pilot was only to trial the tasks with age-appropriate children. Participants were between the ages of 4-5 years old.

Procedures. The testing took place in a quiet space at the nursery. Four counterfactual reasoning tasks were administered, and the time taken varied between 5-10 minutes; 'Travel Scenario', 'The Road Task' (5 minutes), 'The Sweet Task' (10 minutes) and two 'Location Change Tasks' (10 minutes) as only two of the stories were trialled.

*Results***.** The process of trialling the various counterfactual reasoning tasks familiarized the researcher to several factors like: the duration of the task, complexity of the task to be administered, how children in this study context performed on the task, and the comparability of the counterfactual reasoning task to the pretend play measure used in this study. All of these factors influenced the process of deciding which counterfactual reasoning task was suitable for the main study. The results of the phase two piloting are presented in Appendix E but the rationale for excluding and including tasks are given here.

The Travel Task trialled had been modified by excluding parts of the task which assessed False Belief and Hypothetical Reasoning which were part of the original task to make it a complex task but were not relevant to this study. Due to concerns that the modified version of the Travel Task which was trialled did not retain the original complexity and challenge of the task; the Travel Task was excluded from the main study.

Children's performance on the Road Task and Sweet Story showed reasonable variability. In the Road Task, the children did better on the standard counterfactuals than on the open counterfactuals. In the Sweet Story they were better at predicting where the boys would look for the sweets than the girls. However, both tasks were excluded for not being comparable to the pretend play task, the other main study variable, in terms of being considerably shorter tasks to administer and having a smaller range of scores. The Location Change Task was selected for meeting these criteria.

Conclusion. Most of the tasks trialled were designed in response to the argument that responses to traditional counterfactual reasoning questions may be answered using basic conditional reasoning by ignoring the subjunctive premise and simply providing plausible answers. Real world counterfactual reasoning tasks like the Travel Task are designed to encourage children to integrate the reality of the given scenario into their counterfactual assumptions. Open counterfactuals like the Road Task check whether the children can pinpoint when in a given scenario an alternative possibility can occur, that is, keep dual possibilities in mind (Beck et al., 2006). Nearest possible world tasks like the Sweet Story Task and Location Change Story Task go one step further by checking whether children can answer a counterfactual subjunctive question about a past event correctly when a basic conditional reasoning approach will produce a different answer. Nearest possible world tasks require the respondent to use only logically or causally necessary changes to the actual event to arrive at the counterfactual alternative (Rafetseder & Perner, 2010). Given this study aims to draw inferences about whether pretence and counterfactual reasoning share cognitive processes; a primary factor taken into account is that the counterfactual reasoning task does a good job of simulating the cognitive skills required to mentally represent alternatives; consider the given premise and propose a relevant alternative (refer to discussion in the literature review section on Dual Representations of Reality' in section 2.5.1).

3.8.5 Conclusions from the Pilot

The piloting phase was integral to the selection of the study measures. The selection of the measures was based on the extant literature, but piloting provided a means of checking how individual tasks performed in the context in which the study was being carried out. An attempt was made to make measures comparable by focusing on tapping into the cognitive representations of the different constructs of interest. The aim was to ensure the data collection process was rigorous which will in turn ensure that quality data was collected to facilitate appropriate inferences from the analyses. However, a key limitation of the data collection is that it was conducted under time-constraints hence small samples of children were recruited – approximately ten children for each phase of the pilot. Consequently, basic descriptive statistics, rather than inferential statistics, were used to check that the measures were functioning as intended. The piloting allowed me to become familiar with administering the different tasks and to estimate the length of time each task would take to be administered.

3.8.6 Chapter Summary

This chapter set out the research design which framed the development of this study. A cross-sectional research design was planned to support large scale data collection to test the theoretical claim that pretence and counterfactual reasoning share similar cognitive mechanisms. The piloting phase informed how the main study was conducted. After two phases of piloting, appropriate study measures were selected for assessing 4-5-year old children's cognitive ability in relation to pretence, counterfactual reasoning, inhibition, working memory and receptive language. The final selection of measures was chosen on the basis of being age-appropriate, could be administered within a reasonable time frame, and having a history of being reliable and valid measures of the constructs in the study. Additional goals achieved included: becoming familiar with the procedures for administering the different tasks, understanding the scoring procedures for each task, determining the length of time taken to administer each task, identifying the materials needed and trying out the audio and video equipment to be used. This is important given that the inferences made in any study are only as good as the measures upon which these inferences are based. The next chapter outlines the research methods of the study.

Chapter 4 Research Methods

4.1.0 Introduction

The research methods which guided the implementation of the main study are described in this chapter. The study participants are described, the ethical principles adhered to are discussed, each measure used to collect data is described, the data collection procedures are outlined, and the data analysis framework is laid out. A chapter summary is included at the end.

4.2.0 Participants

Study participants were sampled from across schools in Cambridgeshire, UK. Typically developing, reception-aged children were selected because it was thought to be the middle ground – an age where pretend play is still a self-initiated overt activity of children's interaction before it atrophies by middle childhood whilst counterfactual reasoning ability is burgeoning before it matures by middle childhood. Children with atypical development were therefore excluded from the study. The sample was conveniently drawn from seven primary schools across Cambridgeshire as due to financial constraints the research was conducted in the area where the researcher lived. Cambridge is a diverse university city and for many residents English is a second language. Hence, the language backgrounds and the general language development of the children were taken into account.

4.3.0 Study Measures

Two main variables, pretence and counterfactual reasoning, were investigated in this study and four additional variables, inhibition, working memory and receptive language, were also measured. The full task battery of measures selected to collect data on the study variables are stated in Table 4.1. Each measure is reviewed by providing a brief background on the task including information about task reliability, validity, the list of materials, procedures for administering and scoring each measure in the subsequent subsections of section 4.3.0.

Table 4.1 List of measures used in this study

Variables	Measures
Pretence	Child Initiated Pretend Play Assessment - CHIPPA (Stagnitti et al., 2000) Pretend Action Task – PAT (Overton & Jackson, 1973)
Counterfactual Reasoning	Location Change Task (Rafetseder & Perner, 2010)
Executive Function Tasks	
Inhibition	Head Toes Knees and Shoulders Task – HTKS (McClelland, Cameron, Duncan, Bowles, Acock, Miao, & Pratt, 2014) Delay of Self-Gratification Task (Mischel & Underwood, 1974; Thompson et al., 1997)
Working Memory	Spin the Pots (Hughes, 1998)
Receptive Language	Clinical Evaluation of Language Fundamentals -CELF (Wiig, Secord & Semel, 2006)

4.3.1 Pretence

Two measures of pretence were administered; the Child Initiated Pretend Play Assessment (CHIPPA) which assessed child pretend play and the Pretence Action Task (PAT) which assessed a child's ability to represent objects symbolically.

4.3.1.1 Child Initiated Pretend Play Assessment (CHIPPA) -

Background. The Child-initiated Pretend Play Assessment (CHIPPA) developed by Stagnitti, Unsworth, and Rodger (2000) was used as the measure of pretend play. The CHIPPA assessment was video recorded and children's performance on CHIPPA was scored from video. CHIPPA is a norm-referenced standardised assessment designed to measure children's cognitive skills in pretend play by assessing the child's ability to self-initiate pretend play. The CHIPPA can be used with children aged 3-years to 7-years 11 months.

CHIPPA is reported to be a clinically viable, reliable and valid assessment of child pretend play. Several studies have validated the reliability and validity of CHIPPA and found the CHIPPA shows: (a) concurrent validity with a test of children's social competencies assessed, Penn Interactive Play Scale (McAloney & Stagnitti, 2009; Uren & Stagnitti, 2009); test-retest reliability as evidence that the assessment produces a stable measure of pretend play (Stagnitti et al., 2000); and, inter-rater reliability in discriminating between the play of typically developing pre-schoolers and pre-schoolers with pre-academic problems (Stagnitti et al., 2000). According to Stagnitti, Unsworth, and Rodger (2000) their test is a more comprehensive measure of child pretence as compared to other measures like 'The Symbolic Play Test developed' by Lowe, and Costello (1982) which only assesses conventional-imaginative play and 'The Test of Pretend Play or The Warwick Symbolic Play Test' by Lewis and Boucher (1997) which only assesses a child's ability to substitute objects, attribute properties to objects, and refer to absent objects as if present. CHIPPA measures the elaborateness of a child's play (that is, how complex and organised the play is), the ability of a child to use symbols in play, and also considers if a child relies on someone else for play ideas.

Task Materials. There are two conditions of pretend play with the CHIPPA, symbolic play and conventional-imaginative play. A Wendy house is made by hanging a cloth over two chairs. The children are given the following materials and asked to play with them any way that they like.

1) Conventional-imaginative play: 1 truck, 1 trailer, 1 male doll, 1 female doll, 1 wrench, 4 sheep, 2 horses, 3 cows, 2 pigs, 3 goats, 1 rooster, 12 fences
2) Symbolic play: 1 large box, 1 small box, 1 dowel stick, 1 flat stick, 3 pebbles, 1 tin, 1 cone, 1 tea-towel, 1 face washer, 2 cloth dolls

Task Administration. The administration of CHIPPA involved engaging children in symbolic play and conventional-imaginative play for fifteen minutes each. Children were randomly assigned to the play conditions. According to the CHIPPA manual the order of the presentation of the play materials does not affect the overall assessment results. To administer the task each child was invited to sit in front of the Wendy House with the researcher. The toys for a given condition were presented but the researcher retained one doll for the modelling segment of play.

Each play condition ran for 15 minutes and to begin play the child was instructed, "Here are some toys for you to play with, you can play with them anyway that you like". For the first 5-minutes the child was observed playing. In the second 5-minutes the researcher could randomly model five different play actions where ever possible. For conventional-imaginative play five play actions could be modelled, namely: (a) The doll walks; (b) The doll pats the cow; (c) The doll fixes the truck or fence; (d) The doll drives the truck; (e) The doll waves. In the symbolic play the five play actions modelled were: (a) The doll waves; (b) The doll drinks; (c) The doll drives; (d) The doll walks; (e) The doll sleeps. The modelled actions were repeated as often as possible when the examiner had the opportunity to do so, but if the modelling interfered with a child's play, then the examiner did not persist, as the child did not need a model to play. The modelled actions could not suggest a story line. The researcher avoided modelling a play action that a child was actively demonstrating. In the final 5-minutes the child was encouraged to keep on playing, if encouragement was needed. The fifteen minutes of play were child-initiated, so the researcher allowed the child to take the lead and made no suggestions of what to play with or how to play. At the end of the thirty-minutes children were rewarded with stickers as a thank you for their participation.

Task Scoring. Each play action performed by a child while playing with CHIPPA toys is coded (see Appendix C for the CHIPPA coding scheme). The category of play action codes extracted from the coding scheme include:

- Non-play action – non-play action, child is not engaged with the play materials

- Repetitive action – repeats a series of actions or action more than twice
- Functional action – play materials are used in a functional way
- Elaborate action – functional actions used in a logical sequence; verbally attributes properties; refers to absent objects
- Object Substitution – represents objects given as if it were something else
- Imitative Action – child imitates the actions modelled by the researcher immediately

Pretend play behaviours on the CHIPPA are quantitatively scored on three attributes:

(1) Percentage of Elaborate Pretend Play Actions (PEPA): which measures the elaborateness of the child's pretend play. PEPA is calculated by dividing the number of elaborate actions by the total number of actions performed by the child and multiplying the answer by one hundred to get the percentage of elaborate actions score for each child.

(2) Number of Object Substitutions (NOS): measures the number of times the child uses an object in object substitution, for example, using the shoebox as a table. NOS is scored by counting the number of instances of object substitution coded for each child.

(3) Number of Imitated Actions (NIA): measures the ability of a child to carry out his/her own play ideas, without relying on a model to play. NIA is scored by counting the number of instances of imitated actions coded for each child.

Percentage of Pretend Play Actions and Number of Object Substitutions measure cognitive play skills and are referred to as cognitive play scores. Imitated actions measure the number of times the child imitates the examiner during the modelling segment of the play session may indicate that a child is not developmentally able to organise their own play and take charge of their play situation. Thus, a low score for imitated action suggests that the child did not rely on a model for play ideas whereas a high score for imitated actions is indicative of developmental delay and/or inability to self-initiate play ideas. Standard scores accompanied raw scores as test was normed on an Australian sample. A sample of the CHIPPA scoring sheet can be seen in Appendix C. The scoring of the CHIPPA was done from the video recordings children playing.

4.3.1.2 Pretend Action Task

Background. The Pretend Action Task developed by Overton and Jackson (1973) is a measure of children's ability to represent objects and actions symbolically. In the Pretend Action Task children are required to physically demonstrate a series of pretend actions designed to assess their level of representation of pretend gestures (Carlson, White, Davis-Unger, 2014). The Pretend Action Task is considered a reliable and sensitive measure for detecting differences in the developmental complexities of pretence as it relates to symbolic representation (Kirkham & Kidd, 2015).

Task Materials. The materials required are a piece of wood and a piece of paper.

Task Administration. Children were asked to perform action sequences directed to self: (1) pretend you are combing your hair with a comb (comb); (2) pretend you are brushing your teeth with a toothbrush (toothbrush); (3) pretend you are drinking out of a cup (cup); and action sequences directed to the external world (4) pretend you are hammering this (wooden block) with a hammer (hammer); (5) pretend you are cutting this (wooden block) with a knife (knife); (6) pretend you are cutting this (piece of paper) with a pair of scissors (scissors). The first three actions are referred to as actions directed to self (self-directed actions) and the remaining three are referred to as actions to the external world (externally-directed actions) and the two categories of actions were presented to students randomly.

Task Scoring. Scores ranging from 0 to 3 are assigned based on three criteria, respectively;

(1) no representation or performance of action sequences; (0)
(2) the participant uses their hand as the experimental object, for example using a finger to brush one's teeth; (1)
(3) the participant uses his hand '*as if*" correctly holding and operating on the experimental object; (2)

The assumption is that children come to perform symbolic representations of imagined objects toward self, earlier than actions directed toward the external world (Overton & Jackson, 1973). Using a symbolic object represents a more sophisticated developmental level of pretence.

4.3.2 Counterfactual reasoning

To assess children's counterfactual reasoning abilities the Location Change task developed by Rafetseder and Perner (2010) was selected.

4.3.2.1 Location Change Task

Background. The Location Change task was designed to check whether children can inhibit the tendency to use basic conditional reasoning to arrive at the correct answer to counterfactual reasoning questions in favour of effortful reasoning by integrating the counterfactual premise to arrive at the correct counterfactual response. Although this measure has only been reported in one published study it potentially has good construct validity as it is designed to discriminate among the different errors and reasoning strategies children make when reasoning counterfactually for example, realist errors from typical errors and basic conditional reasoning from effortful or adult-like counterfactual reasoning. The task which was originally written in German was obtained from the corresponding author on the publication Rafetseder and Perner, (2010) who translated it to English before sharing. The translation was further reviewed by an independent translator at the University of Cambridge to ensure that the content validity was maintained after translation.

Task Description. The task design uses four story themes relating to four main protagonists - Doctor, Teacher, Fire-fighter, and Police. The task was administered with the use of props designed using toys and cut-outs to create miniature versions of the setting where each character works. The materials used to administer the task are listed below:

(1) Doctor Story: hospital, park, swimming pool, doctor, doctor bag, toy- boy
(2) Teacher Story: school, house, playground, toy- teacher, toy- girl, toy-students,
(3) Firefighter Story: fire-station, forest, living room, fire-extinguisher, fire, toy fire-fighter
(4) Policeman Story: police station, car park, shopping centre, motor cycle, cars, toy-policeman

Task Administration. Each story has four variations or conditions. The four variations or conditions are referred to as Typical-1 (T1), Atypical-1 (At1), Typical-2 (T2), and Atypical-2 (At2). In Typical-1 and Atypical-1 tasks there is one location change – the protagonist moves from the typical or atypical location (counterfactual antecedent) to a final location where they are needed to solve a problem (counterfactual consequent). In the Typical-2 and Ayptical-2 tasks there are two location changes – the protagonist moves between the typical and atypical

locations or vice versa (counterfactual antecedents) before going to the final location where they are needed to solve a problem (counterfactual consequent).

The task simulates a protagonist moving between a typical location where they work to a consequent location and moving between an atypical location where the protagonist goes to the consequent location. The CFR question requires children to identify where the protagonist would be if they had not been called to their final location and the correct answer is the last typical or atypical antecedent location. The Location Change task essentially assesses if children can correctly answer whether the protagonist would counterfactually be in a typical or atypical location if he did not move to his last location (Rafetseder & Perner, 2010). A breakdown of the different location changes across all four of the story themes is presented in Table 4.2.

The administration of the four stories in the Location Change task followed a similar pattern. The full task battery of the Location Change task used in this study is in Appendix D. Each story was presented to participants by first familiarising the child with the different locations the protagonist navigates in the story. An illustration of how the Location Change Task was administered is provided using the Fire-fighter story. All four variations of the Fire-fighter story are presented accompanied with pictures for clarity in Figures 4.1, 4.2, 4.3, and 4.4.

Table 4.2 Location Changes in the Counterfactual Reasoning Location Change Task

CFR Stories	Location Changes	Typical-1	Atypical-1	Typical-2	Atypical-2
Doctor Story	1st	Hospital (typ-location)	Park (atyp-location)	Park (atyp-location)	hospital (typ-location)
	2nd	swimming-pool	swimming-pool	hospital (typ-location)	park (atyp-location)
	3rd			swimming-pool	swimming-pool
Teacher Story	1st	School (typ-location)	Playground (atyp-location)	playground (atyp-location)	school (typ-location)
	2nd	home of Pupil	home of pupil	school (typ-location)	playground (atyp-location)
	3rd			home of pupil	home of pupil
Fireman Story	1st	fire-station (typ-location)	living room (atyp-location)	living room (atyp-location)	fire-station (typ-location)
	2nd	Forest	forest	fire-station (typ-location)	living room (atyp-location)
	3rd			forest	forest
Policeman Story	1st	police-station (typ-location)	shops (atyp-location)	shops (atyp-location)	police-station (typ-location)
	2nd	car park	car park	police-station (typ-location)	Shops (atyp-location)
	3rd			car park	car park

*'typ-location' means typical location *'atyp-location' means atypical location

(a) *Typical-1: Fire-fighter Story*. The firefighter moves between the typical location of a fire station (antecedent location) to the forest (consequent location). The story sequence and location changes are illustrated in Figure 4.1.

Fire-fighter Story

***[1typ]* Set-up: forest and fire-station, but no living room.**

Look what I have brought with me: a fire-station and a forest (*placing both locations on the table*). Could you show me, where the fire-station is? And where the forest is?

Here is a fire-fighter, and I would like to tell you a story about this fire-fighter. This fire-fighter works at this fire-station (*point to fire-station*). Look! At the fire-station he is making sure the fire extinguisher works well for when he needs it. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The fire-fighter is called away to an emergency.
Look what has happened: a fire has broken out in the forest. Some trees are already on fire!
Look! The fire-fighter takes his fire-extinguisher and runs to the forest to put out the fire (*take flames off the trees*).

Now Control Question: "Where is the fire-fighter now?" _____
Counterfactual Question: "If the fire had not broken out, where would the fire-fighter be now?"
_____
If child does not reply provide answer options in a counterbalanced way:

q. "In the forest or at the fire station?"
r. "At the fire station or in the forest?"

Before Control Question: "Where was the fire fighter when he received the phone call that some fire has broken out?" _____

Figure 4.1 Firefighter Story Typical 1 scenario

(b) *Atypical-1: Fire-fighter Story*. The fire fighter moves between the atypical location of a living room (antecedent location) to the forest (consequent location). The story sequence and location changes are illustrated in Figure 4.2.

***[1atyp]* Set-up: forest and living room, but no fire-station.**

Look what I have brought with me: a living room and a forest. Show me, where the living-room is? And where the forest is?

Look, I have a fire-fighter here, and I would like to tell you a story about this fire-fighter. Before work this fire-fighter is at home in his living room (*point to living room*). Look! He is sitting on his sofa watching TV. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The fire-fighter is called to an emergency!

Look what has happened: a fire has broken out in the forest. Some trees are already on fire!

Look! The fire-fighter takes his fire-extinguisher and runs to the forest to put out the fire (*take flames off the trees*).

Now Control Question: "Where is the fire-fighter now?" _____

Counterfactual Question: "If the fire had not broken out, where would the fire-fighter be now?"

_____

If child does not reply provide answer options in a counterbalanced way:

s. "In the forest or the living-room?"

t. "In the living room or in the forest?"

Before Control Question: "Where was the fire-fighter when he received the phone call that some fire has broken out?" _____

Figure 4.2 Firefighter Story Atypical 1 Scenario

(c) *Typical-2: Firefighter Story*. The firefighter moves between the atypical location of a living room and typical location of a fire-station (two antecedent location changes in the story) before proceeding to the forest (consequent location). The story sequence and location changes are illustrated in Figure 4.3.

***[2typ]* Set-up: forest, living room, and fire-station.**

Look what I have brought with me: a fire-station, a living room and a forest. Show me again, where the fire-station is? And where is the forest? And where is the living room?

Look! I have a fire-fighter here, and I would like to tell you a story about this fire-fighter. Before work this fire-fighter is at home in his living room (*point to living room*). Look! He is sitting on his sofa watching TV. But now it is time to go to work.

This fire-fighter works at this fire-station (*point to fire-station*). At the fire-station he is making sure the fire extinguisher works well for when he needs it. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The fire-fighter is called away to an emergency.
Look what has happened: a fire has broken out in the forest. Some trees are already on fire!
Look! The fire-fighter takes his fire-extinguisher and runs to the forest to put out the fire (*take flames off the trees*).

Now Control Question: "Where is the fire-fighter now?" _____
Counterfactual Question: "If the fire had not broken out, where would the fire-fighter be now?"
_____

If child does not reply provide answer options in a counterbalanced way:

u. "At the fire-station or the living-room?"
v. "In the living room or at the fire station?"

Before Control Question: "Where was the fire-fighter when he received the phone call that fire has broken out?" _____

Figure 4.3 Firefighter Story Typical 2 Scenario

(d) *ATypical-2: Firefighter Story*. The firefighter moves between the typical location of the fire-station and an atypical location of a living room (two antecedent location changes in the story) before proceeding to the forest (consequent location). The story sequence and location changes are illustrated in Figure 4.4.

***[2atyp]* Set-up: forest, living room, and fire-station.**
Look what I have brought with me: a fire-station, a living room and a forest. Show me again, where the fire-station is? And where is the forest? And where is the living room?

Look! I have a here, and I would like to tell you a story about this fire-fighter. After work, the fire-fighter walked home and is now in his living room (*point to living room*). Look! He's sitting on his sofa watching TV. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The fire-fighter is called away to an emergency.
Look what has happened: a fire has broken out in the forest. Some trees are already on fire!
Look! The fire-fighter takes his fire-extinguisher and runs to the forest to put out the fire (*take flames off the trees*).

Now Control Question: "Where is the fire-fighter now?" _____
Counterfactual Question: "If the fire had not broken out, where would the fire-fighter be now?"
_____
If child does not reply provide answer options in a counterbalanced way:
w. "At the fire-station or the living-room?"
x. "In the living room or at the fire station?"
Before Control Question: "Where was the fire-fighter when he received the phone call that some fire has broken out?" _____

Figure 4.4 Firefighter Story Atypical 2 Scenario

Task Scoring. All responses were assigned a score of one for correct responses and zero for incorrect responses. This applies to control questions as well as the CFR question. Error patterns from incorrect responses were also coded as these are indicators of the reasoning strategies children employ to answer counterfactual reasoning questions. The classification of responses based on reasoning errors are summarised in Table 4.3.

Table 4.3 Classification of Responses by Reasoning Errors

Story	Task	CF answer = 1	Reality Error = 2	Typical Error = 3	Atypical Error = 4
Doctor	Typical 1	Hospital	Swimming pool		
	Atypical 1	Park	Swimming pool	Hospital	
	Typical 2	Hospital	Swimming pool		Park
	Atypical 2	Park	Swimming pool	Hospital	
Teacher	Typical 1	School	House		
	Atypical 1	Playground	House	School	
	Typical 2	School	House		Playground
	Atypical 2	Playground	House	School	
Fireman	Typical 1	Fire-station	Forest		
	Atypical 1	Liv-room	Forest	Fire-station	
	Typical 2	Fire-station	Forest		Living-room
	Atypical 2	Liv-room	Forest	Fire-station	
Policeman	Typical 1	Police station	Car park		
	Atypical 1	Shopping centre	Car park	Police station	
	Typical 2	Police station	Car park		Shopping centre
	Atypical 2	Shopping centre	Car park	Police station	

Differences from the original task. There were a number of variations between the original version of the story and how this task was administered which should be outlined. These differences will be factored in when interpreting results from the two studies:

a) The order of the presentation of the stories were counterbalanced using a Latin Square design but the conditions were not counterbalanced. Rafetseder and Perner (2010) counterbalanced at both levels.

b) Every task began with introducing the different 'locations' in the story and then asking the participant to identify each location, for example, "show me again where the fire-station is? And where is the forest? And where is the living-room?" The participant did not proceed with the task unless they correctly identified each location. A record was not kept of the number of times these questions had to be repeated. Rafetseder and Perner (2010) kept track of the number of repetitions for these questions, treating them as control questions.

(c) Another noteworthy difference relates to the 'Before Control' question. If a participant failed the before control question; the control question was repeated to give the participant a second go at answering the question. Regardless of the answer the subsequent questions (counterfactual reasoning question and Now Control question) were posed. This is markedly different from how the task was originally administered by (Rafetseder & Perner, 2010) who repeated the story to students if they failed to answer the first control question correctly. Arguably, repeating the story and subsequent control question allows one to attribute a child's success on the counterfactual reasoning task to their capacity for counterfactual reasoning over a memory fault. The researcher therefore acknowledges that by not repeating the story when a participant was unsuccessful at answering the first control question may be a limitation of this study. Traditionally, it is thought that the burden of memory recall removes the focus on whether a child can answer the counterfactual question correctly or not.

4.3.3 Executive Functions

Three measures of executive functions were administered targeting working memory and inhibitory control. Two of the tasks were measures of inhibition which can be defined as simple and complex inhibition similar to the classification used by (Garon et al., 2008). The tasks were a delay of gratification paradigm and the Head Toes Knees and Shoulders task.

4.3.3.1 Head Toes Knees and Shoulders Task (HTKS)

Background. The HTKS was developed by McClelland, Duncan, Bowles, Acock, Miao, and Pratt (2014). It can be described as a complex inhibition measure as it involves holding an arbitrary rule in mind, responding according to this rule, and inhibiting a dominant response (Garon et al., 2008). HTKS is reported to have good construct validity in relation to other executive function measures (McClelland et al., 2014).

Task Administration. HTKS takes the form of a short game which uses no materials but only relying on interactions between the examiner and the child. The only apparatus is the task sheet for recording students' actions. The HTKS comprised of three sections with up to four paired behavioral rules: "touch your head" and "touch your toes", "touch your shoulders" and "touch your knees". Children are guided through a series of instructions first requiring them to respond naturally followed by a switch in the instructions as in, "when I ask you to touch your head instead of touching your head you touch your toes and when I ask you to touch your knees instead of touching your knees you touch your shoulders". Hence, the activity becomes increasingly challenging where children must remember the switch for two actions (head and toes) – first trial, then four actions (head, toes, knees and shoulders) – second trial, and then another switch as in, 'when I ask you to touch your head you touch your knees and when I ask you to touch your shoulders you touch your toes'- third trial.

Task Scoring. Children got one mark for each correct switch they performed. The HTKS record sheet can be found in Appendix E.

4.3.3.2 Delay of Gratification Task

Background. The delay of gratification task used in this study was based on that reported by Thompson, Barresi, and Moore (1997). Delay of Gratification is a measure of impulse control or inhibition. The delay of gratification paradigm used assessed a child's ability to make an initial choice for a delayed reward in preference to a current reward (Thompson et al., 1997). This task was used to keep children motivated, between each counterfactual reasoning story. The reward of stickers based on the options of 'now' or 'later' was used to sustain children's attention for the duration of the administration of the sixteen counterfactual reasoning stories.

Task Materials. The only materials needed for this task were stickers.

Task Administration. A child was offered the opportunity to win "1 sticker now" or "2 stickers for later" before each of the four counterfactual reasoning story set (doctor, teacher, fire fighter, policeman). The four delay of gratification trials were interspersed before each CFR story by saying to the participant, "Before I tell you the stories about the Fire fighter (or Doctor, Teacher, Policeman) you can have 1 sticker now or two stickers for later - which would you like?" If the child chose one sticker now; they could have that sticker right away. If the child chose two stickers for later, they would have to wait to get the stickers after they heard the four versions of a given counterfactual story. The envelope for delayed-reward stickers was shown to the child and they were assured that if delayed-reward were chosen, the stickers would be placed in the envelope and saved until the end of the stories. At the end of the game, all the stickers were taken out of the envelope and handed to the child, so they could take them home. The researcher's responses to any of the participants' choices remained uniform and mildly positive.

Task scoring. The number of stickers the child chooses for each trial makes up their total score on the task. In other words, 1 score for choosing one sticker now and 2 scores for choosing 2 stickers for later. A participant could receive between 4 to 8 stickers unless they indicated that they did not want to receive any sticker reward at all.

4.3.3.3 Spin the Pots

Background. The Spin the Pots task developed by Hughes (1998) was used to assess working memory. Working memory generally involves holding information in mind and updating the information held in mind (Garon et al., 2008). This task has been administered in numerous studies. Hence, it is considered to be reliable and valid measure of working memory (Beck, Schaefer, Pang, & Carlson, 2011; Hughes & Ensor, 2005).

Task Administration. The materials used were: 1 Lazy-Susan, twelve differently shaped boxes each painted a different colour, a white, opaque hand kerchief large enough to cover the boxes, and 10 stickers per children. Each child was given their ten stickers and invited to hide individual stickers in ten of the twelve boxes. Then the boxes were placed on the Lazy-Susan, covered with the hand kerchief and spun. Afterwards, the scarf was lifted, and the child is asked to recall where the stickers were hidden. Whether or not the child wins a sticker the box is returned to the Lazy-Susan, covered, and spun ready for the next trial. After each spin only one box could be selected at a time and this continues until the child finds all 10 stickers hidden or their twenty chances ran out whichever is sooner.

Task Scoring. Performance scores on the task were calculated as 20 trials minus the total number of errors made.

4.3.4 Receptive Language

Receptive language is an index of listening and auditory comprehension (Wigg et al., 2006).

4.3.4.1 Clinical Evaluation of Language Fundamentals

Background. The Clinical Evaluation of Language Fundamentals (CELF) Preschool-2^{uk} pinpoints language and communication strengths and weaknesses in children ages 3 to 6 years. Receptive language developed was the focus of assessment and were assessed using two subtests of the Clinical Evaluation of Language Fundamentals (CELF) by Wigg, Secord, and Semel (2006). The assessment comprises of two components: (a) Sentence Structure and (b) Concepts and Following Directions. Sentence Structure evaluates the child's ability to interpret spoken sentences of increasing length and complexity. Understanding spoken sentences is an integral feature of developing conversational skills, participating in interactive story-telling, following directions, as well as, understanding of relationships between spoken language, real-

life references and situations emphasized through listening to stories, descriptions of events and matching pictured references to spoken or read stimuli. Concepts and Following Directions evaluates the child's ability to interpret spoken directions of increasing length and complexity that contain concepts that require logical operations; remember the names, characteristics, and order of mention of pictures; and identify from among several choices the targeted objects. The task speaks to children's comprehension, recall and the ability to act upon spoken directions. CELF Preschool-2^{uk} is recognized for having been standardized on a UK sample which is comparable to the US and reports having good reliability and validity.

Task Materials. This is a standardised assessment, so the materials are provided in the form of a Stimulus Book, Stimulus Sheets for the Concepts and Following Directions task and the Record Form to input participants' responses. (see Appendix F for record forms for both Sentence Structure and Concepts & Following Directions).

Task Administration. For both tasks, Sentence Structure and Concepts & Following Directions, the child points to pictures in the Stimulus Book in response to oral directions. Each assessment requires participants to respond to twenty-two sentences. Items were not repeated for the Concepts & Following Directions subtest but could be repeated for the Sentence Structure subtest. Discontinue rules were applied if participant scored incorrectly on five consecutive items for the Sentence Structure subtest and six consecutive items for the Concepts & Following Directions subtest.

Task Scores. Participants were assigned one score for correct responses and zero for incorrect responses. Standard scores accompanied raw scores as the test was normed on a UK sample. The CELF is a norm-referenced standardized test that is suitable for comparing children with peer groups allowing comparability between test sample participants and normed sample participants.

4.4.0 Data Collection Procedures

Each child was tested individually in a quiet space at their school. Children completed three sessions of testing. One session to administer the CHIPPA and pretence action task lasting forty minutes, another session to administer the Location Change CFR task and delay of gratification task lasting forty minutes, and the third session to administer the control measures (the EF tasks and the receptive language task) lasting thirty minutes. All the sessions were audio recorded except for the CHIPPA which was video-recorded. A research assistant was recruited and assisted with data collection at two of the seven schools recruited for the study. Table 4.2 shows the breakdown of each task and its corresponding duration time for administration.

Table 4.4 Overview of Data Collection Sessions and Tasks Administered

<table>
<tr><th>Duration (minutes)</th><th>Session One</th><th>Session Two</th><th>Session Three</th></tr>
<tr><td>5 minutes</td><td rowspan="8">CFR Location Change Task

&

Delay of Gratification Task</td><td>Pretence Action Task</td><td>WM – Spin the Pots</td></tr>
<tr><td>10 minutes</td><td rowspan="3">CHIPPA Conventional Imaginative Play</td><td rowspan="2">Concepts & Following Directions</td></tr>
<tr><td>15 minutes</td></tr>
<tr><td>20 minutes</td><td rowspan="3">Head Toes & Knees Shoulders Task</td></tr>
<tr><td>25 minutes</td><td rowspan="3">CHIPPA Symbolic Play</td></tr>
<tr><td>30 minutes</td><td rowspan="3">Language Sentence Structure</td></tr>
<tr><td>35 minutes</td></tr>
<tr><td>40 minutes</td></tr>
</table>

4.5.0 Ethical Considerations

Several ethical principles were adhered to during this study. These include communicating information transparently to secure participants' informed consent, informing participants of their right to withdraw from the study, providing participants with incentives for participating and employing good practices that ensured that the data generated from the study were stored securely so the privacy of participants was maintained (British Educational Research Association [BERA], 2018). Before commencing fieldwork, a Disclosure Barring Service (DBS) check - a criminal records check which verifies that a person is suitable to work with young, vulnerable persons – was undertaken because it is a legal requirement before one can begin working with children in the UK. This present study underwent ethical review in accordance with institutional procedures by the Faculty of Education, University of Cambridge. Permission to carry out the research with school-aged children was subsequently obtained from schools, headteacher and principals, who agreed for their reception classes to participant (see Appendix G – School Information Letter). Written informed consent was obtained from parents on behalf of all children before they could partake in the research activities given data was collected from 3-5-year-old children (see Appendix H – Parent Consent Letter). Upon inclusion into the study, where possible, child assent was also sought by allowing each child to express their agreement to take part in the research exercise before participating in any of the tasks, thereby protecting children's wellbeing by respecting their right to withdraw at any point during testing. Additionally, to keep children motivated during the administration of the battery of cognitive tasks children were rewarded with stickers after each task they completed as an incentive for participating. At all stages of the investigation participant data and records were maintained securely, in a manner that ensured the confidentiality and anonymity of the participant. Identifiable information like names of schools and participant names are not disclosed in this report (American Psychological Association [APA], 2010).

4.6.0 Data Analysis Plan

This section gives an overview of the data analyses conducted for this study. This present study brings together two variables which traditionally have been investigated independently with the intent of exploring possible links which may exist between the two. Hence, it was decided to explore the findings for pretence and counterfactual reasoning separately before considering

associations between the two and with other related cognitive skills. The general data analyses procedures are detailed below:

A) Pretence - This study measured indicators of pretence and used these to draw inferences about the cognitive structure of pretence. Pretence is a multi-dimensional construct and there is no consistent pattern to which indicators of pretence are studied across different studies. To my knowledge, there are no published reports from the CHIPPA with a UK sample. Hence, it was important to understand the relationship between the indicators of pretence measured in this study. Pretence is defined in this present study by the variables of elaborate pretend play, and object substitution derived from the two conditions of play with the CHIPPA (with conventional imaginative toys and symbolic toys), and symbolic representation derived from the Pretend Action Task.

- ANOVA analyses were used as preliminary analyses to explore whether participants' performance on pretence indicators were dependent on factors like gender.
- Correlational analyses were used to explore associations between the indicators of pretence measured - elaborate pretend play, object substitution, symbolic representation.
- Cronbach alpha was run to check that indicators yielded good internal consistency.
- A Confirmatory Factor Analysis (CFA) was run on the measured indicators of pretence to determine whether the indicators of pretence could be explained by a single latent factor. This factor would be subsequently used to assess whether pretence and counterfactual reasoning were correlated at a latent level.

B) Counterfactual Reasoning – The counterfactual reasoning task used in this study has only been published in one previous study by Rafetseder and Perner (2010). This task was selected because it attempts to discriminate between naïve counterfactual reasoning (basic conditional reasoning) and mature adult-like counterfactual reasoning. To my knowledge, there is also no published report of this being used with a UK sample. Hence, it was important to understand how participants from this study context performed in this counterfactual reasoning task. Counterfactual reasoning is inferred by comparing children's performance across the four counterfactual reasoning scenarios based on the typical and atypical scenarios of which atypical-2 tasks, especially, require children to overcome basic conditional reasoning to provide the correct counterfactual reasoning responses.

- Several Chi-square analyses were conducted to assess reasoning error patterns across participants' responses to the counterfactual reasoning questions. These include Friedman Chi-square Test and McNemar Chi-square test.
- Correlation analyses were used to explore associations among the counterfactual conditions specified in the task.
- Cronbach alpha was run to check how well the items from the different counterfactual conditions hang together.
- A Confirmatory Factor Analysis (CFA) was run on the measured indicators of counterfactual reasoning to determine whether the indicators could be explained by a single latent factor. This factor would be subsequently used to assess whether pretence and counterfactual reasoning were correlated at a latent level

(C) The goal of this study is to understand the nature of the relationship between pretence in counterfactual reasoning. One way of achieving this goal is to unpick associations between Pretence and Counterfactual Reasoning with each other and in relation to other cognitive skills. Specifically, contributions of executive functions - working memory, inhibition, delay of gratification, and receptive language, to pretence and counterfactual reasoning were explored in this present study.

- Correlational analyses showed the associations between the latent scores of pretence and counterfactual reasoning to the executive function skills - working memory, inhibition, delay of gratification, - and receptive language variables. Partial correlations established whether correlations remained significant after controlling for age in months.
- Hierarchical Multiple Regression analyses compared the unique contributions of executive function variables and receptive language to pretence and counterfactual reasoning. In separate regressions pretence and counterfactual reasoning were treated as dependent variables. The independent variables added in separate steps in the model were Working memory, inhibition, and language. Age in months and receptive language were added first, in separate steps, as controls. The goal was to understand if pretence and counterfactual reasoning share cognitive mechanisms by comparing which variables significantly predicted pretence and counterfactual reasoning abilities.

(D) As part of the goal of understanding the nature of the relationship shared by pretence and counterfactual reasoning the relationship between the two were explored at a structural level using structural equation modelling analyses (SEM). SEM is a statistical technique used to reduce the number of observed variables into a smaller number of latent variables by examining the covariation among the observed variables (Schreiber et al., 2006). A hypothesized model of the structural relationship shared by pretence and counterfactual reasoning is proposed in Chapter 3 Research Design section 3.2.0. and tested in the following way:

- Bifactor analysis was used to assess whether a general factor accounts for significant covariance in all the observed measures and whether the domain-specific factors of pretence and counterfactual reasoning accounts for unique variance in the indicators of the specific domain over and beyond the general factor (Brown, 2015). A bifactor model is well known for assessing the multi-dimensionality of a domain structure by assessing whether the data are more or less consistent with both unidimensional (i.e., a strong general factor) and multidimensional (i.e., two or more conceptually narrower, correlated factors) measurement models (Rodriguez et al., 2016). Based on this model the prevailing question is whether there is enough variance in the data to extract a general factor that could explain relationship shared by pretence and counterfactual reasoning, as well as, to extract latent constructs representing – pretence and counterfactual reasoning
- A second SEM model used was a second-order factor model which tested whether a higher order factor accounts for the relationship observed among lower order factors (Chen et al., 2006). This model works on the premise that lower order factors (pretence and counterfactual reasoning) are correlated and that association can be explained by second-order general factor.

The two different theoretical models provide two different ways of conceptualizing the explanation of how pretence and counterfactual reasoning might share cognitive mechanisms. Although different in their approaches, both bifactor model analysis and second-order factor analysis start from the same premise; that is, two related domains comprise of a general factor or construct (Chen et al., 2006). However, in a bifactor model approach the data is explored to determine whether it is strong enough to judge whether the multidimensional nature of the data can justify a unidimensional measurement model (Rodriguez et al., 2016). In other words, can the data account for a general factor over and above the variance explained by that of the

domain factors? In a second-order factor analysis approach, the general factor accounts for the commonality among lower order factors or domain factors (Chen et al., 2006). The assumption tested considers if the data are strong enough to estimate a general factor that accounts for the correlation shared by the domain factors. Moreover, the substantive difference between the two models is to do with the extent to which the relationship between the domain-specific factors are independent of the general factor.

The two different models mapping the possible latent relationships shared by pretence and counterfactual reasoning were compared and the adequacy of the models were assessed by: (a) checking that each hypothesized model is identified by the data, and (b) checking that the model meets the required model fit criteria. A model is said to be identified when a unique solution exists for all the model parameters and the statistical adequacy of the model is derived from the results of the goodness of fit tests (Bartholomew et al., 2008). The model which best fit the data was selected and used to explain the structural relationship shared by pretence and counterfactual reasoning.

4.7.0 Missing Data

Instances of missing data were primarily from incomplete task batteries arising from participants being absent from school, non-responses during task administration, and in the case of the pretend play measure some ten percent of pretend play videos were not coded because of time-constraints. The Delay of Gratification task was introduced after the start of the study. Hence, participants from the first two schools (approximately twenty-eight children) did not do this task. Otherwise, missing data was from participant absenteeism and non-responsiveness. Since, cases of missing data varied across tasks; cases with missing data were not entirely excluded from the study but only from those analyses which included the missing measure to avoid losing statistical power. Hence, where applicable analyses were run using pairwise deletion. Missing values were not imputed given the small number of missing cases and that not all cases were missing at random. Table 4.3 summarises missing data across the different variables.

Table 4.5 Number of Missing Data Across Study Tasks

Variables	Measures	Sub-tasks	N	Missing
Counterfactual Reasoning (CFR)	Location Change Task	Doctor Story	189	6 (3%)
		Teacher Story	189	10 (5%)
		Fireman Story	189	7 (4%)
		Policeman Story	189	8 (4%)
Pretence/ Pretend Play (PP)	Child Initiated Pretend Play Assessment (CHIPPA)	Elaborate Pretence Combined*	189	18 (10%)
		Object Substitution Combined*	189	19 (10%)
		Imitated Actions Combined*	189	19 (10%)
	Pretend Action Task (PAT)		189	5 (2%)
Receptive Language	CELF- Sentence Structure and Concepts & Following Directions combined		189	4 (2%)
Working Memory	Spin the Pots Task		189	4 (2%)
Inhibition	Head Toes Knees & Shoulders task (HTKS)		189	8 (4%)
	Delay of Gratification (DoG)		189	36 (19%)

*combined scores are derived from the summing the two conditions of play from the CHIPPA
*Imitated action scores are indicators of the child's reliance on pretend play ideas modelled by the researcher
*refer to section 4.3.1.1 CHIPPA descriptions

4.8.0 Chapter Summary

This chapter provided an overview of the research methods employed for this study. The study participants are identified and the rational for selecting the specific age range to study is explained. All the measures used to collect data in this study are described by providing a background, list of materials, task administration procedures and scoring guidelines. The general data collection procedures followed are explained. Plans for data analysis were framed based on participants' performance for the pretence and counterfactual reasoning tasks independently. Data analyses methods included correlational analyses, ANOVA, factor analyses and hierarchical multiple regressions. Finally, the treatment of missing data is explained.

Chapter 5 Results A

5.1.0 Introduction

This chapter is the first of two results chapters for this thesis. The overall aim of the study, and the research questions which framed the study design are reviewed. The study sample is described and the findings from the first two research questions are addressed in this chapter. The first two research questions are aimed at exploring findings about pretence and counterfactual reasoning independently before considering how the two are related with each other and other cognitive skills like executive functions and receptive language. The first two research questions are important because they clarify how pretence and counterfactual reasoning are conceptualized and set the parameters for generalizations made about pretence and counterfactual reasoning from this study. Quantitative analyses were done primarily using Stata release version 12 (StataCorp., 2011) and to a lesser extent with IBM SPSS version 25 (IBM Corp, 2017).

5.2.0 Study Aim

This thesis aimed to explore the theoretical assertion that counterfactual reasoning and pretence are related cognitive skills which share similar cognitive mechanisms.

5.3.0 Research Questions

The main research questions addressed in this study are outlined here and sub-questions which incrementally generated findings to answer the main research questions are stated.

RQ 1. Is there evidence that the observed pretence behaviours depend on a common underlying ability in this domain?

1a. Are the indicators of pretence correlated?

1b. Can the indicators of pretence be reduced to a single latent factor?

RQ 2. Is there evidence that the observed counterfactual reasoning behaviours depend on a common underlying ability in this domain?

2a. Are the indicators of counterfactual reasoning correlated?

2b. What do patterns of errors and successes in children's counterfactual reasoning responses tell us about the type of reasoning strategies they employ?

2c. Can the indicators of counterfactual reasoning be reduced to a single latent factor?

RQ3. How are pretence, counterfactual reasoning, executive functions, and receptive language associated?

3a. Are pretence, counterfactual reasoning, executive functions, and receptive language correlated?

3b. Do receptive language, symbolic representation, and EFs account for unique variance in Child-initiated Pretence?

3c. Do receptive language, symbolic representation, and EFs account for unique variance in CFR?

RQ4. Is there support for the idea that the constructs from the domain of pretence and counterfactual reasoning are underpinned by a general imaginative representation ability?

4a. Is there support for the latent model showing the relationship between pretence and counterfactual reasoning?

4b. Is there support for the structural model showing that pretence and counterfactual reasoning are underpinned by an imaginative representation ability?

5.4.0 Study Sample

The study participants were reception-aged children attending schools across Cambridgeshire. The sample comprised 192 children. The study focused on typical development so any participant with a diagnosis of atypical development was excluded from the analyses. Three participants were excluded due to having a diagnosis of Autism Spectrum Disorder. Participant data were analysed for 189 typically developing children; males = 101, females = 88 with 32% (n=62) of participants coming from multilingual homes. Participants' ages ranged from 48 months to 68 months (M = 58, SD = 4).

5.5.0 Research Question 1: Is there evidence that the observed pretence behaviours depend on a common underlying ability in this domain?

In this section, the role of pretence as an independent variable in this study is examined. To answer the research question, correlational analysis was used to determine if the indicators of pretence correlated with each other and a confirmatory factor analysis (CFA) was run to extract a latent construct of pretence. This is an important question because it clarifies how well the indicators selected to represent the concept of pretence hang together and thereby indicates the validity of the construct of pretence. Three indicators of pretence were measured – elaborate pretend play, object substitution and symbolic representation. Pretence was assessed using: The Child Initiated Pretend Play Assessment (CHIPPA) developed by Stagnitti, Unsworth, and Rodger (2000) and the Pretend Action Task by Overton and Jackson (1973). A brief recap of what the measure entails will help to provide the reader with some context for interpreting the results. Summary descriptives and tests of parametric analyses are reported. The correlations among the indicators are also examined and the results of the CFA are reported. The section concludes with a summary of the findings.

5.5.1 CHIPPA

The CHIPPA measure provided indicators of elaborate pretend play and object substitution. Children were video recorded participating in two pretend play conditions: (1) Conventional-imaginative Play with conventional or structured play materials in the form of a farm set and (2) Symbolic Play with unstructured play materials in the form of random objects like a tin, cone, et. cetera, both of which lent themselves to eliciting elaborate pretend play actions and object substitution actions (see the Chapter 4 Research Methods section 4.3.1.1 for a full description of the task battery and scoring procedures). For each condition, records of children's play actions are pooled into three categories:

1) **Percentage of Elaborate Pretend Play** to reflect the complexity of a child's ability to logically sequence pretend play actions, such that, the longer the sequence of play actions the more complex and organised the play of the child and the higher the elaborate play score;
2) **Number of Object Substitutions** to indicate the use of symbols in play by representing play object as if they were something else, such that, the higher this score the more symbolic and representative is the play of the child, and;
3) **Number of Imitated Actions** to identify if a child imitates the experimenter's actions as this shows that a child has difficulty initiating their own play ideas, such that the

lower this score the more likely that the child is spending time self-initiating their pretend play.

CHIPPA results are therefore reported for the two play conditions; conventional-imaginative play (CV) and symbolic play (SY). Each condition comprises three subscales: percentage of elaborate pretend play (PEPA), number of object substitutions (NOS), and number of imitated actions (NIA).

5.5.1.1 CHIPPA inter-rater reliability

11% (n=20) of the total sample (n = 189) was double coded by the researcher and a second observer to obtain inter-rater reliability agreement. Intra-class correlation (ICC) analyses based on a mean-rating for two coders (k=2) using a 2-way mixed-effects consistency model was used to measure inter-observer consistency on PEPA, NOS, and NIA. CHIPPA sub-scales were found to have good to excellent reliability and are reported in Table 5.1 (Koo & Li, 2016; Shrout & Fleiss, 1979).

Table 5.1 CHIPPA Inter-rater Reliability Results from Intra-class Correlations

CHIPPA Sub-scores	Average ICC	95% CI	Significance Level
PEPA Conventional	.88	[.67, .95]	F (19,19) = 7.53, p < .001
PEPA Symbolic	.96	[.90, .98]	F (19,19) = 25.03, p < .001
PEPA Combined	.94	[.85, .98]	F (19,19) = 16.29, p < .001
NOS Conventional	.90	[.74, .96]	F (19,19) = 9.73, p < .001
NOS Symbolic	.96	[.89, .98]	F (19,19) = 23.84, p < .001
NOS Combined	.96	[.89, .98]	F (19,19) = 23.75, p < .001
NIA Conventional	.88	[.71, .95]	F (19,19) = 8.56, p < .001
NIA Symbolic	.87	[.67, .95]	F (19, 19) = 7.73, p < .001
NIA Combined	.84	[.60, .94]	F (19, 19) = 6.26, p < .001

ICC: Intraclass Correlation Coefficient
CI: Confidence Intervals
PEPA conventional: Percentage of Elaborate Pretend Play in the conventional imaginative play condition
PEPA symbolic: Percentage of Elaborate Pretend Play in the symbolic play condition
PEPA combined: Percentage of Elaborate Pretend Play combined across conventional imaginative play and symbolic play conditions
NOS conventional: Number of Object Substitutions in the conventional imaginative play condition
NOS symbolic: Number of Object Substitutions in the symbolic play condition
NOS combined: Number of Object Substitutions combined across conventional imaginative play and symbolic play conditions
NIA conventional: Number of Imitated Actions in the conventional imaginative play condition
NIA symbolic: Number of Imitated Actions in the symbolic play condition
NIA combined: Number of Imitated Actions combined across the conventional imaginative play and symbolic play conditions

5.5.1.2 Descriptive Statistics

The scores for the CHIPPA subscales are summarised as means, standard deviations, minimum and maximum scores and presented in Table 5.2. Children had a higher percentage average of PEPA scores in the conventional-imaginative play condition than the symbolic play condition. This shows that children engaged in longer sequences of complex and organised elaborate pretend play when playing with conventional toys than unstructured toys. Conversely, children had a higher average of object substitution scores in the symbolic play condition than the conventional play condition. The low average number of object substitutions in the conventional play condition suggested that children were less likely to engage in symbolic play when playing with familiar conventional toys like a farm set. Scores for imitative action were few for both conventional and symbolic play conditions which is expected for typically developing children suggesting that children were more likely to initiate their own pretend play ideas than to imitate the pretend actions modelled by the experimenter. Overall, children had low mean scores for object substitution in the conventional play condition and for all three number of imitative action scores (conventional play, symbolic play and combined).

Table 5.2 Summary Statistics of CHIPPA Scores

Sub-scales	N	Mean	SD	Min	Max
PEA-CV	170	66.76%	15.77	15%	95%
PEPA-SY	171	48.57%	21.20	0%	86%
PEPA-CB	171	115%	32.55	17%	180%
NOS-CV	170	2.25	6.05	0	49
NOS-SY	171	12.86	9.86	0	42
NOS-CB	170	15.07	10.95	0	49
NIA-CV	170	1.08	2.04	0	18
NIA-SY	171	1.34	1.71	0	7
NIA-CB	170	2.37	2.81	0	19

PEPA-CV: Percentage of Elaborate Pretend Play in the conventional imaginative play condition
PEPA-SY: Percentage of Elaborate Pretend Play in the symbolic play condition
PEPA-CB: Percentage of Elaborate Pretend Play combined across conventional imaginative play and symbolic play conditions
NOS-CV: Number of Object Substitutions in the conventional imaginative play condition
NOS-SY: Number of Object Substitutions in the symbolic play condition
NOS-CB: Number of Object Substitutions combined across conventional imaginative play and symbolic play conditions
NIA-CV: Number of Imitated Actions in the conventional imaginative play condition
NIA-SY: Number of Imitated Actions in the symbolic play condition
NIA-CB: Number of Imitated Actions combined across the conventional imaginative play and symbolic play conditions

5.5.1.3 Testing Assumptions of Parametric Analyses

Shapiro-Wilk tests of normality were conducted for all nine sub-scales of the CHIPPA measure and are reported in Table 5.3 along with skewness and kurtosis statistics. Histograms visualizing the distribution of CHIPPA scores with normality curves are presented in the Appendix I Figures I-1 to I-12 to illustrate the results from Shapiro Wilk's normality tests.

The distribution of scores for all categories showed significant deviation from normality except for the scores for the percentage of elaborate pretend play in the symbolic play condition (PEPA-SY) and the scores for the percentage of elaborate pretend play combined (PEPA-CB), that is, the sum of scores for the symbolic pretend play and conventional imaginative play conditions. The three categories of PEPA scores showed small but negative skewness in contrast to the three categories of NOS and NIA scores which were all positively skewed. According to Acock (2018), a normal distribution has skewness of 0 and kurtosis greater than 10 is typically concerning whilst greater than 20 is problematic.

Three subscales had kurtosis greater than 10; NOS-CV, NIA-CV, and NIA-CB. A closer inspection of NOS-CV and all three NIA scores indicate scores were at floor on these scales (see Figure 5.1 for the distribution of these four scores using box plots). Imitated actions are a marker of limited self-initiated pretend play skills therefore floor effects mean that children are capable of pretending, hence the NIA subscales were not considered in further analyses. NOS-CV were also excluded as the range of scores were also limited.

Table 5.3 Results of Tests of Assumptions of Normality for CHIPPA sub-scales

CHIPPA Sub-scales	Results Shapiro-Wilks Test of Normality	Skewness	Kurtosis
PEPA-CV	$W(170) = .96, p < .05$	-.71	3.22
PEPA-SY	$W(171) = .99, p = .10$	-.08	2.15
PEPA-CB	$W(171) = .98, p = .05$	-.34	2.81
NOS-CV	$W(170) = .56, p < .05$	4.73	30.00
NOS-SY	$W(171) = .95, p < .05$	.73	2.94
NOS-CB	$W(170) = .95, p < .05$	.68	2.90
NIA-CV	$W(170) = .66, p < .05$	4.54	32.49
NIA-SY	$W(171) = .91, p < .05$	1.36	4.31
NIA-CB	$W(170) = .81, p < .05$	2.42	12.22

PEPA-CV: Percentage of Elaborate Pretend Play in the conventional imaginative play condition
PEPA-SY: Percentage of Elaborate Pretend Play in the symbolic play condition
PEPA-CB: Percentage of Elaborate Pretend Play combined across conventional imaginative play and symbolic play conditions
NOS-CV: Number of Object Substitutions in the conventional imaginative play condition
NOS-SY: Number of Object Substitutions in the symbolic play condition
NOS-CB: Number of Object Substitutions combined across conventional imaginative play and symbolic play conditions
NIA-CV: Number of Imitated Actions in the conventional imaginative play condition
NIA-SY: Number of Imitated Actions in the symbolic play condition
NIA-CB: Number of Imitated Actions combined across the conventional imaginative play and symbolic play conditions

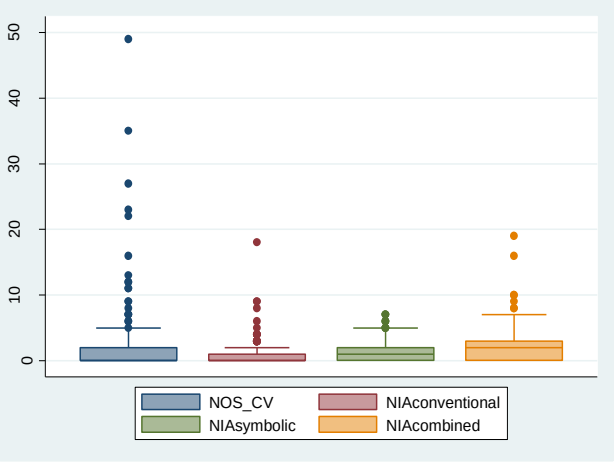

Figure 5.1 Box Plot Showing CHIPPA Sub-scales with Problematic Kurtosis Values

5.5.2 Pretend Action Task

The Pretend Action Task provided an indicator of symbolic representation in pretence. Children were video recorded performing six self and externally directed pretend actions. The resulting pretend action score indexes a capacity for symbolic representation from a concrete signifier and through abstract symbolization (Kirkham & Kidd, 2015).

5.5.2.1 PAT Inter-rater Reliability

The Pretence Action Task was coded from video. Hence, 11% (n=20) videos of the total sample (n=189) were double coded by the researcher and a second observer to obtain inter-rater reliability agreement on children's representation of symbolic actions (refer to Chapter 5 Research Methods section 4.3.1.2 for the coding scheme for the Pretence Action Task). Inter-rater reliability on the 20 videos was excellent yielding a Kappa coefficient of .93 similar to that of the original study by Overton and Jackson (1973).

To determine the reliability of the Pretence Action Task, a Cronbach alpha reliability analysis was run to check the reliability of the six questions which made up the task. Cronbach alpha assesses the internal consistency of items within a task by assessing how closely the items are correlated. The results of Cronbach alpha analysis on the Pretence Action Task indicated good internal consistency (α = .73, M = 7.17, SD = 1.80). The value of Cronbach's alpha met the recommended alpha of .70 (Streiner, 2003). This result suggested that the six pretence action sequences were potentially a reliable measure of symbolic representation.

5.5.2.2 Descriptive Statistics & Tests of Assumptions of Parametric Analyses

Children performed relatively well on the Pretend Action Task (PAT) N = 184, Mean = 7.17, SD = 1.8, Min = 0, Max = 12. The score distribution had skewness value = -.22 and kurtosis value = 5.68. Normality plots for children's scores on PAT are displayed in Appendix I Figures I-13 and I-14. The results of the Shapiro-Wilk tests of normality showed that symbolic representation scores significantly deviated from normality; W (184) = .95, p = .00. Skewness and kurtosis statistics as well as a histogram showed that the distribution of scores were negatively skewed and kurtosis was not a cause for concern.

5.5.2.3 Preliminary Analyses: Pretence Scores

Of the two measures of pretence, only four of the scores were used in subsequent analyses - PEPA-CV, PEPA-SY, NOS-SY, and symbolic representation. The individual CHIPPA scores were used over the combined subscales of PEPA-CB and NOS-CB and outliers were retained to maintain the full variability of scores from the different tasks (Song et al., 2013).

Preliminary analyses in the form of one-way ANOVAs were conducted to determine if there were gender differences for the four pretend scores. There was a significant difference in participants' elaborate pretend action scores in play with conventional toys (PEPA-CV) based on gender: $F(1,168) = 10.29$, $p = .002$, $\eta^2 = .06$. Girls had more elaborate pretend actions ($N = 83$, $M = 70.63$, $SD = 15.23$) than boys ($N = 87$, $M = 63.07$, $SD = 15.47$) and Scheffe follow-up test of mean differences was significant ($M = 8.54$, $p = .002$).

Similarly, there was a significant difference in participants' elaborate pretend actions in play with symbolic toys (PEPA-SY) based on gender: $F(1,169) = 7.19$, $p = .01$, $\eta^2 = .04$. Girls had more elaborate pretend actions ($N = 83$, $M = 52.96$, $SD = 20.75$) than boys ($N = 88$, $M = 44.42$, $SD = 20.89$) and Scheffe follow-up test of mean difference was significance ($M= 8.54$, $p = .008$).

In contrast, there was no significant difference in the number of object substitutions in play with symbolic toys (NOS-SY) that participants generated based on gender: $F(1,169) = .86$, $p = .36$, $\eta^2 = .005$. Similarly, there was no significant difference in the number of pretence action scores that participants generated based on gender: $F(1,182) = .97$, $p = .32$, $\eta^2 = .005$.

Essentially, gender differences were observed only for girls on PEPA sub-scores suggesting that girls were more likely to engage in elaborate imaginative pretend play than boys. There were no gender effects for the number of object substitution and symbolic representation actions generated by children.

5.5.3 Research Question 1a. Are the indicators of pretence correlated?

A Pearson pairwise correlation was used to explore correlations between the scores from the CHIPPA subscales and the pretence action task. The results are presented in Table 5.4. All CHIPPA subscales were significantly intercorrelated with each other but the pretend action task did not correlate with any of the CHIPPA scores. The results imply that the pretence action task may be tapping into a different aspect of pretence from that measured by the CHIPPA suggesting that symbolic representation (from the pretence action task) may be conceptually different from elaborate pretend play and object substitution (from the CHIPPA). This same pretend action task was found not to be correlated with the ability to make pretend-reality distinctions in a study with similar aged children by Carlson, White, and Davis-Unger, (2014).

Table 5.4 Pearson Pairwise Correlation of Pretence Measures

Variables	1	2	3	4	5	6
1. PEPA-CV	-					
2. PEPA-SY	.50*	-				
4. NOS-SY	.20*	.42*	.36*	-		
5. Symbolic Representation	.12	.05	.10	.08	.02	-

* significant correlations at the .05 level
PEPA-CV: Percentage of Elaborate Pretend Play in the conventional imaginative play condition
PEPA-SY: Percentage of Elaborate Pretend Play in the symbolic play condition
NOS-CV: Number of Object Substitutions in the conventional imaginative play condition
NOS-SY: Number of Object Substitutions in the symbolic play condition

Internal Consistency of CHIPPA. As a result of not being correlated with the other pretence indicators the symbolic representation task was excluded from further analyses. This meant that the remaining indicators were drawn only from the CHIPPA assessment and represented the constructs: elaborate imaginative pretence and object substitution. Since, one of the four CHIPPA indicators (NOS-CV refer to discussion in section 5.5.1.3) was also excluded a reliability analysis was run to assess the reliability of the CHIPPA with the three indicators which had been retained. The results of the Cronbach's alpha analysis on the standardized score of the three indicators yielded modest internal consistency ($\alpha = .63$). Although, the value of Cronbach's alpha was slightly below the recommended alpha of .70; an alpha of greater than .60 is also viewed as reasonable in basic research (Streiner, 2003).

5.5.4 Research Question 1b. Can the indicators of pretence be reduced to a single latent factor?

Inferences about the construct of pretence drawn from this study are based on how well the indicators of pretence cohere together. A confirmatory factor analysis (CFA) was run to test whether the covariation among the respective indicators of pretence and counterfactual reasoning could be explained by a single latent factor for each construct (Brown, 2015)). A latent factor representing Child-initiated Pretence was derived from the correlated measures of pretence – elaborate imaginative pretence in conventional, elaborate imaginative pretence in symbolic play, and object substitution in symbolic play. These measures were derived from the CHIPPA assessment. The three indicators were moderately correlated with each other (refer to Table 5.4) and had a reasonable internal consistency $\alpha = .63$ (refer to section 5.5.3 on internal consistency of the CHIPPA in this chapter).

A confirmatory factor analysis was conducted using Promax oblique rotation solution with the three indicators from the CHIPPA based on robust maximum likelihood ratio. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO = .56. which is mediocre but meets the bare minimum criteria; however, there is need for caution in interpreting the results because ideally, we are looking for a KMO value which is close to 1 to indicate that the patterns of correlation are relatively compact for the factor analysis to yield distinct and reliable factors values between (Field, 2013). Bartlett's test of spherecity $\chi^2 (6) = 81.80$, $p = .001$, indicated that the correlations met the criteria for a factor analysis. The analysis returned eigenvalues for each component in the data and found only one component had eigenvalues over Kaiser's criterion of 1 and explained 58.84% of the variance (see Figure 5.2 for scree plot showing eigenvalues). Hence, CHIPPA indicators were reduced to a single latent factor score referred to as child-initiated pretence (or CIpretence when abbreviated) which was in turn used in subsequent analyses as a proxy measure of pretence in relevant analyses.

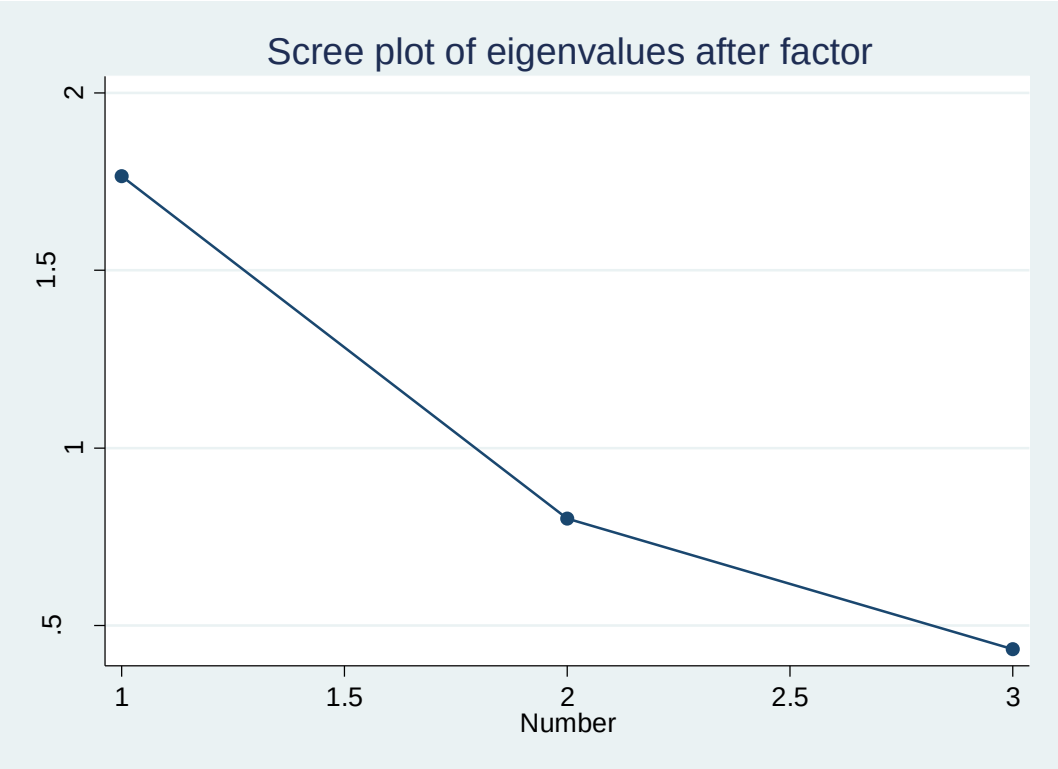

Figure 5.2 Scree Plot Showing Eigenvalues from Indicators of Pretence

5.5.5 Conclusion

This section addressed the first research question which investigated the relationship between the indicators of pretence measured. The findings revealed that symbolic representation did not correlate with elaborate pretend play and object substitution which were correlated with each other. The measure of symbolic representation (PAT) was different from that of elaborate pretend play and object substitution (CHIPPA) suggesting that not all measures of pretence are correlated. However, it may be that different measures of pretence may correlate with counterfactual reasoning. It is interesting to note that girls engaged in longer periods of elaborate pretend play than boys. The indicators of pretence cohered unto a latent pretence construct referred to as child-initiated pretence. The results will be fully discussed in the Chapter 7 which is the Discussion Chapter.

5.6.0 Research Question 2. Is there evidence that the observed counterfactual reasoning behaviours depend on a common underlying ability in this domain?

In this section, the role of counterfactual reasoning as an independent variable in this study is examined. To answer the research question, it was necessary to first examine the patterns of children's responses to the questions posed in the task. Children's responses to control questions and counterfactual questions are reported and the probability of correct to incorrect responses are explored to make conclusions about the strategy used to answer counterfactual reasoning questions. Correlational analysis was used to determine if the different types of counterfactual reasoning questions were correlated with each other and a confirmatory factor analysis was run to extract a latent construct of counterfactual reasoning. This is an important question because it clarifies whether variations in counterfactual responses are representative of a single construct of counterfactual reasoning and thereby potentially indicates the validity of the construct of counterfactual reasoning. Counterfactual reasoning was assessed using the Location Change Task developed by Rafetseder and Perner (2010). A short recap of the counterfactual reasoning task is given to facilitate interpretation of the results section. Summary descriptives, tests of parametric analyses, and the main results are reported. The section concludes with a summary of the results of children's performance on the counterfactual reasoning task.

5.6.1 CFR Location Change Task

The counterfactual reasoning task developed by Rafetseder and Perner (2010) was specifically designed to tease apart basic conditional reasoning from adult-like counterfactual reasoning on child-level assessment of counterfactual reasoning. The assumption is that early years counterfactual reasoning is still naïve and does not fully represent mature counterfactual reasoning. In basic conditional reasoning plausible real-world answers are provided as a default response to a counterfactual scenario. In adult-like counterfactual reasoning, the contents from a given counterfactual story are duly considered and factored into counterfactual responses. This task varies from counterfactual scenarios exploring the differences where correct counterfactual answers can be correct and incorrect if basic conditional reasoning is the reasoning strategy being relied on.

The Location Change Task comprised four main story themes about a doctor, teacher, fireman and policeman. Each story contained four conditions, two of which target conditional reasoning and two counterfactual reasoning. The counterfactual conditions are classified as single and dual location changes. Single location changes are categorised as Typical-1 and Atypical-1 stories, and dual location changes are categorised as Typical-2 and Atypical-2 stories. In total, the task battery comprised of sixteen counterfactual reasoning questions derived from 4 story themes each story theme consisting of the four counterfactual conditions – two single location change stories and two dual location change stories. Each counterfactual condition also has two related control questions - one posed before the counterfactual reasoning question, referred to as a Now Control Question (NCQ) and one posed after the counterfactual reasoning question referred to as a Before Control Question (BCQ).

The counterfactual reasoning task is analysed by children's performances according to story themes and counterfactual conditions. First, performances on control questions are explored. Second, performances by story themes and then by story conditions are analysed. The purpose for analysing responses by story *themes* is to check for order effects. To address the research question, children's responses are analysed according to the different *counterfactual conditions*.

5.6.2 Research Question 2a. What do patterns of errors and successes in children's counterfactual reasoning responses tell us about the type of reasoning strategies they employ?

The results are presented according to control questions, performances by story themes, and story conditions.

5.6.2.1 CFR: Control Questions

Participants correctly answered 98% of NCQ and 73% of BCQ indicating that children were better at recall on the first control question than on the last control question.

The first control question – Now Control Question (NCQ) - checked that children could tell the location of the protagonist when the story ends whereas, the second control question – Before Control Question (BCQ) - required the child to remember the location of the protagonist

when the protagonist was called to change their location in the story. While both NCQ and BCQ are memory questions; the chain of events to backtrack to arrive at the correct answer is more demanding in the latter control question than the former control question. It is unsure whether the decline in children's performance may be attributed to task complexity or issues with recall. Hence, a decision was made to analyse counterfactual responses only for instances of answering NCQs correctly.

5.6.3 CFR Responses: Story Themes

This section discusses children's performances on the counterfactual reasoning task based on the story themes. Descriptive statistics are reported, assumptions of parametric analyses are considered and order effects for administration of the story are assessed.

5.6.3.1 Descriptive Statistics

The average responses given to now control questions and counterfactual reasoning questions by story themes are presented in Table 5.5. For example, it shows that for the Doctor Story 183 children answered the first control question (NCQs) correctly and 183 children also answered the CFR question correctly having also answered the NCQ correctly. In all cases counterfactual scores are counted only if the child answered NCQs correctly. A difference between the number of participants succeeding on the control questions and the counterfactual questions indicates a drop in the number of children who successfully answered the control question. For each sub-score, the mean, standard deviation, minimum and maximum scores are reported.

Table 5.5 Summary Statistics for Counterfactual Reasoning Stories

Theme		Criteria	N	Mean	Sd	Min	Max
Doctor	Story	NCQ	183	3.95	.27	2	4
		CFR questions	183	3.06	.92	0	4
Teacher	Story	NCQ	181	3.87	.47	1	4
		CFR questions	179	3.28	.94	0	4
Fireman	Story	NCQ	182	3.82	.63	0	4
		CFR questions	180	3.07	.92	0	4
Police	Story	NCQ	181	3.92	.42	0	4
		CFR questions	181	3.02	1.07	0	4

*NCQ – Now Control Questions
*CFR – Counterfactual Reasoning

5.6.3.2 Test of Parametric Assumptions

Shapiro-Wilk tests of normality were conducted on the CFR scores by story themes. The distribution of scores for all four counterfactual stories showed significant deviation from normality: Doctor story $W(183) = .92$, $p < .001$, Teacher story $W(179) = .89$, $p = .001$, Fireman story $W(180) = .93$, $p = .001$, and Police story $W(181) = .95$, $p = .001$.

Histograms visualizing the distribution of CFR scores by story themes are presented in Appendix J Figures 1-4. Skewness and kurtosis statistics are presented in Table 5.6. According to (Acock, 2018) a normal distribution that has skewness of 0 and kurtosis greater than 10 is typically concerning whilst greater than 20 is problematic. The histograms, skewness, and kurtosis statistics show that the distribution of scores for all story conditions were negatively skewed but kurtosis was not an issue.

Table 5.6 Counterfactual Reasoning Scores by Story Themes: Skewness & Kurtosis Statistics

Story Conditions	Doctor	Teacher	Fireman	Police
Skewness	-1.13	-1.51	-1.02	-1.03
Kurtosis	4.41	5.16	3.99	3.42

5.6.3.3 Order and Gender Effects

The percentages of correct counterfactual responses were similar across the different stories: doctor story = 77%, teacher story = 82%, firefighter story = 78% and police story = 75%. The order of administering the stories were randomized using a fixed block Latin Square design. There was a significant main effect of story order $F(3, 179) = 3.71$, $p = .01$, $\eta^2 = .08$ but further post hoc analyses using Scheffe follow-up procedure found no significant differences in the pairwise comparisons suggesting that the order in which the stories were told to children did not influence their performance. Additionally, there was no significant main effect of gender for correctly answering counterfactual questions $F(1, 179) = 3.57$, $p = .06$, $\eta^2 = .08$.

5.6.3.4 Conclusion

The goal of this section was to check whether the order in which the differently themed counterfactual stories were told influenced children's pattern of responses. The results of the ANOVA indicated there was no effect of either story theme order or gender based on story theme order; hence the classification of responses by story was not considered further.

5.6.4 Counterfactual Responses: Story Conditions

This section discusses children's performances across the story conditions of the counterfactual reasoning task. There were four categories or conditions of counterfactual reasonings questions classified as typical-1, atypical-1, typical-2, and atypical-2. Stories based on typical-1 and atypical-1 conditions involved a protagonist moving from one antecedent location to consequent location after being called to respond to an emergency. Stories based on typical-2 and atypical-2 conditions involve a protagonist moving between two locations to a consequent location before being called to respond to an emergency. Stories in the typical condition present participants with the typical location where a protagonist works, for example, a firefighter is working at the fire-station when called to respond to an emergency fire in the forest. Atypical stories present participants with an atypical location where a protagonist is before responding to an emergency call, for example, a firefighter is at home in his living-room when he is called to respond to an emergency fire in the forest. The assumption is that individuals use knowledge either from the counterfactual scenario or from their own general-knowledge of the world to respond to counterfactual scenarios – the latter response is referred to basic conditional reasoning. This counterfactual reasoning task assesses whether children are able to integrate

non-typical information from the story into the counterfactual response to arrive at the correct counterfactual answer by comparing the frequency of responses between typical and atypical conditions.

For the initial analyses, descriptive statistics are reported, assumptions of parametric analyses are considered, and patterns of errors and successes across the four counterfactual conditions are explored. To conclude, consideration is given to how counterfactual scores should be summarised for use in subsequent analyses. Hence, the construct validity of the task is evaluated to justify summarising the scores from the four counterfactual conditions into one factor score that represents one underlying dimension of counterfactual reasoning.

5.6.4.1 Descriptive Statistics

The average responses given to control questions and counterfactual reasoning questions by condition are presented in Table 5.8. For example, it shows that for the typical-1 condition 184 children answered the first control question (NCQ) but 183 children answered the counterfactual reasoning question correctly having succeeded at the control question. In all cases counterfactual scores are counted only if the child answered the control question correctly. A difference between the number of participants succeeding on the control questions and the counterfactual questions indicate a drop in the number of children who successfully answered the control question. For each sub-score, the mean, standard deviation, minimum and maximum scores are reported.

Table 5.7 Summary Statistics of Counterfactual Reasoning Stories by Story Conditions

Conditions	Criteria	N	Mean	Std	Min	Max
Typical-1	NCQ	184	3.88	.49	0	4
	CFR responses	183	3.57	.78	0	4
Atypical-1	NCQ	184	3.84	.53	1	4
	CFR responses	184	3.40	.89	0	4
Typical-2	NCQ	183	3.86	.49	0	4
	CFR responses	182	2.78	1.06	0	4
Atypical-2	NCQ	182	3.86	.44	1	4
	CFR responses	182	2.37	1.19	0	4

*NCQ: Now Control Questions
*CFR: Counterfactual Reasoning

5.6.4.2 Tests of Parametric Assumptions

Shapiro-Wilk tests of normality were conducted on the counterfactual reasoning scores by story conditions. All counterfactual condition categories showed significant deviation from normality except the atypical-2 condition which did not deviate from a normal distribution; Typical-1 $W(183) = .79$, $p = .00$. Atypical-1 $W(184) = .87$, $p = .00$, Typical-2 $W(182) = .97$, $p = .00$, and Atypical-2 $W(182) = .99$, $p = .28$.

Histograms visualizing the distribution of counterfactual reasoning scores by condition are presented in Appendix K Figures 1 – 4. The histograms also support that the distribution of atypical-2 scores show a trend towards a normal distribution but skewness and kurtosis statistics reported in Table 5.9 indicated that the distribution of the scores for the other four variables were negatively skewed. According to (Acock, 2018) a normal distribution has skewness of 0 and kurtosis greater than 10 is typically concerning whilst greater than 20 is problematic. Kurtosis was not an issue.

Table 5.8 Skewness & Kurtosis Statistics for Counterfactual Reasoning by Story Conditions

	Typical-1	Atypical-2	Typical-2	Atypical-2
Skewness	-2.19	-1.58	-.66	-.34
Kurtosis	8.15	5.15	2.82	2.16

5.6.4.3 Children's errors and successes across the counterfactual conditions

Children's responses to the counterfactual questions are summarised in Figure 5.3. The percentage of correct responses to counterfactual questions in each condition include: typical-1 = 89%, atypical-1 = 85%, typical-2 = 73% and atypical-2 = 59%. Children could make three types of counterfactual reasoning error: realist error, typical error and atypical error (see Chapter 4 Research Methods section 4.3.2.1, Table 4.3 Classification of Responses by Reasoning Errors for an overview of possible errors and responses per counterfactual conditions).

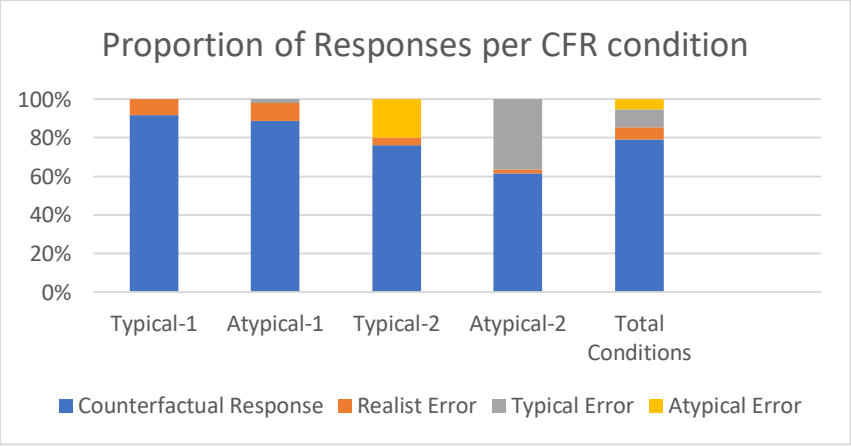

Figure 5.3 Bar Graph showing Proportion of Responses per Counterfactual Reasoning Conditions

Realist error. Realist errors indicate that a child has difficulty inhibiting the salient features of a story and occurred 6% of the time across all sixteen counterfactual questions. For each of the four counterfactual conditions, realist errors occurred in all the four conditions: typical-1 = 8%, atypical-1 = 9%, typical-2 = 4%, atypical-2 = 2%. The average occurrence of realist errors across all counterfactual questions for all children were *M* = .89, *SD* = 1.75, *min* = 0, and *max* = 14.

A Freidman test found the differences in the frequency of realist errors across the four counterfactual conditions were significant χ^2 (3, N = 182) = 64.62, p < .001. The results from pairwise comparisons with Bonferroni corrections for multiple comparisons showed that the number of realist errors in the atypical-2 condition (2%) were statistically different from the number of realist errors in the typical-1 condition (8%) (*Median* = 0, p = .024) and the number of realist errors in the atypical-1 conditions (9%) (*Median* = 0, p = .004). In contrast, the number of realist errors between the typical-1 condition (8%) and atypical-1 condition (9%), and the typical-2 (4%) and atypical-2 (2%) conditions were not significantly different (p > .05) for all comparisons. The results show that children were more likely to make realist errors in stories with only one location change (typical-1 & atypical-1 conditions). Also, the number of realist errors in related conditions were similar. The drop in the number of realist errors in the two-condition stories gives the impression that the ability to overcome the salient features of the story and engage in more effortful reasoning is within reach of some of the children who made realist errors in the one-condition stories.

Typical and Atypical errors. Typical errors are considered to stem from a difficulty inhibiting what is known to be true about the world and reasoning from general real-world knowledge (Rafetseder & Perner, 2010). Typical errors could occur with stories in the atypical-1 condition as well as atypical-2 condition. The difference is that in the atypical-2 condition the child is presented with the real-world option (the resultant typical error) as a plausible answer - one of the two locations where the protagonist could be. On average, typical errors occurred more frequently in atypical-2 conditions, 35% (*M* = 1.40, *SD* = 1.10, *min* = 0, *max* = 4) than in typical-2 conditions, 2% (*M* = .06, *SD* = .28, *min* = 0, *max* = 2).

For all pairs of atypical-1 and atypical-2 responses across the four-story conditions McNemar repeated measures chi-square test with continuity correction determined that the difference in the proportion of typical errors in atypical-1 and atypical-2 conditions was statistically different (reported in Table 5.10). Children were more likely to make a typical error when it is presented as a plausible option in the story scenario as was the case with 2-condition stories. It is also interesting that children made typical errors on their own even when they were not presented as plausible answers (atypical-1 stories). This suggests that children are able to retrieve real-world answers as responses to counterfactual questions from independent experience of the world.

Table 5.9 Proportion of Typical Errors in Atypical-1 & Atypical-2 Conditions

Story	Proportion of Typical Errors		McNemar Test Results
	Atypical-1 Conditions	Atypical-2 Conditions	
Doctor	.03	.43	χ^2 (1, N = 174) = 62.35, p < .001
Teacher	.02	.33	χ^2 (1, N = 170) = 46.45, p < .001
Firefighter	0	.27	χ^2 (1, N = 167) = 43.02, p < .001
Police	.001	.42	χ^2 (1, N = 173) = 68.12, p < .001

Scenarios with two location changes could result in either an atypical error in typical-2 conditions or typical error in atypical-2 conditions. An atypical error could only occur in typical-2 conditions. Atypical errors accounted for 19% of children's responses (*M* = 0.78, SD = .90, *min* = 0, *max* = 4) in contrast to typical errors which accounted for 35% (*M* = 1.40, *SD* = 1.10, *min* = 0, *max* = 4) as reported earlier. For all pairs of typical-2 and atypical-2 responses across the four-story conditions McNemar repeated measures chi-square test with continuity correction determined that the difference in the proportion of typical and atypical errors in typical-2 and atypical-2 conditions was statistically different (as reported in Table 5.11). Children were more likely to make typical errors, for example, say fire station instead of living room in 2-condition stories. This suggests that although children can overcome realist errors children are prone to making typical errors when reasoning counterfactually. In other words, they apply basic conditional reasoning which leads to wrong answers.

Table 5.10 Proportion of Typical Errors in Typical-2 and Atypical-2 Conditions

Story	Proportion of Atypical & Typical Errors		McNemar test Results
	Typical-2 Conditions	Atypical-2 Conditions	
Doctor	.19	.43	χ^2 (1, N = 176) = 18.82, p < .001
Teacher	.08	.32	χ^2 (1, N = 168) = 28.07, p < .001
Firefighter	.40	.26	χ^2 (1, N = 171) = 5.13, p = .02
Police	.13	.43	χ^2 (1, N = 174) = 35.15, p < .001

Counterfactual Successes. Children performed better in tasks with one location change; typical-1 = 89% (M = 3.57, SD = .79, min = 1, max = 4) and atypical-1 = 85% (*M* = 3.42, *SD* = .85, *min* = 0, *max* = 4) than on tasks with two location changes; typical-2 = 73% (*M* = 2.95, *SD* = 1.08, *min* = 0, *max* = 4) and atypical-2 = 59% (*M* = 2.37 , *SD* = 1.19, *min* = 0, *max* = 4). The difference between correct counterfactual responses in 1-condition and 2-condition scenarios was assessed using the McNemar repeated measures chi-square test. The difference between the 1-conditions was not significant with Teacher story being the only exception (reported in Table 5.12). Generally, children performed similarly in the two single condition stories.

Table 5.11 Proportion of Successes between Typical-1 and Atypical-1 Conditions

Story	Proportion of Correct CF Responses		McNemar test Results
	Typical-1 Conditions	Atypical-1 Conditions	Binomial Distribution
Doctor	.91	.89	N = 179, p = .68
Teacher	.95	.88	N = 173, p = .004
Firefighter	.93	.95	N = 167, p = .23
Police	.90	.86	N = 174, p = .23

For all pairs of 2-condition scenarios, successful responses to counterfactual responses between typical-2 and atypical-2 stories were significantly different (reported in Table 5.13). Children had difficulty inhibiting typical responses like fire station in favour of the correct answer living room.

Table 5.12 Proportion of Successes between Typical-2 and Atypical-2 Conditions

Story	Proportion of Correct CF Responses		McNemar test Results
	Typical-2 Conditions	Atypical-2 Conditions	
Doctor	.77	.55	χ^2 (1, N = 176) = 15.92, p < .001
Teacher	.89	.67	χ^2 (1, N = 168) = 24.45, p < .001
Firefighter	.58	.73	χ^2 (1, N = 171) = 6.62, p = .010
Police	.82	.53	χ^2 (1, N = 174) = 30.72, p < .001

5.6.4.4 Summary of Reasoning Strategies

According to Rafetseder and Perner (2010), four reasoning strategies could be elicited from this counterfactual reasoning task – counterfactual reasoning, basic conditional reasoning, realist reasoning, or a mixed reasoning strategy wherein none of the aforementioned strategies are distinguishable. Counterfactual reasoning is judged as correctly answering all counterfactual questions, for example answering with 'fire-station' in all typical story conditions and 'living-room' in all atypical story conditions of the fire-station stories. In all, only 13 children (7%) met the criteria for 'counterfactual reasoning' in this sample, that is, succeeding on all sixteen counterfactual scenarios. Basic conditional reasoning is classified as successfully answering all counterfactual questions (typical-1, atypical-1, typical-2) but failing atypical-2 questions (Rafetseder & Perner, 2010). In this study, no child succeeded in answering all questions in typical-1, atypical-1 and typical-2 conditions correctly to the exception of atypical-2 questions. Similarly, no child used only realist reasoning across all four counterfactual conditions. Consequently, majority of the participants (93%) did not show an identifiable reasoning strategy and can be described as using a mix of reasoning strategies.

5.6.4.5 Conclusion

This section addressed the second research question which explored children's patterns of errors and successes on the counterfactual reasoning task as an indication of the reasoning strategy they employed. The goal of the task was to determine whether children were equally successful at counterfactual reasoning as basic conditional reasoning. The findings indicate counterfactual reasoning was not distinguishable from basic conditional reasoning among four to five-year-olds as children applied a mix of strategies.

5.6.5 Research Questions 2a. Are the indicators of counterfactual reasoning correlated?

The correlation between the four counterfactual conditions was assessed by running a spearman's rank-order correlation to determine whether the sub-scales were correlated with each other; in addition to having modest internal consistency. The results showed all four counterfactual conditions to be significantly correlated (Table 5.14).

Table 5.13 Spearman Rank-order Correlation of Sub-scales of CFR Conditions

Variables	1	2	3	4
1. Typical 1	-			
2. Atypical 1	.50*	-		
3. Typical 2	31*	.36*	-	
4. Atypical 2	31*	36*	.25*	-

*all associations significant at $p < .05$

Internal Consistency of the Location Change Task. To determine the reliability of the counterfactual reasoning task, a Cronbach alpha reliability analysis was run to check the reliability of the sixteen questions which made up the task. Cronbah alpha assesses the internal consistency of items within a task by assessing how closely the items are correlated. The results of Cronbach's alpha analysis on the counterfactual task used in this study indicated modest internal consistency ($\alpha = .67$, $M = 12.05$, $SD = 3.10$). Although, the value of Cronbach alpha was slightly below the recommended alpha of .70; an alpha of greater than .60 is also viewed as reasonable in basic research (Streiner, 2003). This suggested that the sixteen counterfactual reasoning questions were potentially a reliable measure of counterfactual reasoning. This was promising considering that children's responses did not show that children were relying on any distinct counterfactual reasoning strategy.

The four counterfactual conditions used to make inferences about children's reasoning strategies (refer to section on summary of reasoning strategies) can be classified as subscales of the counterfactual reasoning task since they were specifically designed to simulate different conditions of counterfactual reasoning. The reliability of the subscales was calculated using Cronbach's alpha for the sum of responses of the four items in each subscale or counterfactual condition. The results of Cronbach's alpha for the four subscales of the counterfactual task indicated the following internal consistency: typical-1 ($\alpha = .51$, $M = 3.57$, $SD = .79$), atypical-1 ($\alpha = .30$, $M = 3.40$, $SD = .89$), typical-2 ($\alpha = .50$, $M = 2.78$, $SD = 1.06$) and atypical-2. ($\alpha = .40$, $M = 2.37$, $SD = 1.19$). The Cronbach's alpha for the individual sub-scales ranged from $\alpha = .30$ to $\alpha = .51$ suggesting that the sub-scales were modestly correlated with their component items. A limitation of Cronbach's alpha is that it is strongly influenced by the length of the scale, so it is not surprising for Cronbach's alpha to be low in a four-item sub-scale (Streiner,

2003). A further check of the internal consistency of the four sub-scales together resulted in α = .72. Generally, for a developmental task the subscales show a positive trend of being a reliable measure of counterfactual reasoning.

5.6.6 Research Question 2b. Can the indicators of counterfactual reasoning be reduced to a single latent factor?

Inferences about the construct of counterfactual reasoning drawn from this study are based on how well the indicators of counterfactual reasoning cohere together. A confirmatory factor analysis (CFA) was run to test whether the covariation among the respective indicators of pretence and counterfactual reasoning could be explained by a single latent factor for each construct (Brown, 2015). The factor representing CFR was derived from the four sub-scales of the counterfactual reasoning task. The four indicators were moderately correlated with each other (refer to Table 5.14) and had reasonable internal consistency α = .72 (refer to section 5.6.5 above in this chapter).

A confirmatory factor analysis was conducted using Promax oblique rotation solution with the four indicators from the counterfactual reasoning tasks based on robust maximum likelihood ratio. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO = .75 (good according to Field, 2013). Bartlett's test of spherecity χ^2 (6) = 171.01, p = .001, indicated that the correlations were sufficiently large for a factor analysis. An initial analysis was run to obtain eigenvalues for each component in the data and found only one component had eigenvalues over Kaiser's criterion of 1 and explained 57.44% of the variance. Hence, the counterfactual reasoning sub-scales were reduced to a single factor score subsequently used as a proxy measure of children's CFR in relevant analyses.

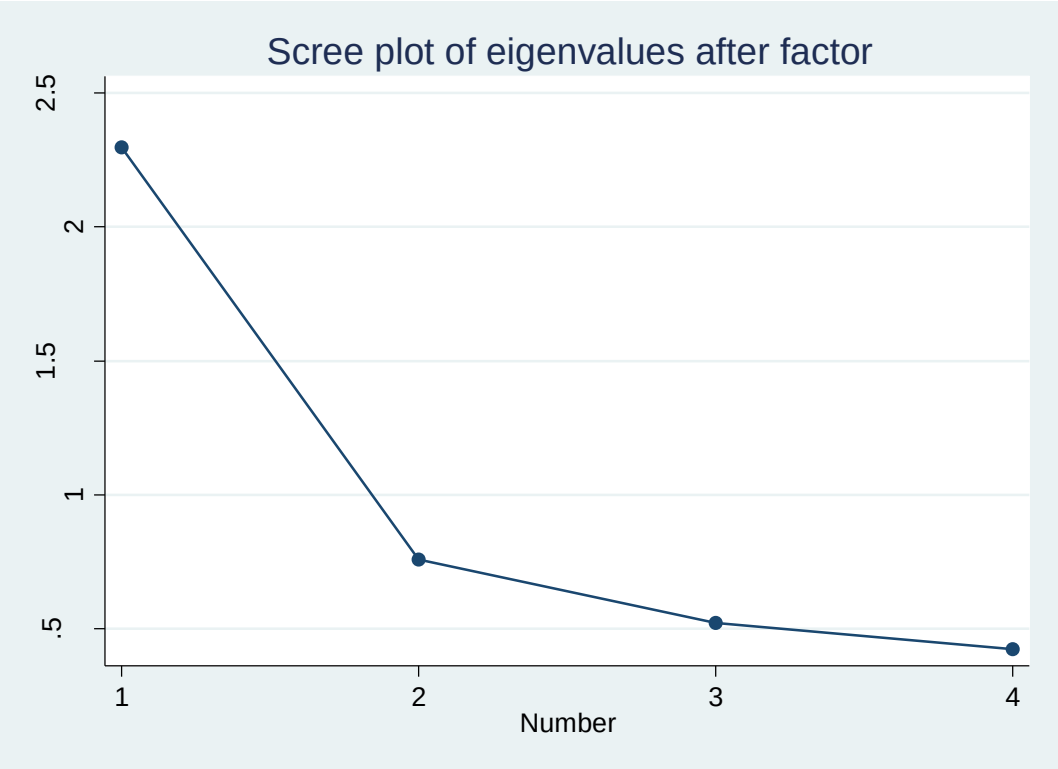

Figure 5.4 Scree Plot Showing Eigenvalues for Indicators of Counterfactual Reasoning

5.7.0 Chapter Summary

This chapter addressed the following research questions:

RQ 1. Is there evidence that the observed pretence behaviours depend on a common underlying ability in this domain?

1a. Are the indicators of pretence correlated?

1b. Can the indicators of pretence be reduced to a single latent factor?

RQ 2. Is there evidence that the observed counterfactual reasoning behaviours depend on a common underlying ability in this domain?

2a. Are the indicators of counterfactual reasoning correlated?

2b. What do patterns of errors and successes in children's counterfactual reasoning responses tell us about the type of reasoning strategies they employ?

2c. Can the indicators of counterfactual reasoning be reduced to a single latent factor?

The general findings indicate that children's engagement in elaborate pretend play was significantly correlated with object substitution but not symbolic representation and could be reduced to a single latent factor to represent the construct Child-initiated Pretence. Basic conditional reasoning was not distinguished from counterfactual reasoning in this sample suggesting that a child can successfully answer counterfactual questions but use a mix of strategies. The CFR subscales were generally correlated with each other, had modest internal consistency and could be reduced to a single latent factor to represent the construct CFR. The remaining research questions are answered in the next chapter.

Chapter 6 Results B

6.1.0 Introduction

This chapter is the second of two results chapters for this thesis. The goal of this chapter is to unpack the theoretical assertion that pretence and counterfactual reasoning share similar cognitive mechanisms. To explore this assertion, associations between pretence and counterfactual reasoning are explored together and in relation to other related cognitive skills. Several sub-research questions are posed investigating correlations among the relevant study variables; in addition to exploring similarities, differences, and general associations between pretence, counterfactual reasoning, executive functions, and receptive language. The aim is to tease apart associations between the variables with the goal of understanding the mechanisms that input the cognitive workspace that underpins imaginative thinking.

6.2.0 Chapter Research Questions

To achieve the goals of the study, two main research questions were posed and are the focus of this chapter. The research questions are outlined as follows:

RQ3. How are pretence, counterfactual reasoning, executive functions, and receptive language associated?

3a. Are pretence, counterfactual reasoning, executive functions, and receptive language correlated?

3b. Do receptive language, symbolic representation, and EFs account for unique variance in Child-initiated Pretence?

3c. Do receptive language, symbolic representation, and EFs account for unique variance in CFR?

RQ4. Is there support for the idea that the constructs from the domain of pretence and counterfactual reasoning are underpinned by a general imaginative representation ability?

4a. Is there support for the latent model showing the relationship between pretence and CFR?

4b. Is there support for the structural model showing that pretence and counterfactual reasoning are underpinned by an imaginative representation ability?

6.3.0 Descriptive Statistics

Descriptive statistics summarising how children performed on the pretence and counterfactual reasoning tasks which were reported in the previous chapter are reported here again together with summary statistics for the new measures explored in this chapter, namely executive functions (EFs) and receptive language. Therefore, Table 6.1 reports the scores from the pretence sub-scales, counterfactual reasoning sub-scales, in addition to the scores for three executive functions skills – working memory, inhibition and delay of gratification measured in this study. The table shows the mean, standard deviation, minimum and maximum values for all the study measures. The working memory score represents the proportion of success on the working memory trials, the inhibition, delay of gratification, and receptive language scores represent the total number of correct responses.

Table 6.1 Descriptive Statistics: Pretence and Counterfactual Reasoning

Variables		Sub-scales	N	Mean	Std	Min	Max
Pretence		PEPA_CV	170	66.76%	15.77	15%	95%
		PEPA_SY	171	48.57%	21.20	0%	86%
		NOS_SY	171	12.86	9.86	0	42
Counterfactual	Reasoning	CFR_Typical-1	183	3.57	.78	0	4
		CFR_Atypical-1	184	3.40	.89	0	4
		CFR_Typical-2	182	2.78	1.06	0	4
		CFR_Atypical-2	182	2.37	1.19	0	4
Executive	Functions	Working memory	185	.62	.16	.35	1
		Inhibition	181	27.56	18.15	0	58
		Delay of Gratification	153	5.97	1.70	2	8
Language		Receptive Language	185	27.27	8.33	7	40

PEPA-CV: Percentage of Elaborate Pretend Play in the conventional imaginative play condition
PEPA-SY: Percentage of Elaborate Pretend Play in the symbolic play condition
NOS-SY: Number of Object Substitutions in the symbolic play condition
CFR_T1: CFR scenario typical condition with one location change
CFR_At1: CFR scenarios atypical condition with one location change
CFR_T2: CFR scenarios typical condition with two location changes
CFR_At2: CFR scenarios atypical condition with two location changes

6.4.0 Test of Parametric Assumptions.

Tests of parametric assumptions are reported for the variables not previously reported on – working memory, inhibition, delay of gratification, and receptive language. Shapiro-Wilk tests of normality were conducted for all four control variables. All control variables showed significant deviation from normality: language $W(185) = .95$, $p < .001$, working memory $W(185) = .97$, $p < .001$, inhibition $W(181) = .93$, $p < .001$, and delay of gratification $W(153) = .97$, $p < .001$.

Histograms and box plots visualizing the distribution of each control variable are presented in Appendix L Figures 1 - 4. The histograms support the results of the normality tests that the distribution of scores for the control variables show some skewness. Skewness and kurtosis statistics are presented in Table 6.2 and confirm that all four variables were negatively skewed, except working memory because a proportional score is used. According to (Acock, 2018) a normal distribution has skewness of 0 and kurtosis greater than 10 is typically concerning whilst greater than 20 is problematic. Issues with kurtosis was not concerning for these variables were not explored further and outliers were retained in subsequent analyses.

Table 6.2 Skewness & Kurtosis Statistics for EF & Receptive Language Variables

	Receptive Language	Working Memory	Inhibition	Delay of Gratification
Skewness	-2.19	-1.58	-.66	-.34
Kurtosis	8.15	5.15	2.82	2.16

6.5.0 Research Question 3. How are pretence, counterfactual reasoning, executive functions, and receptive language associated?

This research question sets the foundation for exploring whether pretence and counterfactual reasoning share cognitive mechanisms. Several sub-questions are answered towards this goal as outlined here:

3a. Are pretence, counterfactual reasoning, executive functions, and receptive language correlated?

3b. Do receptive language, symbolic representation, and EFs account for unique variance in Child-initiated Pretence?

3c. Do receptive language, symbolic representation, and EFs account for unique variance in CFR?

6.5.1 Research Question 3a. Are pretence, counterfactual reasoning, executive functions, and receptive language correlated?

A Pearson's product-moment correlation was run to assess the relationship among all the variables measured to the constructs of Child-initiated pretence and counterfactual reasoning (see Table 6.3). There were small to moderate statistically significant correlations among some variables. Child-initiated pretence was significantly correlated with all variables except working memory. Inhibition was significantly correlated with all variables except delay of gratification. Delay of gratification did not correlate with any other executive function variable.

Table 6.3 Pearson Pairwise Correlation between Study Measures

Variables	1	2	3	4	5	6
1. Child-initiated Pretence	-					
2. Counterfactual Reasoning	.50*	-				
3. Receptive Language	.36*	.53*	-			
4. Working Memory	.11	.21*	.22*	-		
5. Inhibition	.41*	.55*	.54*	.25*	-	
6. Delay of Gratification	.18*	.20*	.08	.06	.15	-

*p < .05

A Pearson's partial correlation was run to assess the relationship among the variables after controlling for age in months (see Table 6.4). Generally, correlations among variables remained statistically significant with a few exceptions. Specifically, working memory did not retain any statistically significant relationships with the other variables and delay of gratification which was previously associated with both child-initiated pretence and CFR only shared significant correlations with CFR when age was controlled. The relationship between inhibition and working memory was also not retained. It was interesting to see that the effects of controlling for age did not influence previous statistically significant correlations with receptive language and inhibition with child-initiated pretence and CFR.

Table 6.4 Pearson Partial Correlation between Study Measures

Control	Variables	1	2	3	4	5	6
Age	1. Child-initiated Pretence	-					
	2. Counterfactual reasoning	.50*	-				
	3. Receptive Language	.34*	.49*	-			
	4. Working memory	.10	.09	.12	-		
	5. Inhibition	.45*	.53*	.54*	.16	-	
	6. Delay of Gratification	.14	.16*	.01	.01	.08	-

*p < .05

6.5.2 Research Question 3b. Do receptive language, symbolic representation, and executive functions account for unique variance in Child-initiated Pretence?

Previous studies have identified executive functions and receptive language as cognitive skills which are related to pretend play as well as counterfactual reasoning (Beck et al., 2009; Carlson et al., 2014). For this reason, it was important to tease apart the independent contributions of executive functions (EFs) and receptive language to explaining variance in pretence and counterfactual reasoning scores in this study, over and beyond the influence of age and gender. Raw scores for each of the variables were used in these analyses.

A hierarchical multiple linear regression (HMR) was calculated to test the hypothesis that executive functions and receptive language account for unique variance in child-initiated pretence, beyond age and gender. Age in months and gender were entered in the first block, receptive language was entered in the second block, and inhibition, working memory and delay of gratification were entered in the third block.

The three regression models, that is each block, were all significant: age and gender $F(2,185) = 9.20$, $p = .001$, receptive language $F(3,180) = 11.93$, $p = .001$, and executive functions $F(6,142) = 8.52$, $p = .001$. The contribution of each model to account for variance in Child-initiated Pretence were: 9%, 17%, and 27%, respectively. The results of the HMR are reported in Table 6.5. Age was a significant predictor only in the first step (model 1: $\beta = .20$, $p = .007$; model 2: $\beta = .10$, $p = .09$; model 3: $\beta = .05$, $p = .46$). There was a consistent effect of gender

(model 1: β = .27, p = .001; model 2: β = .24, p = .002; model 3: β = .22, p = .004). When receptive language was added in the second step, the variance accounted for in child-initiated pretence significantly increased by 8% (p = .001) but the effect of receptive language was lost when the executive function measures were added to the model. Although only inhibition was a significant executive function contributor (β = .29, p = .002); an additional 10% (p = .01) of variance was accounted for.

Table 6.5 Contribution of age, receptive language, and EFs to Child-Initiated Pretence

	B	SE B	β	R^2	ΔR^2
				.10	
Constant	-26.77	.7.87			
Age	.36	.13	.20*		
Gender	3.85	.1.17	.27*		
				.19	.09*
Constant	-26.43	7.66			
Age	.22	.13	.10		
Gender	3.53	1.14	.24*		
Receptive Language	.29	.07	.28*		
				.31	.12*
Constant	-22.90	8.47			
Age	.12	.15	.05		
Gender	3.52	1.22	.22*		
Receptive Language	.16	.10	.12		
Inhibition	.13	.04	.29*		
Working Memory	.10	4.02	.004		
Delay of Gratification	.54	.36	.10		

6.5.4 Research Question 3c. Do receptive language, symbolic representation, and EFs account for unique variance in CFR?

A hierarchical multiple linear regression (HMR) was calculated to test the hypothesis that executive functions and receptive language account for unique variance in CFR beyond age and gender. Age in months and gender were entered in the first block, receptive language was entered in the second block, and inhibition, working memory and delay of gratification were entered in the third block (see Table 6.6).

The three regression models were all significant: age and gender $F(2,185) = 5.37$, $p = .01$, receptive language $F(3,180) = 21.93$, $p = .001$, and executive functions $F(6,142) = 11.58$, $p = .001$. The contributions of each model to account for variance in CFR were: 6%, 26%, and 33%, respectively. However, the change in r-square for the third model (7%) was not significant ($p = 1.00$) suggesting that the combination of independent executive function variables together did not have additional explanatory power. The results of the HMR are reported in Table 6.6. Age was a significant contributor only in the first step of the model (model 1: $\beta = .24$, $p = .01$; model 2: $\beta = .09$, $p = .11$; model 3: $\beta = .04$, $p = .54$) and there was no effect of gender (model 1: $\beta = .20$, $p = .08$; model 2: $\beta = .16$, $p = .06$; model 3: $\beta = .14$, $p = .07$). Receptive language was added in the second step of the model and was a consistent contributor to CFR (model 2: $\beta = .42$, $p = .001$; model 3: $\beta = .42$, $p = .001$). When receptive language was added in step 2 an additional 21% of variance in counterfactual reasoning was accounted for ($p = .001$). Although, the executive functions variables together did not explain additional variance in CFR; inhibition and receptive language were significant predictors of CFR in model 3 (Inhibition $\beta = .23$, $p = .01$; receptive language $\beta = .30$, $p = .001$).

Table 6.6 Contribution of age, receptive language, and EFs to Counterfactual Reasoning

	B	SE B	β	R^2	ΔR^2
				.07	
Constant	-1.38	.45			
Age	.02	.01	.24*		
Gender	.12	.07	.20*		
				.31	.24*
Constant	-1.53	.41			
Age	.01	.007	.09		
Gender	.11	.06	.16*		
Receptive Language	.03	.004	.42*		
				.43	.12
Constant	-1.27	.42			
Age	.005	.01	.04		
Gender	.11	.06	.14		
Receptive Language	.02	.01	.30*		
Inhibition	.01	.002	.23*		
Working Memory	-.03	.20	-.01		
Delay of Gratification	.04	.02	.14		

6.5.5 Conclusion

The links between child-initiated pretence, counterfactual reasoning, executive functions and receptive language were analysed to explore the theoretical assumption that pretence and counterfactual reasoning shared common variance. Inhibition significantly predicted both Child-initiated Pretence and CFR ($\beta = .29$ and $\beta = .23$), respectively. The effect of receptive language on child-initiated pretence was lost when executive functions were added to the model; although inhibition was the only executive function measure to be significantly associated with counterfactual reasoning in this study. Receptive language was a significant predictor of CFR ($\beta = .30$) but not of Child-initiated pretence ($\beta = .12$) above and beyond age, gender, and executive functions.

6.6.0 Research Question 4. Is there support for the idea that the constructs from the domain of pretence and counterfactual reasoning are underpinned by a general imaginative representation ability?

A hypothetical model delineating links between pretence and counterfactual reasoning at observable and latent levels was specified in the research design stage of this study (refer to the Figure 3.1 in Chapter 3 Research Design section 3.2.0 Statement of the Problem). The hypothetical model was a conceptual framework mapped in response to the suggestion that pretence and counterfactual reasoning share cognitive mechanisms and an underlying cognitive dimension might be linking the two cognitive skills (Walker & Gopnik, 2013b; Weisberg & Gopnik, 2013). The conceptual framework provided a starting point for exploring latent relationships between pretence and counterfactual reasoning using structural equation modelling analysis (SEM). Although SEM is more of a confirmatory technique it can also be used for exploratory purposes (Schreiber et al., 2006). Hence, in this study, although theory driven statistical approaches were required to test the proposed hypothetical models; the findings reported here are to some extent exploratory in nature given the proposed theory being tested is still rudimentary and inchoate in nature with no pre-existing empirical evidence to draw from. Two different models mapping the possible latent relationships shared by pretence and counterfactual reasoning were compared and used as the basis for refining ideas about the nature of the relationship between pretence and counterfactual reasoning. The model which best fit the data was selected to explain the structural relationship of pretence and counterfactual reasoning.

6.6.1 Hypothesized Model of Pretence and CFR (adjusted)

The initial theoretical framework, Figure 3.1, set out in Chapter 3 Research Design section 3.2.0 Statement of the Problem was revised based on trends in the data from analysing the pretence and counterfactual reasoning tasks. The revised conceptual framework is presented in Figure 6.1.

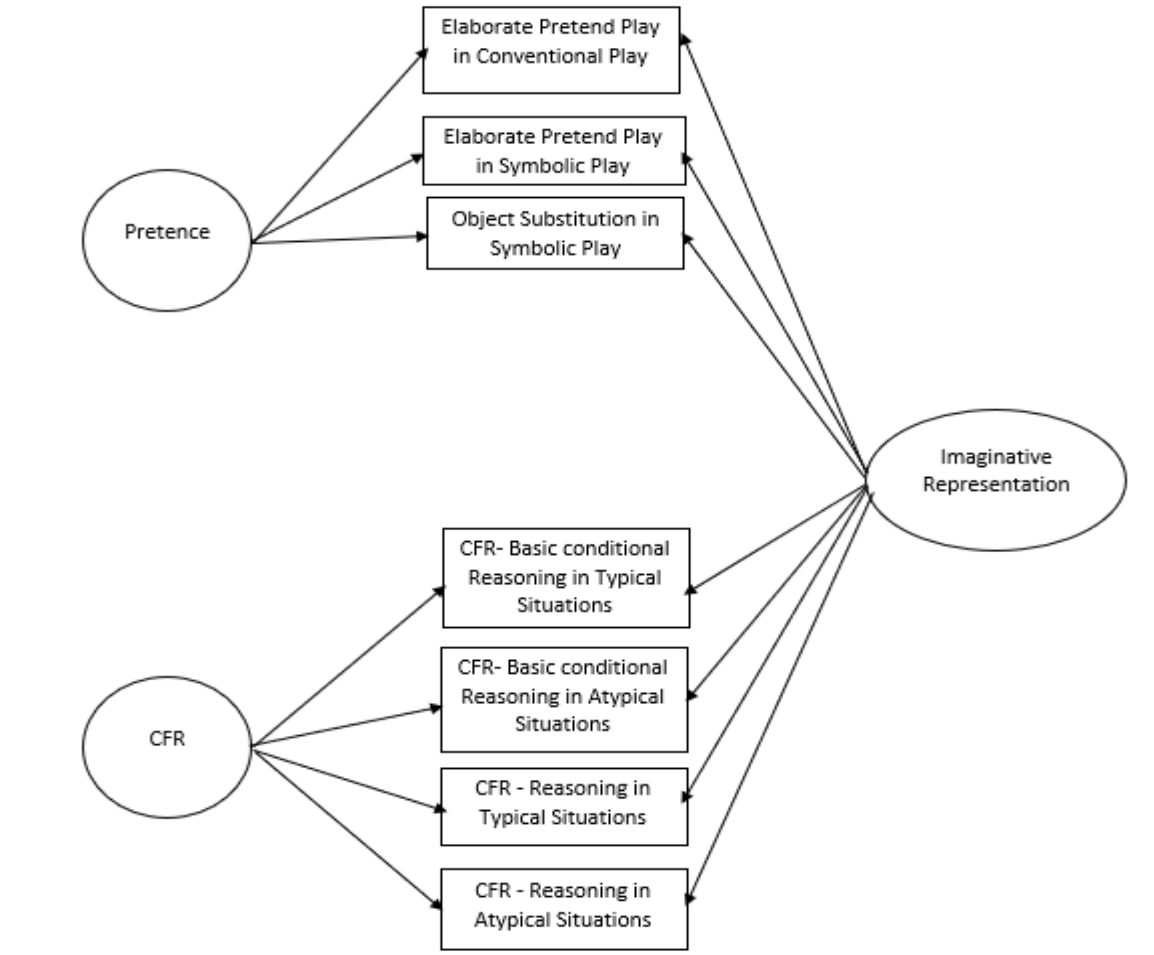

Figure 6.1 Adjusted Hypothesized Model of Counterfactual Reasoning and Pretence

Two of the pretence measures from the study were excluded from structural equation analyses:

a) Number of Object Substitution in Conventional Play, because scores had a floor effect (see Chapter 5 Results A section 5.5.1.3 Testing Assumptions of Parametric Analyses for CHIPPA).
b) Symbolic representation because this task did not correlate with the other indicators of pretence (See Chapter 5 Results A section 5.5.3 where correlations among pretence indicators are reported).

As a consequence, the three pretence measures retained were from the CHIPPA assessment. Hence, it was decided that the factor score generated would be a measure of a child-initiated pretence (CIpretence) and the factor score generated from the four counterfactual reasoning tasks would simply be a measure of counterfactual reasoning (CFR).

6.6.2 Structural Equation Modelling (SEM)

The hypothesized model of the underlying relationship between pretence and counterfactual reasoning specified in Figure 6.1 was tested using structural equation modelling analysis (SEM). In the first instance, the hypothesized model proposed during the research design stage of the study specified a type of structural equation model known as a bifactor model. A bifactor model is used to assess whether (a) there is a general factor that is hypothesized to account for the commonality of all the items (a capacity for Imaginative Representation – IR); and (b) there are multiple domain specific factors (child-initiated pretence and CFR). In bifactor analysis researchers are interested in the domain specific factors as well as the common factor (Chen et al., 2006).

In the second instance, model revisions were made to the hypothesized model by integrating the findings from the data to inform modifications to the proposed theoretical framework. A revised theoretical framework was designed using the model of a hierarchical factor analysis. The hierarchical factor model specified was a second-order factor model. In a second-order factor analysis (a) the lower order factors are correlated, and (b) there is a higher order factor that is hypothesized to account for the relationship among lower order factors (Chen et al., 2006). In this study, the second-order factor represented the general factor - imaginative representation (IR) and the lower order factors were child-initiated pretence and CFR.

Structural equation modelling analyses involve two levels of analyses; at the first level the measurement model specified is assessed and at the second level the structural model is assessed. The measurement part links the observed variables to the latent variables in a confirmatory way and is measured first; whereas the structural part links the latent variables to each other and is only measured when an adequate or satisfactory fit of the measurement model is obtained (Bartholomew et al., 2008). The models were estimated using maximum likelihood estimation and the fit indices used to evaluate how well each model fits the data included: Chi-square, the Comparative Fit Index (CFI), the Standardized Root Mean Square (SRMR), and the Root Mean Square Error of Approximation (RMSEA). The interpretations of the fit indices are based on the following criteria: CFI values above .90 indicate acceptable fit, while values above .95 indicate good fit; SRMR values below .06 indicate good fit; RMSEA values below .08 indicate acceptable fit and values below .06 indicate good fit (Brown, 2015; Longo et al., 2016). The fit of competing models was compared using the Bayesian Information Criterion (BIC), which produces lower values for better fitting models and average variance explained

by each factor was compared to the variance shared by the factors (Longo et al., 2016). The chi-square test statistics are known to be sensitive to sample size (Bartholomew et al., 2008). The results from the analyses of the measurement models are presented and the structural models are presented afterwards.

6.6.3 Research Question 4a. Is there support for the latent model showing the relationship between pretence and CFR?

6.6.3.4 Results of Measurement Model

The Bi-factor model comprised two measurement portions; (a) the two-factor model – which tests that the observed measures can be explained by two latent factors which are correlated and (b) the unidimensional model – which test that the observed measures can also be explained by one latent factor (refer to Figure 6.1).

(a) Two-factor model. The two factors – child-initiated pretence and CFR were significantly correlated ($r = .52$, $p = .001$). The two-factor model showed good fit and the results of the two-factor model without any method correction are shown in Table 6.7.

(b) Unidimensional model. The unidimensional model without any method correction showed poor fit. To improve the model fit, covariances were added between the three child-initiated measures. The model was significantly improved with good fit. The results of the model fit are shown in Table 6.7 alongside the two-factor model.

The BIC indices for the two models were comparable; although the unidimensional model had a slightly lower value. Diagrams showing the standardized factor loadings of two-factor model and unidimensional model are presented in Figure 6.2 and Figure 6.3.

Table 6.7 Goodness of Fit Indices for the Two-factor and Unidimensional Models

Measurement Model	Two-Factor Model	Unidimensional Model	Improved Unidimensional Model
Chi-Square	χ^2 (167) = 74.28 (p = .001)	χ^2 (167) = 266.73 (p = .047)	χ^2 (167) = 15.32 (p = .224)
RMSEA	.066	.161	.041
CFI	.961	.755	.986
SRMR	.051	.090	.040
BIC	5797.24	5843.84	5795.11

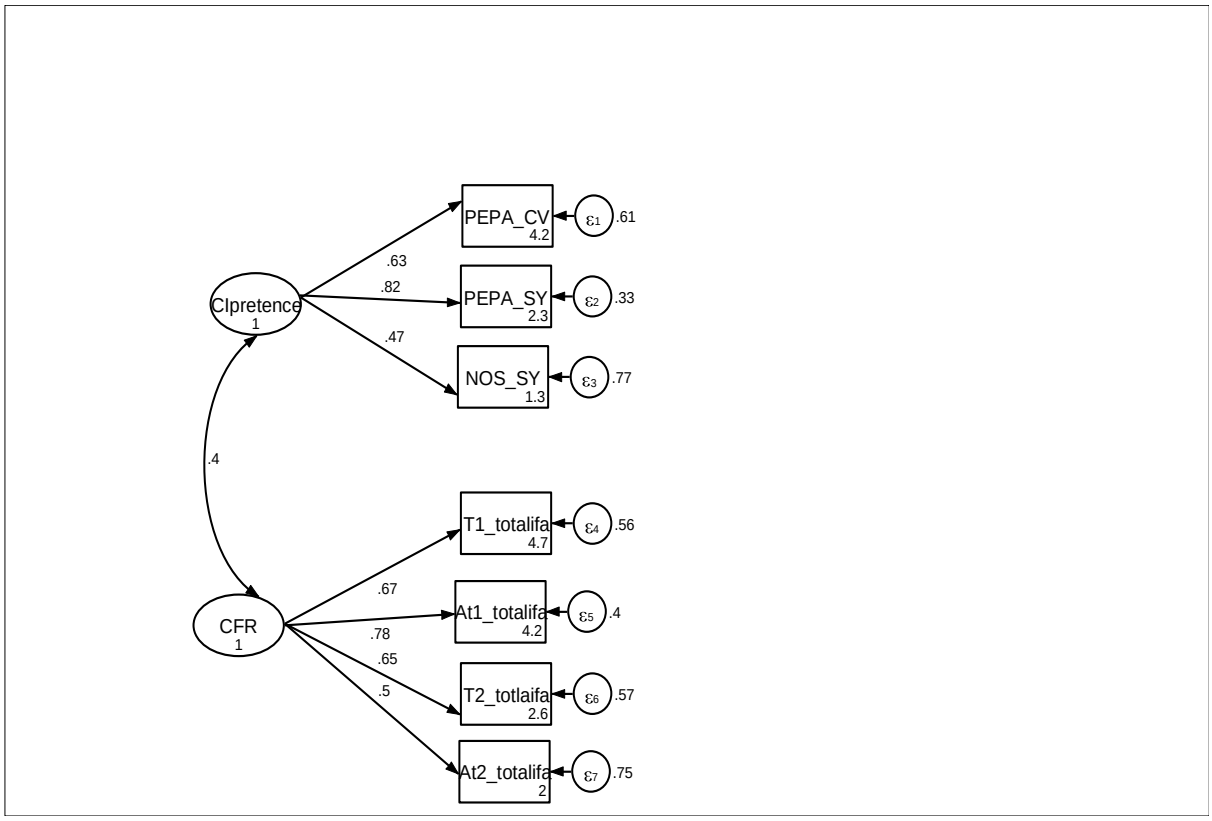

Figure 6.2 Model Fit for the Two-factor Model

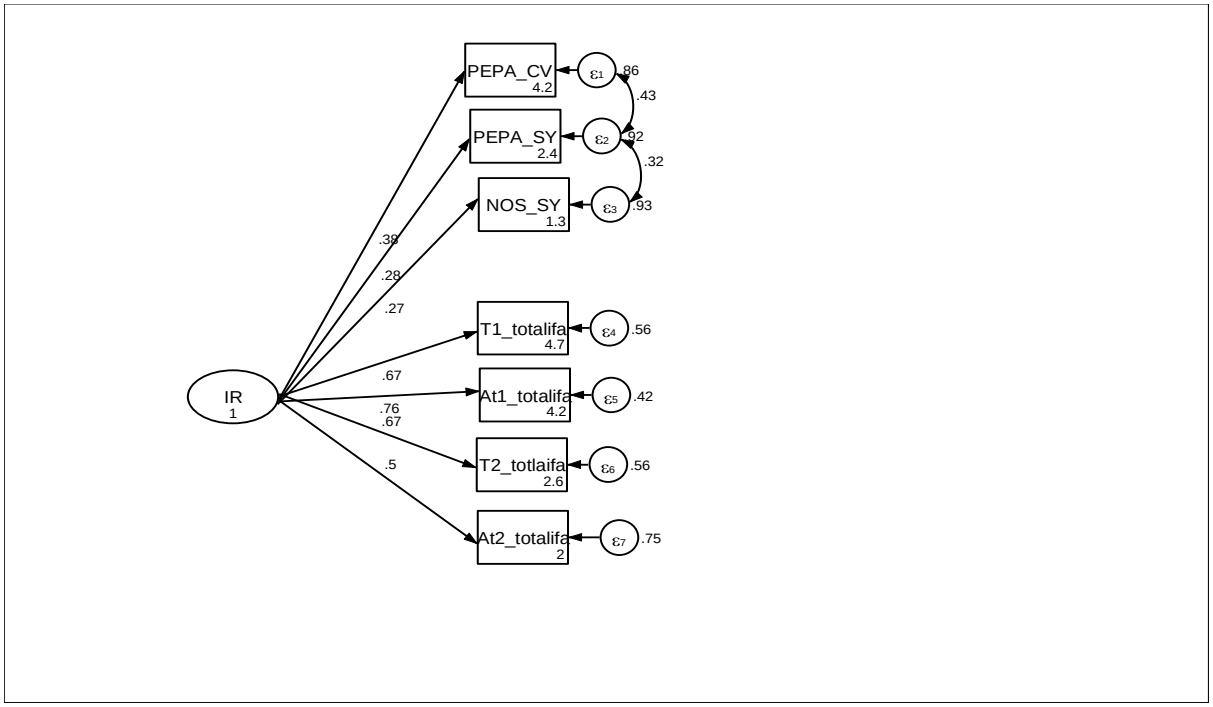

Figure 6.3 Model Fit for the Unidimensional Model

6.6.4 Research Question 4b. Is there support for the structural model showing that pretence and counterfactual reasoning are underpinned by an imaginative representation ability?

6.6.4.1 Results of Structural Model 1

A bi-factor model analysis was run on the general factor (imaginative representation) and specific factors (child-initiated pretence and CFR); however, the estimation of the bi-factor model was under-identified as indicated by the Stata software. This estimation problem may be due to the fact that a bi-factor model with equal loadings and covariates is not identified, that is, it is not possible to get a unique solution for the parameter estimates (Eid et al., 2018).

In a bi-factor model, as it was previously explained, the model specifies that for a given set of indicators, correlations among items can be accounted for by (a) a general factor representing shared variance among all the indicators, and (b) the domain-specific factors where variance over and above the general factor is shared among subsets of indicators presumed to be highly similar in content (Rodriguez et al., 2016). Essentially, general and domain-specific factors are uncorrelated, thus representing unique variance that is not shared with other factors. If the

indicators do not differ in their loadings on the general factor (imaginative representation) and the domain-specific factors (child-initiated pretence & CFR); estimation problems will arise since in a bi-factor model the two measurement components are additively decomposed into the (a) covariance of the general factor (imaginative representation) and (b) variance of the general factor with the domain-specific factors (child-initiated pretence & CFR) (Eid et al., 2018). The similarities in the BIC value for the two-factor model and unidimensional model; as well as, a comparison of the two models presented in Figure 6.2 and Figure 6.3 indicate that the factor loadings for the indicators of CFR also to be fairly similar and this may be indicative of why the bi-factor model could not be identified.

Although, the bifactor model could not be estimated it was important that this finding be reported in light of its implication for the hypothesized model framework proposed in the research design. The assumption was that if child-initiated pretence and CFR were associated one likely explanation is that the variance shared between these two skills could be uniquely partitioned from a broader imaginative representative ability. The results of an under-identified model can only be interpreted as an inconclusive finding until it can be disproved that the relationship between the domain-specific factors of child-initiated pretence and CFR can be explained over and beyond by a general factor. In a case such as this, it is worth exploring whether an alternative explanation might fit the data from this study since in practice structural equation modelling is used to assess whether the model holds approximately instead of whether it holds exactly (Bartholomew et al., 2008).

6.6.4.2 Revised Hypothetical Model

A revised theoretical framework based on a second-order hierarchical model was developed as an alternative hypothetical model delineating links between pretence and counterfactual reasoning at observable and latent levels. In contrast to bi-factor models which specify general factors to be uncorrelated with specific factors; second-order hierarchical models account for the covariation among multiple factors such that the construct consists of a single broader factor which is correlated with several sub-factors (Brown, 2015). Additionally, the findings from the regression analyses indicated that inhibition was a consistent, significant predictor of child-initiated pretence and CFR so the decision was taken to include inhibition into the model as an indicator of imaginative representation (see section exploring similarities or differences in the unique contributions of executive functions and receptive language to pretence and

counterfactual reasoning). The revised hypothesized model mapping links between the latent factors – child-initiated pretence and CFR to second-order latent factor proposed to be a capacity for imaginative representation is specified in Figure 6.4.

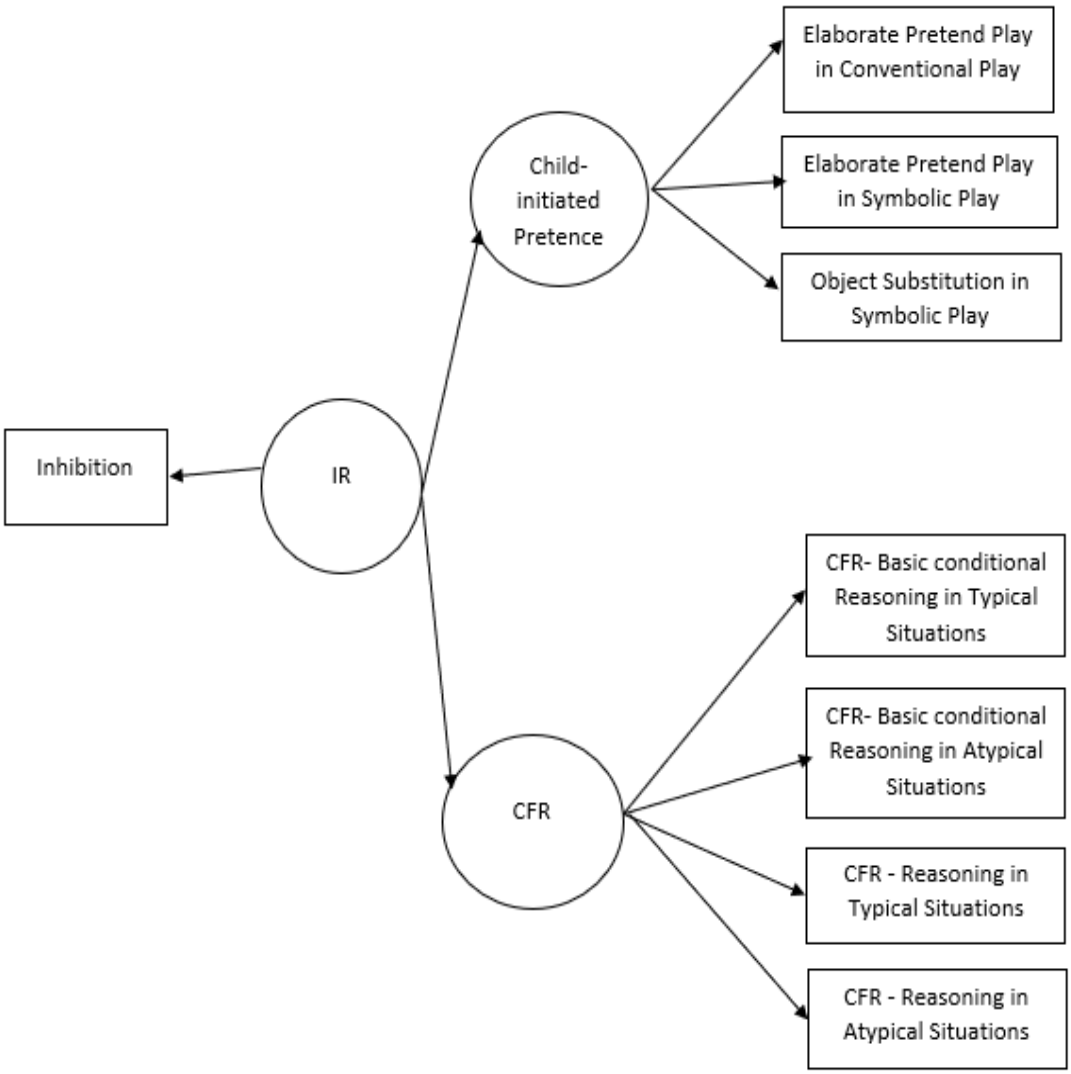

Figure 6.4 Revised Hypothesized Model of Pretence and Counterfactual Reasoning

6.6.4.3 Results of Structural Model 2

The measurement portion of this hypothesis model is based on the two-factor model specified in the section, Results of Measurement Model in this chapter which found that the two-factor model was a good fit for the data; hence the results are applicable to this new hypothetical model being tested (refer to Figure 6.2).

The results of the second-order factor model without any method correction showed good fit χ^2 (167) = 24.46 (p = .14), RMSEA = .047, CFI = .975, and SRMR = .047, BIC = 6987.85. This suggests that a second-order factor analysis is a better fit of the data and supports the view that an underlying capacity might underpin child-initiated pretence and CFR.

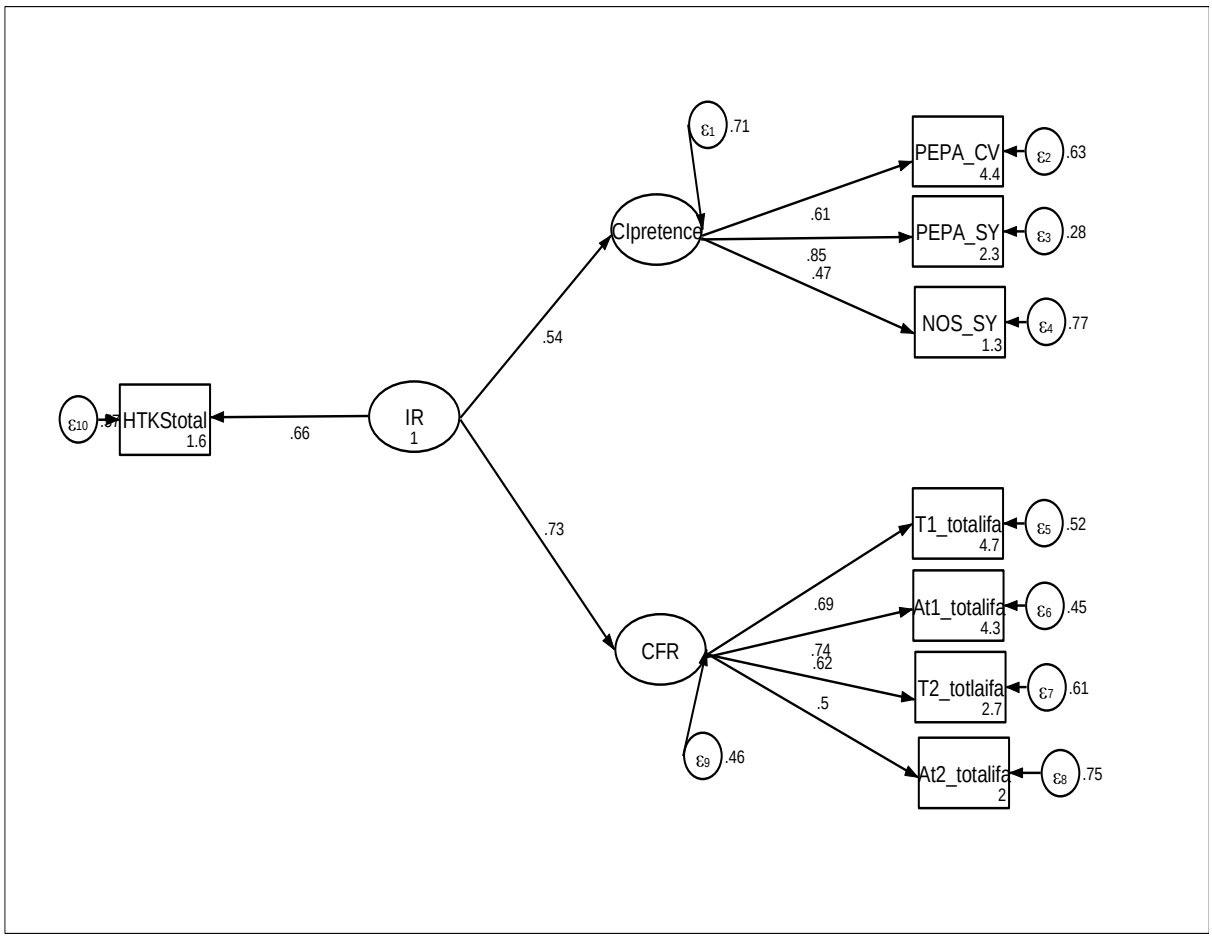

Figure 6.5 Model Fit for the Second-order Factor Model

6.6.5 Conclusion

This section addressed the research question whether a common underlying latent factor could explain the relationship between pretence and CFR. The initial theoretical proposal suggested that the cognitive structure of pretence and counterfactual reasoning comprised a general capacity, as well as the independent cognitive skills of pretence and counterfactual reasoning. A bi-factor model tested the hypothesis that the group factors of child-initiated pretence and CFR accounted for significant variance in the data above that of a general factor (imaginative representation) The result of the bi-factor model analysis was under-identified suggesting that the amount of variance in the data did not support the extraction of unique variance for both a general imaginative representative factor alongside the sub-factors of child-initiated pretence and CFR. It would be interesting to see whether this finding would be upheld in a larger dataset with greater statistical power.

An alternative hypothetical framework was proposed which specified a second-order factor analysis. The assumption was that a general factor called imaginative representation would be correlated with the group factors – child-initiated pretence and CFR. Inhibition was also included as a predictor of the general factor given it was a consistent, independent predictor of child-initiated pretence and CFR. The second-order factor analysis fitted the data well and supports the hypothesis that an underlying factor might underpin associations between pretence and CFR.

6.6.6 Chapter Summary

This chapter addressed the following research questions:

RQ3. How are pretence, counterfactual reasoning, executive functions, and receptive language associated?

> 3a. Are pretence, counterfactual reasoning, executive functions, and receptive language correlated?
>
> 3b. Are there similarities or differences in the unique contributions of executive functions and receptive language to pretence and to counterfactual reasoning?
>
> 3c. If pretence is a form of counterfactual reasoning, is pretence a significant predictor of counterfactual reasoning and vice versa?

RQ4. Is there support for the hypothesized model showing that the constructs of pretence and CFR are underpinned by an imaginative representation ability?

4a. Is there support for the latent model showing the relationship between pretence and CFR?

4b. Is there support for the structural model showing that pretence and counterfactual reasoning are underpinned by an imaginative representation ability?

The chapter unpacked the hypothesis that pretence and counterfactual reasoning share cognitive mechanisms. Data was analysed exploring the relationship between child-initiated pretence, CFR, executive functions and receptive language. For the most part, the variables were correlated with each other except for working memory and delay of gratification which did not significantly correlate with several variables. Receptive language and inhibition correlated strongly with child-initiated pretence and CFR.

A number of hierarchical multiple regression analyses were run to assess the contribution of executive functions and receptive language to child-initiated pretence and CFR. Inhibition was a significant predictor of both Child-initiated Pretence and CFR above and beyond factors like working memory, delay of gratification, age, gender and receptive language. Interestingly, the effect of receptive language was not retained when child-initiated pretence was regressed on CFR. These results were consistent when child-initiated pretence was added to account for unique variance in CFR and vice versa. Both child-initiated pretence and CFR were significant predictors of each other.

Competing models of the hypothesized relationship between pretence and counterfactual reasoning at the latent level were compared using structural equation modelling. Two measurement models were tested to assess whether the data best fit a two-factor model or a unidimensional model. A comparison of the two models showed the fit indices generated for the two models were similar suggesting that both measurement models might equally represent the data. The results from testing the structural model showed that a bi-factor model analysis approach was under-identified but a second-order factor analysis produced good model fit. The resulting conclusion was that the data better supported the theoretical idea of a second order general factor which represents an imaginative representation capacity that is correlated with the domain-specific factors of child-initiated pretence and CFR.

Chapter 7 Discussion Chapter

7.1.0 Introduction

This study sought to generate empirical evidence to test the theoretical claim that pretence and counterfactual reasoning share cognitive mechanisms. Overall, the evidence supported the claim that pretence and counterfactual reasoning are related cognitive skills. This chapter examines the results with the intention of elucidating what are the cognitive mechanisms shared by pretence and counterfactual reasoning. The key findings discussed are organized around the main research questions and the results are examined in relation to the existing body of literature in the fields of pretence and counterfactual reasoning. There is a theorising section which evaluates the theoretical proposal made about pretence and counterfactual reasoning. The empirical evidence generated in this study are taken into consideration and new ideas for furthering a general theory that links between pretence and counterfactual reasoning are proposed. A consideration of the strengths and limitations of the study is presented followed by a discussion of the implications of the findings, and the contribution of this study to the discussion about the role of pretence in child development. The chapter concludes with a general summary of the chapter.

7.2.0 Discussion of Findings

7.2.1 Research Question 1

> Is there evidence that observed pretence behaviours depend on a common underlying ability in this domain?

Both pretence and counterfactual reasoning are complex constructs having multiple measures by which they are defined. Pretence has several defining features and definitions of pretence will vary based on the goals of a study (Frahsek et al., 2010; Thompson & Goldstein, 2019). In this present study, the construct of pretence was inferred from a child's ability to engage in elaborate pretend play and object substitution. These two constructs were measured independently and were significantly correlated with each other ($r = .50$). The indicators of pretence were elicited in the context of a child-initiated pretend play paradigm where children

generated imaginary ideas including projecting unto objects in the spirit of fun or play (Lillard, 1993a).

The results of the confirmatory factor analyses yielded psychometric support for a generalized construct of pretence and as the indicators of the generalized construct came from a measure of child-initiated pretend play; the pretence factor was named 'child-initiated pretence'. Pretend play behaviours such as elaborate imaginative pretend actions with objects, verbally attributing properties to objects, using one object to represent another, and referring to an absent object as if it were present were used to infer the cognitive skill of pretence. Other studies have also validated a cognitive construct of pretence; although, there were slight variants in the composition of the factor mostly influenced by contextual differences in the conceptualization and development of the aspect of pretence being studied. For example, the Affect in Play Scale-Preschool Version (APS) has validated a two-factor model of their measure – an affect factor and pretence factor explained by imagination, organization, and comfort (Kaugars & Russ, 2009; Marcelo, 2016). The inputs of the pretence factor in the APS are similar to that of the CHIPPA with the exception of comfort. Moreover, a study investigated changes in children's pretend play ability based on the APS over a period of twenty-three years concluded that children demonstration of these cognitive pretence skills (imagination in play and comfort in play) have significantly increased over time despite children having less time to play (Russ & Dillon, 2011). This suggest that pretence is potentially a stable construct. Future studies should give more consideration to conceptualising pretence more globally beyond its individual pretend play indicators.

Contrary to expectations, not all the indicators of pretence correlated with each other. In this instance, symbolic representation inferred from the pretend action task (a separate measure to the CHIPPA) did not correlate with either elaborate imaginative pretend play or object substitution – the indicators of pretence elicited from CHIPPA. One possible explanation is that the two pretence measures used different play contexts. The Pretend Action Task is a highly structured prescriptive task as children are instructed on the pretend actions to perform; whereas, the CHIPPA used a free play paradigm where children are given set objects but are encouraged to engage in spontaneous extended pretend play. Congruent with the present findings, a study with similar aged children found that the pretend action task did not correlate with a pretend-reality task which was used to assesses a child's ability to differentiate between the actual and pretend identities of objects, or with measures of executive functions (Carlson,

White, & Davis-Unger, 2014). In the study by Carlson, White, and Davis-Unger (2014) both measures of pretence were structured tasks so this suggests that dissociations among pretend play tasks may extend beyond the task structure to the quality of non-literal representation elicited within the task. Perhaps, being asked to represent an object symbolically evokes a different quality of pretence representations from engaging in extended elaborate pretend play with object substitutions. This gives rise to the question of whether all categories of pretence require the capacity to metarepresent – hold in mind dual representations by decoupling the pretend world from the real world (Leslie, 1987; Nielsen & Dissanayake, 2000). Although, the pretend action task is a well-established task of symbolic representation further research is needed in understanding differences in mental representations, symbolic representations, metarepresentations, and imaginative representations.

There was an effect of gender on the amount of pretence actions elicited. Girls engaged in more elaborate pretend play than boys. Previous studies have found gender differences in engagement in pretend play throughout development (Jones & Glenn, 1991; Meland, Kaltvedt, & Reikerås, 2019; Sansanwal, 2014; Smith & Lillard, 2012). Jones and Glenn (1991) observed that at the age of four girls engaged in more person fantasy orientation whereas boys were more inclined towards object fantasy play. Sansanwal (2014) reported that girls were found to engage more in realistic role-playing than boys of their age in the preschool years. In contrast, retrospective reports from undergraduates on the persistence of their engagement in pretend play over the course of their childhood revealed that pretend play persisted well into middle childhood with males reporting that they continued to engage in pretend later than females (Smith & Lillard, 2012). The observed differences in males and females engagement in pretence in the early years as compared to later years have been attributed to the idea that girls mature earlier than boys in respects like linguistic development so what may be happening is that girls are growing into and maturing out of pretence more quickly than their male counterparts (Meland et al., 2019; Smith & Lillard, 2012). A validity study would therefore need to consider whether gender differences influences the robustness of a generalized pretence construct.

7.2.2 Research Question 2

> Is there evidence for a generalized latent construct of Counterfactual Reasoning?

Similar to the findings for pretence, the results of a confirmatory factor analysis yielded psychometric support for a generalized cognitive construct of counterfactual reasoning. The latent construct is referred to by the abbreviation CFR. The CFR construct is drawn from a social-causal counterfactual reasoning task which assessed whether children could successfully apply counterfactual reasoning over basic conditional reasoning when responding to counterfactual questions. What has been observed is that to reason counterfactually all the features of the story must be preserved and integrated into the counterfactual response instead children tend to apply basic conditional reasoning where they drop all non-permanent features of the story and rely on as default domain-general real world knowledge (Leahy et al., 2014; Rafetseder & Perner, 2010). Since a goal of this study was to understand the cognitive mechanisms of counterfactual reasoning it was important to select a task that elucidated the cognitive skills children were applying. The findings replicated the work of Rafetseder and Perner (2010) who reported that before the age of six years the children were not successful at giving mostly correct answers to counterfactual reasoning questions on a social-causal task but demonstrated a mix of basic conditional and counterfactual reasoning strategies.

Social-causal tasks like the one used in this present study generally fall into the category of real-world counterfactuals which are focused on how past events could have been different and involve changing a course of action (Beck & Riggs, 2014; Byrne, 2016). The difference between real world counterfactuals and pretence is the cognitive process of mentally undoing an aspect of the past event sequence that has happened (McCormack, et al., 2018). The similarity is that both are derived from setting up false premises of the real-world as it is known. The expectation when engaging in real-world counterfactual reasoning is that children will be able to constrain their thinking based on the real world and avoid forming conclusions primarily based on background assumptions (Beck, Riggs, et al., 2011; Rafetseder & Perner, 2010).

The reasoning strategies deployed by children in this study included basic conditional reasoning, counterfactual reasoning and realist reasoning. A realist error is a difficulty with reasoning in counterfactual situation which occurs when a child responds with the current state

of affairs (Robinson & Beck, 2000). So, when asked a counterfactual question, children struggled with whether they should answer with the present location in the real world, resulting in a realist error, or with the present location in the possible world, resulting in the correct counterfactual answer (Rafetseder & Perner, 2010). Realist reasoning was the least likely strategy used by children in this study. Generally, three-year olds are prone to making realist errors but by the age four children are generally able to overcome this tendency (Riggs et al., 1998). Reasoning with the current state affairs means that the counterfactual premise is completely ignored and implies an absence of considering the alternative possible world which was proposed.

Trends in basic conditional reasoning or counterfactual reasoning strategies were compared by looking at the likelihood of children not using basic conditional reasoning to respond to counterfactual reasoning questions in scenarios where it would yield incorrect answers. For instance, in one of the scenarios used in this study a firefighter leaves the fire-station where he works and is at his living-room watching TV when he is called to respond to an emergency fire in the forest. In response to the counterfactual question, "if there had not been a fire where would the firefighter be?"; to answer with fire-station suggests that the child did not factor in their response that the fire-fighter was no longer at the fire-station but was at his living-room when the emergency call was received. An explanation put forward is that young children are unable to interpret the relevant part of the counterfactual question, "…where would the firefighter be?"; instead they take it to mean, "where is a firefighter (typically)?" and thus answer with 'fire-station' (Rafetseder & Perner, 2010). What we see from the present data is that while most children were able to overcome making the realist error by answering with the firefighter's actual location (forest); the most common error was indeed to answer with the typical location where a firefighter would be thereby making a typical error. This is symptomatic of basic conditional reasoning where although the child recognised the imagined impact of the 'if' antecedent when there are two alternatives to the real location, children tend to pick the typical location where the firefighter works (basic conditional reasoning).

However, that is not to say that the children in the present study had a consistent pattern of responses for answering questions with two alternative locations. Their response was consistent with the findings from Rafetseder and Perner (2010) in that in the two location scenarios children mixed the strategies of basic conditional reasoning with counterfactual reasoning. For

the participants in Rafetseder and Perner (2010) study, reasoning with counterfactual antecedents became dominant only by the age of six. This dominance in counterfactual reasoning was not observed in this study, probably because the participants were less than six years old. Hence, this study supports the conclusion that mature counterfactual reasoning is still a developing ability between the ages of four to five years (Beck, Riggs, et al., 2011; McCormack et al., 2018b; Rafetseder & Perner, 2010). It can therefore be argued that the generalized construct of counterfactual reasoning (referred to as CFR) found in this study represents a combination of both basic conditional reasoning and mature counterfactual reasoning.

Children's difficulty with counterfactual reasoning is intriguing especially since children seem to be able to handle counterfactual imaginations in pretence from eighteen months but seemingly have difficulty with counterfactual imaginations in formal contexts of counterfactual reasoning (Riggs et al., 1998). The core attributes of adopting a counterfactual premise by decoupling, creating an event sequence while having an awareness of the reality and fantasy distinction identified as common to both pretence and counterfactual reasoning by Weisberg and Gopnik (2013) seem to occur quite simplistically in pretence. Perhaps it is because in pretence there are no constraints on the real world and there are no bounds to the imaginative worlds hypothesized. Hence, children could elaborate on their imaginative ideas and object substitutions at will while playing pretence. The only comparison necessary in pretence is to separate the real-world model of the world from its counterfactual imaginative alternative model. In counterfactual reasoning, it may not always be enough to hold a model of the real and alternative world in mind. Additionally, inferences are drawn from comparing these two worlds and sometimes multiple counterfactual models must be held in mind, compared to each other and reality (Amsel & Smalley, 2000; Weisberg & Gopnik, 2013). Essentially, the space of counterfactuals is continuous and can be characterised along a continuum of developmental milestones as opposed to pretence which may lack such levels of differentiation (Beck, 2016; Weisberg & Gopnik, 2016). Regardless of demands from having to draw inferences of varying difficulties in a counterfactual reasoning, it is the capacity for dual representation that sits at the core of both pretence and counterfactual reasoning.

There are several explanations as to why children are not able to consistently reason counterfactually between the ages of four to five years. It may be that the psychological demands arising from the nearest possible world constraints of the task may be too taxing on

children. Children must hold in mind the understanding of the causal relationship between the specific past event and its subsequent outcome, and the other possible world where had the specific event been different another outcome would have occurred (Beck & Riggs, 2014). These require multiple mental models to facilitate changing only these features of a scenario that are causally dependent on a counterfactual antecedent while holding all else constant (McCormack et al., 2018b; Nyhout & Ganea, 2019). Children may just not be able to consistently and successfully maintain making multiple modifications to specific elements of reality and simultaneously inhibit their own empirical knowledge in difference to the contents of the counterfactual premise.

Alternately, it may be that different counterfactual tasks may be more challenging than others. Counterfactual reasoning tasks used with children can be broadly classified into two groups: physical causal tasks where children engage in causal action sequences on objects or things (Nyhout & Ganea, 2019; McCormack, et al., 2018) and social causal tasks or mental tasks which take the form of people deciding to do things (Rafetseder et al., 2013). There are conflicting claims about the age which children can successfully reason counterfactually, depending on which task is used. In contrast to previous suggestions that children can successfully reason counterfactually by the age of six; Nyhout and Ganea (2019) claim that four to five-year old children can engage in mature counterfactual reasoning given a clear, novel causal structure. The researchers used a physical causal task using a 'blicket detector' machine and showed children over-determined trials having two causal blocks on a box and single causal trials having one causal and one non-causal block; then asked children what would have happened if one of the two blocks had not been placed on the box. Five-year olds performed at ceiling even when the experiment was repeated using a temporal delay paradigm between the first and second causal block sequence (Nyhout & Ganea, 2019). The researchers argued that a possible explanation for failed evidence for robust counterfactual thinking before six years rest with the use of overly complex tasks which expect children to reason from opaque causal structures. It may be that social-causal tasks are inherently complex because they aim to replicate real-world experiences to children so inadvertently require adequate context and explanation. The counterfactual reasoning task used in this present study was a social-causal task which was lengthy to administer such that reward strategies were employed to sustain children's attention and ensure that they understood the scenarios. Although task was made to be as simple as possible; the complexity of such tasks cannot be overlooked. It stands to reason that complex tasks would therefore be more cognitively demanding. Beck (2016) argued that

real-world counterfactuals may be different from other types of counterfactuals (e.g. physical-causal tasks) in their relationship with reality but also by a matter of degree, for instance, by making greater inhibitory control demands. In this vein, the case for recognizing the boundaries by which counterfactual reasoning tasks are conceptualised, as proposed by Beck (2016), may be warranted.

7.2.3 Research Question 3

> What is the relationship between pretence, counterfactual reasoning, executive functions and receptive language?

It was hypothesized that if pretence and counterfactual reasoning draw on the same core cognitive processes; then their pattern of associations with other related cognitive skills should bear similarities. On this basis, the associations between executive functions and receptive language with pretence and counterfactual reasoning were compared. The findings showed that inhibition was a significant predictor of both child-initiated pretence and CFR as opposed to working memory and delay of gratification which were significantly associated with neither child-initiated pretence nor CFR. Receptive language also significantly predicted child-initiated pretence and CFR but the effect of receptive language on child-initiated pretence was not sustained over and beyond the influence of executive functions; in the case of child-initiated pretence. Interestingly, receptive language accounted for more variance in CFR than inhibition; (receptive language $\beta = .30$ and inhibition $\beta = .23$) probably because of the linguistically demanding nature of the counterfactual reasoning task.

Researchers have hypothesised strong conceptual relationships among the processes of pretence and counterfactual reasoning with language, executive functions, and other cognitive skills (Bergen, 2002). For this reason, a strategy for understanding the associations between pretence and counterfactual reasoning was to investigate how other related cognitive skills might potentially influence children's ability to pretend or reason counterfactually. It is a widely discussed idea in the literature that the representational qualities of pretence may be a part of the same core abilities needed to consider alternatives in counterfactual thinking and that both rely on an ability to execute dual representations of the real and imagined world

(Carlson, White, & Davis-Unger, 2014; Harris & Levers, 2000; Gopnik & Walker, 2013; Weisberg & Gopnik, 2013). One view drawn from connectionist theory is that representational abilities are innate but representations recruit other cognitive processes like language and executive functions (Carlson, et al., 2014; Guajardo & Cartwright, 2016). However, domain-general cognitive abilities are subject to the process of development and maturation throughout the course of childhood which have an adverse effect on how skills reliant on mental representations are applied across different contexts. Support for the idea of shared cognitive processes come from neuroscience research that report for example, that goal-oriented cognitive processes of executive functions recruit similar regions of the brain (Van Hoeck et al., 2015; Whitehead et al., 2009).

The findings for this research question speak to the question about which executive function skills are more likely to be associated with pretence and counterfactual reasoning and why might it be the case. In a study exploring evidence for a relationship between executive function and pretence representation in preschool children; the results revealed there was a robust, positive correlation between inhibition and the ability to manage dual representations in pretence (Carlson et al., 2014). In addition, a positive correlation was also found between inhibition and counterfactual reasoning in a study which related children's counterfactual reasoning and executive functions (Beck et al., 2009). In both these studies, inhibition shared the strongest correlations with pretence or counterfactual reasoning; whereas, working memory did not significantly predict engagement in pretence or counterfactual reasoning after controlling for factors like age and language. The results are consistent with the findings from this present study but raises questions about the role of working memory in pretence and counterfactual reasoning. It may be that thinking about possibilities allows the thinker not to depend on their memory of how the world should be but to suspend conventional understanding in favour of creating fantastical themes.

On the other hand, other studies exploring links between executive functions and counterfactual reasoning have reported slightly different results. Guajardo, Parker, and Turley-Ames (2009) found that working memory and cognitive flexibility significantly predicted performance in counterfactual reasoning and Drayton, Turley-Ames, and Gaujardo (2011) reported working memory, inhibitory control and counterfactual reasoning were all significantly correlated. A study by Slot, Verhagen, and Leseman (2017) found no correlations between a pretend factor score and executive functions measured as selective attention, visuospatial short-term memory,

visuospatial working-memory, delay of gratification. Pretend play was defined in terms of role play and symbolization. Across different studies, the type of executive functions selected varied and the pattern of results were not always consistent. However, inhibitory control has been attributed as central to the ability to suppress one's empirical knowledge of the world to reason from a counterfactual premise. Others have argued that working memory is inadvertently activated by virtue of having to remember the contents of the false premise. It might be that as a complex executive function cognitive flexibility is predictive beyond inhibitory control and working memory (Guajardo & Cartwright, 2016). There is need for further research aimed at understanding the contribution of executive functions to pretence and counterfactual reasoning.

There remain strong arguments for the influence of inhibition in solving or generating counterfactuals. As previously discussed, to successfully answer real-world counterfactuals require that one applies real-world constraints by changing only those features of an event that are causally dependent on a counterfactual antecedent, holding all else constant, and inhibiting the prepotent tendency to defer to general real-world knowledge about the counterfactual premise (Leahy et al., 2014; Nyhout & Ganea, 2019). The salience of real-world knowledge comes from it being a strong, desirable response since it is a habitual well-practice response; but to overcome basic conditional reasoning it must be inhibited so that the less activated response – the contents of the counterfactual premise – can be activated (Beck, Carroll, et al., 2011). So, there is an expectation that inhibitory control will account strongly in counterfactual reasoning. Interestingly, support for the influence of inhibition comes from research with children with autism. Scott, Baron-Cohen, and Leslie (1999) attributed the success of children with autism in answering counterfactual questions to having a weak central coherence system described as a diminished drive to integrate new information with information from long term memory leaving children to rely solely on information from the counterfactual premise. This suggests that children with autism are not faced with the need to apply real-world constraints by inhibiting prepotent responses from their knowledge of the real world but for typically developing children without a cognitive impairment this skill is essential. Furthermore, while a pretence dysfunction is characteristic of autistic children that is not to say that they are incapable of imaginative thought. The evidence indicates that children with autism can imagine when instructed to do so (Scott et al., 1999). Moreover, it may mean that for typically developing children inhibitory control is one of the cognitive mechanisms that influences engagement in pretence and counterfactual reasoning.

Receptive language was significantly correlated with both pretence and counterfactual reasoning but was a unique predictor of only counterfactual reasoning, not pretence. From a practical perspective, the counterfactual reasoning task was linguistically demanding so it stands to reason that success on this task require that children have acquired receptive language skills. In contrast, the CHIPPA, which was used to assess pretence, focuses on pretend action sequences and does not necessarily require children to be verbally expressive unless they choose to. Language is considered parallel to pretence, and by extension counterfactual reasoning, as all involve the use and comprehension of symbols (Lillard et al., 2011). Therefore, one can infer from the results of this study that whilst receptive language is associated with pretend play given their simultaneous appearance in development; pretend play does not necessarily depend on receptive language especially considering it appears in children from eighteen months when formal language communication is just developing. In contrast, one's ability for counterfactual reasoning can only be inferred from a shared language exchange, that is, the child must understand the counterfactual premise presented and verbally or gesturally respond to the counterfactual question. Hence, it makes sense that receptive language would be predictive of counterfactual reasoning. It has also been found that children with lower language ability found counterfactual conditional questions with short causal chains more difficult than long causal chains whereas for children with higher language ability their performance was unaffected by the length of the causal chains they had to consider (Beck, Riggs, & Gorniak, 2010). Language is generally viewed as influential as it is elemental to understanding mental representations. In related fields like theory of mind there is the suggestion that conceptual developments in theory of mind may also be facilitated later by advances in language development (de Villiers & de Villiers, 2000). Similarly, the expectation is that advances in language development will facilitate successfully counterfactual reasoning.

7.2.4 Research Question 4

> Is there support for the hypothesized model of the structural relationship between pretence and counterfactual reasoning?

This study directly responded to the assertion that pretence and counterfactual reasoning are related cognitive skills sharing psychological processes (Gopnik & Walker, 2013; Weisberg & Gopnik, 2013). It makes a unique contribution to knowledge because no study has attempted to empirically quantify the direct associations between independent measures of pretence and counterfactual reasoning. It is well understood that the representational abilities of pretence and counterfactual reasoning in young children are not developmentally aligned. On one hand, very early in development (from the age of eighteen months) young children have little difficulty with counterfactual representations in pretence and can successfully manoeuvre pretend-reality distinctions without getting confused. Alternately, formal counterfactual reasoning by virtue of being more cognitively demanding develops later than pretence with children having to overcoming several counterfactual reasoning milestones like realist errors and basic conditional reasoning before laying claim to the prize of mature counterfactual reasoning. Bearing the developmental difference in mind, this study uniquely modelled the relationship between pretence and counterfactual reasoning at a time in development when pretence climaxes and counterfactual reasoning begins to become cemented. This ensured that conclusions about the relationship between pretence and counterfactual reasoning were captured at a time when children could reasonably produce both skills. Thus, claims from this study about how pretence and counterfactual reasoning share cognitive processes are in reference to early years development.

This study is novel as it has showed that the constructs of child-initiated pretence and CFR are significantly correlated at a latent level. Child-initiated pretence was moderately correlated with CFR ($r = .52$). The only other study to investigate the relationship between pretence and counterfactual reasoning was conducted by Buchsbaum, Bridgers, Weisberg, & Gopnik (2012). The researchers used an experimental design and taught children a novel causal system in a real-world context and pretend context and children were asked counterfactual reasoning questions about the causal system in the real-world context and questions about the causal system in a pretend context. For two versions of this experiments Buchsbaum, Bridgers, Weisberg, and Gopnik (2012) reported that children's pretence scores were significantly correlated with their counterfactual reasoning scores ($r = .62$ and $r = .44$). The correlational

link found between child-initiated pretence and CFR provided justification for computational modelling of the cognitive link shared between these two abilities.

The fundamental probing question asked what is the underlying capacity that supports the dual representations involved when children engage in pretend play or counterfactual reasoning. In both contexts, children seemingly make a cognitive leap from a real-world premise venturing into an imaginary cognitive workspace where contrary to fact hypothetical ideas are imposed on their real-world ideas, objects, things, interactions or experiences. The difference, however, between pretence and counterfactual reasoning lies in how loosely or tightly the information from the real world is decoupled from the alternate imaginary world evoked. It was, therefore, hypothesized that the cognitive architecture activated during pretence and counterfactual reasoning is one where an underlying imaginative representative capacity is germane to the mental representations elicited when reality is represented in alternative hypothetical ways.

The evidence from this study supported the theoretical model which was designed to test the proposed hypothesis that the underlying mechanism linking pretence and counterfactual reasoning was the capacity to represent imaginative thoughts. The data fitted the theoretical model which specified path relationships predicting that the covariation between the latent variables of child-initiated pretence and CFR could be explained a second-order latent factor named imaginative representation. The theoretical model also included inhibition as a significant predictor of the second-order factor imaginative representation. It was predicted that this theoretical model would explain most of the covariation among the latent constructs and the indicators or observed variables measured in the study (Brown, 2015). Specifically, the results showed that the intercorrelations among child-initiated pretence and CFR were explained by a common cause or underlying construct named imaginative representation which was also significantly predicted by inhibition.

There is strong conceptual evidence that alternating between real and counterfactual thoughts requires inhibiting what is known about the real world to explore the possibilities of the imaginary world while holding both representational models in mind (Amsel & Smalley, 2000; Beck, Riggs, et al., 2011; Beck et al., 2006; Weisberg & Gopnik, 2013). Developmentally, this feat is accomplished early in pretence as children are able to distinguish between the real and imaginary world and often rebuff intrusions from the real world by reminding their play partner that they are pretending. In counterfactual reasoning, this ability develops more slowly as the

evidence shows that children gradually become better at deciding when bits of information from the real world are necessary for reasoning successfully in the counterfactual world (Beck et al., 2014). This study found support for this perspective as inhibition was a significant predictor of both child-initiated pretence and CFR. The arguments from the literature suggested that inhibitory control is in its own right a cognitive skill which facilitates being able to generate imaginary thoughts. A deductive approach was used and the theoretical model was mapped to show that the mechanisms by which imaginative representations are portrayed also relies on inhibitory control.

In the final analysis, the data supported the theoretical model that the relationship between pretence and counterfactual reasoning could be explained by a second-order factor, imaginative representation which relied on inhibitory control. The model was a good fit of the data as all fit indices were well above acceptable ranges. The preliminary tests of the measurement model confirmed that child-initiated pretence and counterfactual reasoning were better conceptualised as a two-factor model as opposed to viewing all the measures from the two factors as unidimensional. This model is promising in terms of having scope for considering whether other cognitive skills that rely on generating alternative representations of the real-world like false belief understanding or even creativity are also underpinned by this broad capacity for imaginative representations.

An alternative model was considered but did not fit the data. This other theoretical model was tested using a bifactor model to determine whether the data could uniquely explain the variance in child-initiated pretence and CFR after extracting a general factor of imaginative representation factor (Bonifay et al., 2017). The bifactor model, however, was under-identified. An under-identified model is one in which it is impossible to obtain a unique estimate of all the model's parameters but it is not necessarily the case that barring modifications to the data the equation cannot be solved (Kenny & Milan, 2012). Suggestions for making the model identifiable include measuring more variables of a particular type or obtaining additional indicators of the latent construct because adding another good indicator or an instrumental variable can help (Kenny & Milan, 2012). Limits on the time-frame for finishing this thesis did not permit these options to be explored. Hence, recommendations which could be implemented to make the bifactor model identifiable include: (a) explore the option for increasing the number of indicators for pretence and counterfactual reasoning, and (b) include other counterfactual reasoning variables which may also be reliant on an imaginative representation

capacity that is grounded in reality or a given premise., for example, false belief, syllogistic reasoning or even creativity.

Moreover, by virtue of the model being under-identified the question of whether a general imaginative representation factor can account for variance independent from that shared by child-initiated pretence and CFR remains unanswered. Why is this question important? Bifactor models provide a different way of thinking about the psychological structure of counterfactual reasoning. If a bifactor model of the relationship between pretence and counterfactual reasoning is supported there are implications for how these cognitive skills are conceptualised in future research - as a general factor as well as by domain-specific factors (Chen et al., 2006). This may also provide a novel way of conceptualizing measures of imaginative thinking, counterfactual thinking, and other cognitive skills which rely on some form of imaginative representation, for example, false belief understanding, creative thinking et. cetera, as bi-factor models are useful tools for understanding the psychometric properties of a concept (Bonifay et al., 2017). However, there is a caveat for attempts to be made at validating confirmatory evidence about psychological processes from bifactor models be validated at psychobiological levels (Bonifay et al., 2017). Notwithstanding, future considerations of other theoretical models are worth investigating as a model having a good fit does not rule out competing models given many different models may fit a given dataset (Thompson & Borrello, 1992).

An important consideration is that the efficacy of structural models rest with the validity and reliability of the measures or indicators purported to predict the hypothetical latent constructs. This was a challenge in this study as there are currently limited robust theories providing clear definitions and measurements of pretend play and counterfactual reasoning. In fact, the extant literature indicates that the construct of pretend play is ill-defined and there is lack of consensus on its multiple components and how these components can be measured in tandem (A. S. Lillard et al., 2013; B. N. Thompson & Goldstein, 2019). Similarly, historical measures of counterfactual reasoning have come under scrutiny for whether they are indeed capturing a true definition of counterfactual reasoning (Leahy et al., 2014; Rafetseder & Perner, 2010, 2014). This study uniquely tackled these notions by developing psychometric evidence that can contribute to building construct definitions for both pretence and counterfactual reasoning.

The results of the factor analysis produced strong evidence that the construct of child-initiated independent pretend play comprised of an ability to substitute objects and attribute pretend properties to objects, people or ideas during play. Support for this finding was found in a paper by Thompson and Goldstein (2019) who proposed a hierarchical developmental progression of pretend play from reviewing one hundred and ninety-nine empirical articles which had measured pretend play. From their review of the literature, the researchers suggested that it is likely that pretend play behaviours develop additively from least to psychologically complex following the order of object substitution, attribution of pretend properties, social interactions within pretend play, role enactment, and pretence-related metacommunication. The final three pretend play behaviours identified by Thompson and Goldstein (2009) are typically measured in the context of social-pretend play, which was not a condition of this study. However, my study provides evidence that object substitution and attribution of pretend properties are definitional to the construct of pretence.

Current discussions in the counterfactual reasoning literature has scrutinized historical tasks that measure children's counterfactual reasoning and questions whether children's successes on such tasks should be attributed to basic conditional reasoning or mature adult-like counterfactual reasoning and whether basic conditional reasoning counts as counterfactual reasoning. I think that in addition to clear conceptual distinctions of what a concept is and is not; there is space for recognising the developmentally age appropriate ways that children can reasonably represent concepts at different stages of their development. The counterfactual reasoning task used in this study replicated the findings of Rafetseder and Perner (2010) that before the age of six years children are not very good at applying mature counterfactual reasoning consistently in responding to counterfactual reasoning questions and more often use basic conditional reasoning as their reasoning strategy. It was not that children could not apply mature counterfactual reasoning but that they were not doing so consistently. Essentially, they were not good at it. However, the evidence from the current literature is mixed on the precise age that children can actually apply mature counterfactual reasoning consistently (Nyhout & Ganea, 2019; Rafetseder et al., 2013; Robinson & Beck, 2000). With this awareness, I propose that construct validity evidence for counterfactual reasoning should be drawn from indicators that showcase children's age appropriate depictions of the construct (refer to section 2.3.4 of the Literature Review for a breakdown of levels of counterfactual thinking). The results of the factor analysis showed that basic conditional reasoning and mature-counterfactual reasoning responses were significantly correlated and were reliable indicators of the construct of

counterfactual reasoning. Hence, I think that an age appropriate definition of the construct of counterfactual reasoning during early childhood needs to include basic conditional reasoning.

This study provides evidence for defining and measuring the constructs of pretence and counterfactual reasoning. Concept definition and measurement is a critical first step in testing structural equation models. A challenge for future studies modelling the structural relationship of pretence and counterfactual reasoning is to consider whether there are additional dimensions that can serve as indicators of the concepts. One constraint of the structural models tested in this study is the limited number of dimensions that predicted the latent constructs – the child-initiated pretence construct comprised of three dimensions and the counterfactual reasoning construct comprised of four. Future attempts at testing the structural relationship between pretence and counterfactual reasoning could benefit from exploring the inclusion of addition dimensions that may potentially be included in the construct measurement of these variables and thereby increase the robustness of the structural model (Kline, 2015). This field of research would greatly benefit if convergent validity (the degree to which two or more attempts to measure the same concepts through dissimilar methods agree) on an increase number dimensions for each construct could be achieved (Fornell & Larcker, 1981).

Notwithstanding, the findings describing the structural model of pretence and counterfactual reasoning are valuable and are linked to other evidence from neuroscience research showing pretence, counterfactual reasoning, and executive functions inhabit the same cognitive workspace. Separate studies investigating the brain systems activated when adults pretend, reason counterfactually or engage in executive function tasks have identified that similar cortical locations in the brain become active. For instance, activity was observed in the inferior frontal gyrus and medial frontal gyrus when participants viewed pretence acts and the inferior parietal lobule, fusiform & superior parietal lobule associated with substitute object pretence (Smith et al., 2013). Similarly, a study by Whitehead, Marchant, Craik, and Frith (2009) found that when participants viewed object substitution the medial prefrontal cortex, posterior superior temporal sulcus and temporal poles were activated. Another study found patients with frontal and parietal impairments had difficulties with identifying pretend actions (Apperly, Samson, & Humphreys, 2009). Counterfactual sentences elicited activity in the left superior frontal gyrus, medial frontal gyrus, supplementary motor area and neural activity also overlapped with executive function networks such as the medial prefrontal structures which underpin selection and inhibition of alternate action representations (Urrutia et al., 2012). A

meta-analysis of neuroimaging data for inhibition, updating and switching showed the areas with the most significant activation in the whole adult sample included the left medial and superior frontal gyri; bilateral areas of the insula and parietal areas; and right sided activation in the precentral gyrus, claustrum, and precuneus; and the child sample group showed that activation resided bilaterally in the medial frontal gyri and right sided activation in the cingulate gyrus, claustrum, the inferior parietal lobe, and precuneus (McKenna et al., 2017). The findings from neuroscience research taken together with the findings that the relationship between pretence and counterfactual reasoning can be explained at a structural level provides compelling evidence that the two are shared cognitive skills.

7.2.5 Conclusion

The empirical associations from this study supported the theoretical claim that pretence and counterfactual reasoning share the same cognitive machinery. This study established that pretence and counterfactual reasoning are correlated at a latent level. Inhibition consistently accounted for unique variance in pretence and counterfactual reasoning. The cognitive processes of pretence and counterfactual reasoning are underpinned by a general capacity for imaginative representations which is influenced by inhibitory control skills. The findings presented here presents a first foray into understanding the development of pretence and counterfactual reasoning during the early years at a structural level. More importantly, it opens for discussion a proposal that the cognitive mechanisms responsible for generating alternative representations of reality or thinking about possible worlds is an underlying capacity for imaginative representations.

7.3.0 Application to the Unified Theory of Pretence & Counterfactual Reasoning

The purpose of this thesis was to undertake empirical work that would illuminate the unifying theoretical framework proposed by Gopnik and Walker (2013) and Weisberg and Gopnik (2013) explaining that pretence and counterfactual reasoning involve the same cognitive mechanisms and as such the two may share underlying cognitive dimensions. The crux of the argument is that the very early manifestation of pretence in young children may be responsible for enhancing children's cognitive abilities generally and more specifically presents as an opportunity to practice the cognitive skills responsible for the serious business of counterfactual reasoning and by extension causal reasoning (Weisberg & Gopnik, 2013). The

researchers argued that pretence is crucial for early years learning likening its cognitive mechanisms as a counterfactual process reflective of a Bayesian learning strategy typically applied to understanding causal models. The aim of Gopnik and Walker (2013) and Weisberg and Gopnik (2013) papers were to establish pretence as having an integral role in the development of important cognitive skills which involve the process of generating alternatives to reality. The researchers argue that cognitive skills which engage in generating alternatives to reality all follow a process of: disengaging with current reality, making inferences about an alternative representation of reality, and keeping this representation separate from reality. However, beyond pointing out the process of generating counterfactual alternatives, the researchers did not venture to postulate about the specific cognitive structures which might make these processes possible.

The empirical work conducted in this present thesis aims to add to the description of the cognitive processes utilized to engage in pretending or counterfactual reasoning. The findings are used to propose a possible explanation of the cognitive structures which interact when pretending or reasoning counterfactually and in so doing advances the theoretical claim that the manifestation of early years pretence has a development role in the progression of counterfactual reasoning. The ensuing discussion will draw on the work of researchers like Amsel and Smalley (2000), Byrne (2016), Leslie (1987), and Lillard (2001) who have reported on the cognitive mechanisms of pretence or counterfactual reasoning. The empirical evidence from the structural equation model reported in this present study is used to elucidate a feasible explanation of cognitive structures activated when thinking about possible imaginary worlds. The goal here is to merely present a theoretical suggestion developed through an exercise of deduction, scrutiny of the empirical evidence, and induction which remains open to being falsified based on the cycle of theory generation by Goodwin & Goodwin (2014) and demonstrated in Figure 7.1.

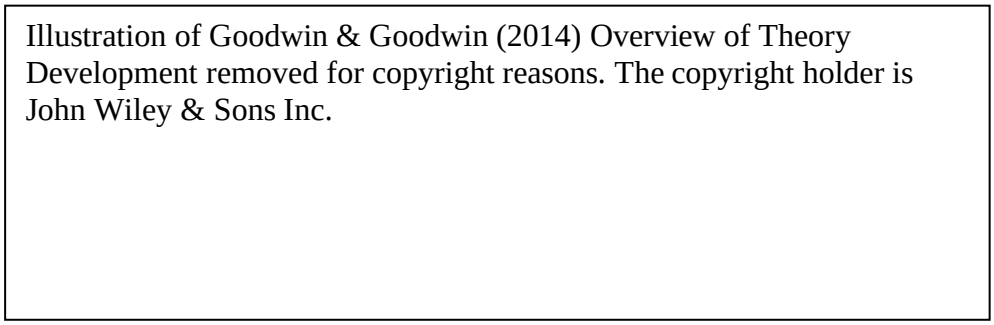

Figure 7.1 Overview of Theory Development (from Goodwin & Goodwin, 2014)

7.3.1 Theoretical Premise

The expectation that pretence and counterfactual reasoning are empirically related stems from the observation that to perform either skill requires one to:

- disengage with current reality
- make inferences about an alternative representation of reality
- keep this representation separate from reality

On this premise, Weisberg and Gopnik (2016) proposed a unifying theory of imaginative processes to suggest how pretence and counterfactual reasoning come share these component cognitive skills. This proposal was empirically tested in this study through the use of structural equation modelling analyses (SEM) which tested the latent relationship between pretence and counterfactual reasoning and whether a common underlying factor might explain the correlation between the two. The study results found support for the prediction that pretence and counterfactual reasoning are underpinned by a general cognitive ability. The key finding from this research was that a second-order factor could explain the relationship between pretence and counterfactual reasoning. This latent factor was named imaginary representation as I believe it accounts for the idea from the theoretical discussions (see Chapter 2 Literature Review section 2.5.2) that imaginative processes are the common link between pretence and counterfactual reasoning. The second-order factor was also predicted by inhibitory control providing credence to the argument that domain-general cognitive skills like executive functions influence hypothetical thinking. The finding from the SEM supports the idea that a capacity for imaginary representation may be the cognitive structure that facilitates an ability to generate alternatives to reality.

7.3.2 Theoretical Proposal

This study proposed to test a theoretical model which hypothesized a model of the cognitive structure of the relationship between pretence and counterfactual reasoning (refer to Chapter 3 Research Design section 3.2.0 which discussed the Statement of the Problem). The initial prediction was the variance from the data would successfully partition a general factor, referred to as imaginary representations; in addition to latent factors that captured the constructs of pretence and counterfactual reasoning. However, the empirical evidence supported only a second-order factor model where only one general latent factor accounted for the variance

shared by pretence and counterfactual reasoning (refer to Chapter 6 Results B section 6.6.4). The resulting theoretical proposition from the empirical findings supports a tentative claim that the relationship between pretence and counterfactual reasoning could be explained by an underlying general factor, that is, an ability to generate imaginary representations. I propose that if this theoretical proposition holds true then it means the cognitive structure which facilitates the cognitive skills utilised when someone is pretending or reasoning counterfactually is derived from the ability to imagine possible worlds. Whilst this conclusion has been pointed out by researchers of pretence and counterfactual reasoning; the findings from this present study shows that a construct called 'imaginary representations' can be empirically tested. Given that the construct was extracted from two different types of hypothetical thinking, I propose that different types of hypothetical thinking are reliant on the same imaginary representational capacity. An imaginary representational capacity is therefore relied on to pretend, reason counterfactually, as well as to perform related skills like engage in future hypothetical thinking, syllogistic reasoning, false belief, et cetera. Therefore, I argue that there is empirical evidence showing that it is an ability to imagine that makes it possible for someone to consider events that have not occurred.

7.3.3 Theoretical Model

Drawing on the work of Amsel and Smalley (2000) who proposed a model of counterfactual reasoning about possibilities (see discussion in Chapter 2 Literature Review section 2.5.1), I propose 'A Mental State Model of Imaginary Representations', depicted in Figure 7.2, to capture how interactions between true and false states of affairs are reliant on the ability to imagine possible worlds. In essence, I extended Amsel and Smalley's (2000) model to consider false premises as a more general imaginary representational capacity from which other specialised forms of thinking about possible worlds originate. Essentially, all cognitive skills relating to generating alternative hypothetical worlds that reflect off of reality have been pulled under the umbrella of a spectrum of imaginative thinking. As discussed in Chapter 2 Literature Review section 2.5.1, Amsel and Smalley (2000) proposed that the representational format of the true world and its counterfactual representation, in any given context, operate through a process whereby a sequence of events from the real world are copied and then edited by altering a specific event, to result in the final change being the alternative (imaginary) representation.

I use the Mental State Model of Imaginary Representations to depict the cognitive interactions involved in thinking of imaginary worlds that are counterfactual to reality. Four broad arrows are used towards the bottom of the model. The first two of the broad arrows show how sensory or perceptual information and the environment or social context influences the process of forming our knowledge of the world. The second two of the broad arrows show that the process by which real world knowledge is received and acted upon as imaginary mental representations may be influenced by domain general skills like executive functions and other cognitive processes, perhaps like language. The model also includes two smaller arrows pointing in opposite directions to each other between the real-world representations and imaginary representations. Based on Amsel and Smalley's (2000) explanation, one of the small arrows, pointing from the real-world premise to its counterfactual alternative, shows how information from the real world is copied, edited and received as an input or a mental representation of the real world. How the real world is edited would depend on the type of hypothetical thought being imagined. The second small arrow, pointing from the imagined world back to the real-word premise, depicts the comparing and contrasting processing requirements of the edited imagined representation to real-world representation necessary to reason from the false premise. This pattern of cognitive processing may occur when pretending, reasoning counterfactually or engaging in other related forms of hypothetical thinking. The challenges experienced with reasoning from false premises may reside with cognitive skills being undeveloped but children overcome this challenges as their cognition matures and through learning (Amsel & Smalley, 2000).

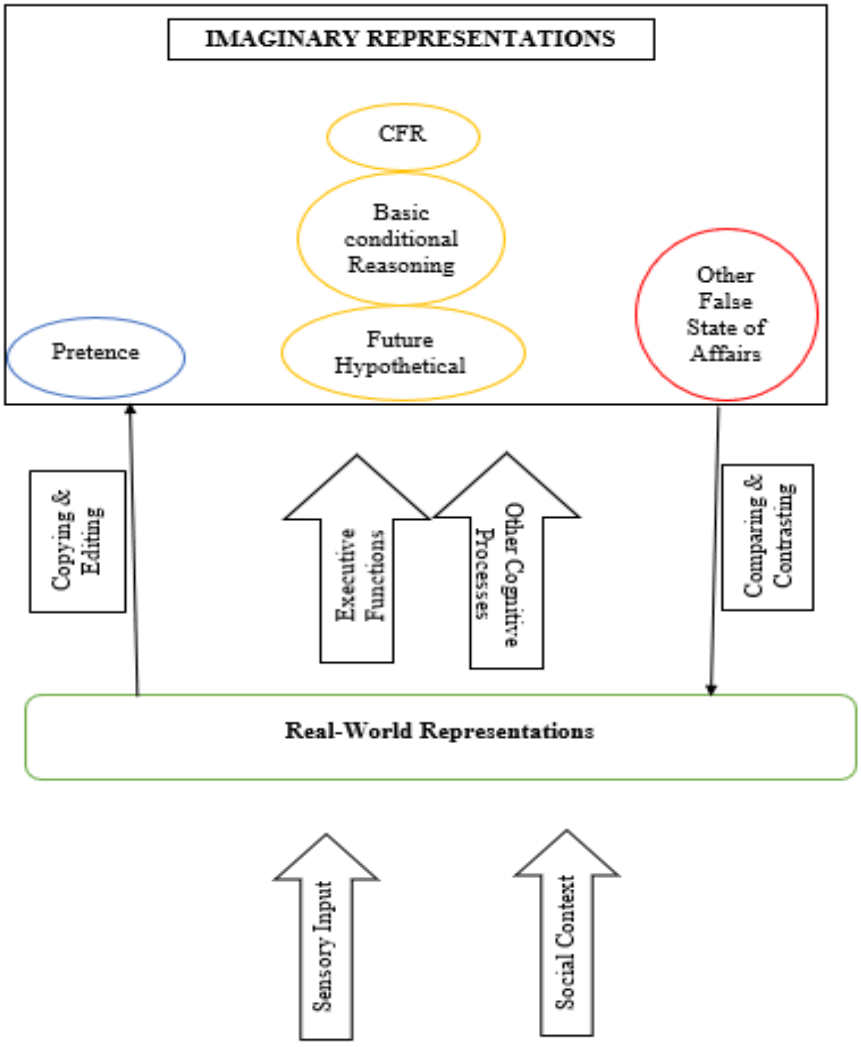

Figure 7.2 A Mental State Model of Imaginary Representations

According to Amsel and Smalley (2000) very early in development children struggle with comparing and contrasting the true state of affairs with the false state so as to reason successfully from the imagined false premise. The researchers identified that children have difficulties with: (a) the ability to evaluate how changes in the false state of affairs impact the true state of affairs or the real world (counterfactual reasoning); (b) the ability to understand pretence as representational and intentionally create mental representations of another's representation of the false state of affairs (false belief). Children's difficulties have been associated with poor executive function skills and the results from this present study showed that inhibitory control is integral to both pretending and counterfactual reasoning. The structural model tested in the results section suggested that the activation of imaginary

representations is influenced by inhibitory control. Researchers generally agree that counterfactual thinking makes inhibitory demands on children and real-world counterfactuals are more cognitively demanding than others types of counterfactuals (Beck, 2016; Weisberg & Gopnik, 2016).

Moreover, the 'Mental State Model of Imaginary Representations' uses Amsel and Smalley's (2000) model of counterfactual reasoning about possibilities to show how different forms of thinking about counterfactuals or false states of affairs may actually share the same cognitive workspace - general ability to generate imaginary representations. If the imaginary representational model proposed is to be upheld it should be able to account for: (a) the differences in imaginary ideas which are derived from pretending or counterfactual reasoning, (b) the discrepancies in the different demands that pretence and counterfactual reasoning make place on the imagination, that is, pretending is typically open-ended whilst, counterfactual reasoning is more constrained, (c) the incremental successes children have with counterfactual reasoning as they develop, for example, progressing from basic conditional reasoning to counterfactual reasoning.

To account for these differences across different forms of hypothetical thinking and how they develop, I argue that connectionist theory of cognition provides a model of explaining how mental representations emanate in the mind and can shed light on how an imaginary representational capacity might function. Connectionism was previously discussed in Chapter 2 Literature Review section 2.5.2.1 as a theory which can explain how seemingly different cognitive processes share similar cognitive mechanisms. Connectionists use the model of the brain to conceive the mind as a networked system of connected units capable of sending signals to each other and function because of an inherent capacity to learn from interactions with the environment and from the maturation of neural connections (Fodor & Pylyshyn, 1988; Herberle, 1998; Smith & Conrey, 2007). The units in a connectionist model are sometimes referred to as distributed representations owing to shared connections with units in the brain and outside environments (Fodor & Pylyshyn, 1988). Units of mental representations become interconnected via means of relevant properties becoming excited and irrelevant properties being inhibited. The general principles of how mental representations function in a connectionist system were described in section 2.5.2.1 in Chapter 2 Literature Review. Following on from this discussion, counterfactuals depicted in the Mental State Model of Imaginary Representations would bear the following characteristics in a connectionist system:

(1) that counterfactual worlds receives as input perceptual and context information to form a mental representation of the real-world

(2) an edited imaginary version of the real-world presented is created to hold in mind dual representations

(3) it is possible for there to be multiple imaginary possibilities of the real-world hence the relevant imaginary representation is activated and non-relevant representations are inhibited

(4) evaluations of the dual world representations are influenced by domain-general cognitive processes like inhibition

(5) Intentional understanding or metarepresentations are subject to the processes of cognitive maturation

The proposal that I have put forward describing the ability to think about possible worlds as an imaginary representational ability that operates on a spectrum of hypothetical thinking skills, allows us to take into account the role of imagination across the lifespan. Theories explaining imaginary representations in counterfactual contexts, therefore, need to account for the incremental changes in children's success with counterfactual reasoning over the course of development (Harris, 2000). The Mental State Imaginative Representation Model provides a reasonable explanation of thinking about how different imagination related phenomena that draw on reality, albeit closely or loosely, including those exhibited in adulthood are still underpinned by the same cognitive mechanism. Over the course of development human beings generate alternative hypothetical versions of the real-world as they know it for various reasons. During the early years it emerges as pretence where the alternative imaginary world is a product of the real-world as it is experienced but over the course of development it takes on different formats like thinking about future hypotheticals, basic conditional reasoning, counterfactual reasoning, theory of mind understanding, and even potentially expanding to thinking about fantastical realms far removed from the world as we know it. Within different types of hypothetical thinking there is also marked by incremental improvements in the extent to which children are able to hold multiple imaginary models in mind, reason from them, to eventually come to understand imaginary worlds as being mental or representation.

Therefore, the expectation is that different forms of counterfactuals would be associated and perhaps predictive of each other over the course of development. Support for this hypothesis comes from our understanding of the link between pretence and theory of mind. A study by Dore and Lillard (2015) found that children's measures of fantasy orientation predicted improvement in theory of mind over two time points where at time point one children's ages ranged from 3.0 – 3.11 years and at time point two children's ages ranged from 3.7 – 4.7 years. Fantasy worlds differs from reality but it differs from pretence in that the focus is on possible worlds that could not actually exist (Dore & Lillard, 2015). Another example of the imagination-reality dichotomy in adulthood is from fantasy proneness. Fantasy proneness is defined as a tendency to imagine fictitious situations often to escape reality and is believed to be normally distributed in the population with various degrees of daydreaming considered a fairly universal part of normal emotional functioning (Bacon et al., 2013). A study by Bacon, Walsh, and Martin (2013) found that individuals high in fantasy proneness had a general tendency to think counterfactually. Fantasy proneness bears similarities to early years pretence, so it may be interesting to test the hypothetical model used in this study with an adult population by measuring fantasy proneness and counterfactual reasoning to see if the model could be replicated. In a similar aged population to this present study, the legitimacy of the hypothesized model tested in this present study can be assessed by extending it to include measures like syllogistic counterfactual reasoning and false belief understanding to check if these related hypothetical skills are indeed correlated and whether a general higher-order factor can explain the associations predicted. The empirical evidence can provide meaningful insight for evaluating the Mental State Imaginative Representational Model proposed here in this study. Additional executive functions can be added for good measure. An example of the hypothesized model suggested for empirical testing is shown in Figure 7.3.

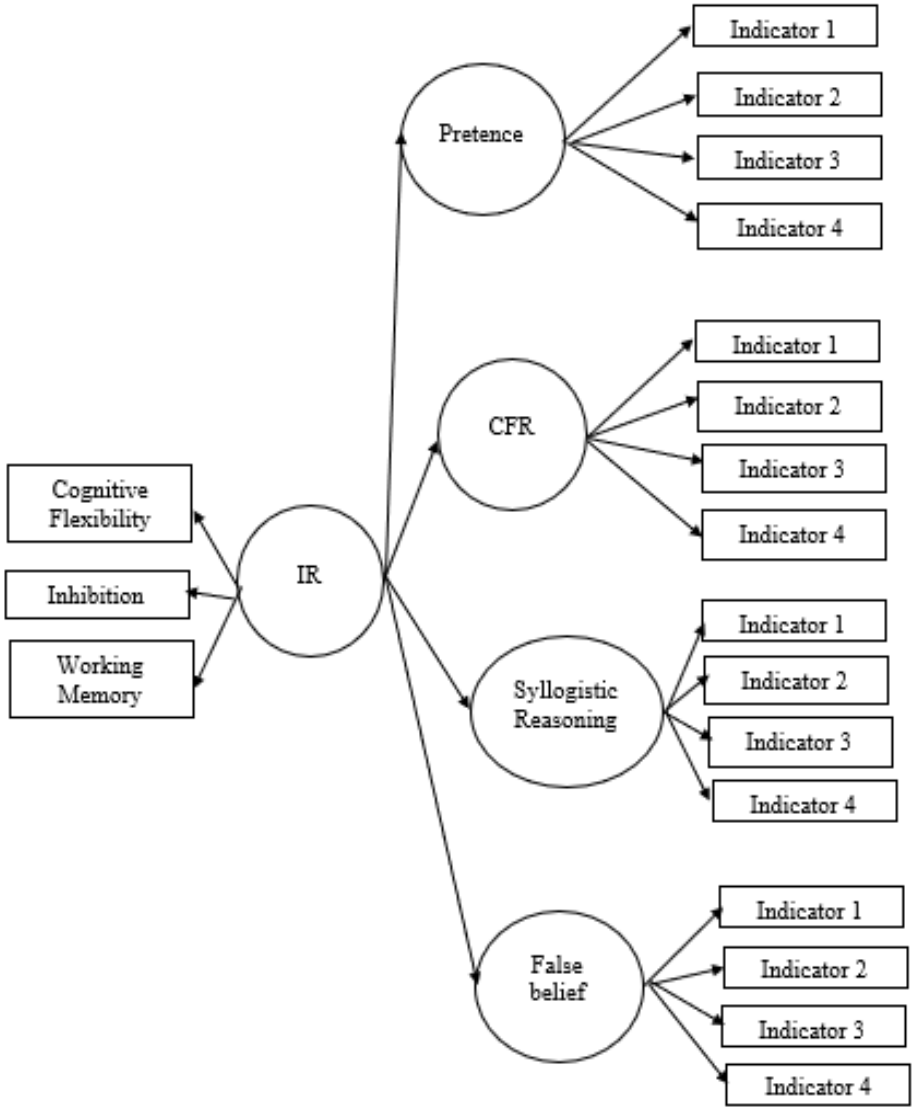

Figure 7.3 Hypothesized Model of Imaginary Hypothetical Thinking

7.3.4 Application to the Initially Proposed Framework of Pretence & Counterfactual Reasoning

The Mental State Model of Imaginary Representations proposed in this present thesis provides a coherent explanation of how the interconnections among all the cognitive processes proposed by Weisberg and Gopnik (2013) as being integral to unified a framework of pretence and counterfactual reasoning come together and supports the claim that a possible role of early years pretence is to facilitate counterfactual reasoning. The Mental State Imaginative Representational Model meet all the criteria for the unified framework discussed in Weisberg and Gopnik's (2013) paper. It takes into account the crucial role of learning by giving latitude to how the aspects of context, cognitive control, and cognitive maturation results in incremental change over the course of development whether that be through the process of Bayesian inferencing or via other means of learning through play. Learning, therefore, becomes cemented as children become better at different forms of counterfactual thinking. An imaginative representational cognitive workspace allows the representation of multiple possible worlds from one real-world premise and to eventually be able to compare these worlds to each other. The perception of an underlying imaginative capacity provides a meaningful explanation of how all versions of counterfactual thinking about possible worlds, ranging from absurdities to serious reasoning, could occur. More importantly, the proposal made in this present thesis provides support for thinking about the relationship between pretence and counterfactual reasoning at a computational level and gives an account for how early years pretence might evolve into the serious formal business of counterfactual reasoning.

7.4.0 Limitations of the Research

It is worth pointing out that there are some features of this work which limit the conclusions we can draw about the findings concerning the relationship between pretence and counterfactual reasoning. Firstly, this study employed an observational research design and as such is subject to all the shortcomings associated with this research method. The main caveat of observational studies is that conclusions made about the associations between the variables in the study do not suggest that any one of the variables is causing the other to occur (Goodwin & Goodwin, 2014). Although evidence is stronger in longitudinal designs; they also cannot prove causation Therefore, it must be emphasized that no causal claims are being made about the direction of the relationship between pretence, counterfactual reasoning and other related

cognitive skills such as executive functions, receptive language, measured in this study. In order to make causal claims about the relationship of the variables in this study it would have been necessary to use an experimental, longitudinal or cross-lagged observational study design.

Moreover, this does not take away from the value of observational research in that it can be used to describe, explain and predict the strength of the associations shared among variables in a study. Observational studies are powerful research approaches that are (a) descriptive in that they can provide the first steps towards the generation of new knowledge; (b) explanatory in that they provide scientific explanations which form the basis for theory building; and (c) useful for testing predictions based off of scientific explanations (Dyer, 2007). Hence, the findings from this research are valuable because it provides quantifiable evidence of how the psychological constructs of pretence and counterfactual reasoning can be conceptualized, it confirms that pretence and counterfactual reasoning are indeed correlated, and tests cognitive models aimed at explaining the cognitive mechanisms involved in pretence and counterfactual reasoning. The findings from this study can therefore provide foundational information necessary for making decisions about controlling variables in follow up experimental design studies or longitudinal studies.

An inherent characteristic of observational studies is the third variable problem – the inability to control extraneous variables directly (Goodwin & Goodwin, 2014). In developmental studies like this, not all measurable third variables can be in included usually because only a limited number of observations can be reasonably and ethically be carried out with children. One such example, is the exclusion of the variable 'false belief' which has been considered a type of counterfactual reasoning by some researchers (Amsel & Smalley, 2000). Practically, the third variable problem exists because only a limited number of measures could be included in studies with children otherwise the testing time with children would become unreasonably and unethically long. The structural model is therefore limited in that it does not include other cognitive skills known to rely on alternative, imaginative thinking. It would be worth designing future research that tests how additional, related cognitive, constructs involving alternative, imaginative thinking hang together in a structural model. Hence, it is important to be aware that the hypothetical model is limited but the results from this study provided a good starting point for thinking about the cognitive tenets that underpin a capacity for imaginative representation.

Another limitation relates to the extent to which all of the measures used in the study maintained the standard of being valid assessments of the cognitive skill being measured in the context of this research. Of particular concern was the validity and reliability of the working memory, delay of gratification and symbolic representation tasks and thinking about whether they did a good job of capturing variable performance in this sample. None of these measures correlated well with other study variables of the same domain. For example, the working memory and delay of gratification tasks did not correlate with measure of inhibition and the symbolic representation tasks did not correlate with the other indicators of pretence. Two possible explanations are either: (a) the measures fell prey to a task selection issue, that is, not the most appropriate task given the background of students in the study; or (b) that the results are indeed robust and the constructs which these tasks assessed were really in fact not associated with the other variables measured in this study. A case for there being a task selection issue is on the basis that the participants' scores in the symbolic representation task had a limited range, that is, most scores fell within the range of the third percentile. These results merits asking whether the tasks were age-appropriate and performed the discriminatory function of capturing variability in participants' performances. A recommendation going further is to allow for a more extensive pilot in the study context so that study measures can be validated with the sample of interest. Alternately – check other studies to know if a similar pattern of non-correlations existed. For this reason, it is worth emphasizing that the generalizability of quantitative research is limited to the extent that the population bears the characteristics of the study sample. Participants from this study came from a relatively affluent community.

7.5.0 Implications of the Research

The findings from this present study addresses the gap which exists since there is a dearth of empirical evidence which has investigated the proposal that a unifying theory of pretence and counterfactual reasoning can explain the conceptual similarities observed between the two. At the time of submitting this dissertation, this study brought the count to two studies to have tested associations between pretence and counterfactual reasoning. Accordingly, the first major and significant contribution made by this present research is the contribution of empirical evidence which can be used to evaluate the claim that pretence and counterfactual reasoning share the same component cognitive processes.

This present research adds to the conversation about the unity of counterfactual thought. Is the space of counterfactuals continuous? Does it mean that the same psychological processes are recruited across different counterfactuals? According to Beck (2016) different counterfactuals like real-world counterfactuals are qualitatively different by a matter of degree as well as in their relationship with reality and children's difficulties with counterfactual reasoning may not necessarily be attributed to executive function demands but could equally stem from concerns about children's competence. Indeed, extensive research has been done by Rafetseder, Cristi-Vargas, and Perner (2010), Rafetseder, Schwitalla, and Perner (2013), and Rafetseder and Perner (2014), as example, about qualitative differences in children's ability to reason counterfactually. In contrast, Weisberg and Gopnik (2016) makes the case for thinking of all counterfactuals more generally as united imaginative abilities whilst acknowledging that differences in the form, function, and explicit links to an objective real-world reference influences children's success with counterfactual reasoning over time. The theoretical claims from this present study suggests that thinking of counterfactuals as being underpinned by a general imaginative representation capacity does not negate the qualitative differences which exists across different types counterfactuals. I hope that this study pushes the boundaries of counterfactual reasoning research to explore subtle the differences and similarities across different forms of counterfactual reasoning that will move toward refining a psychometric construct definition of counterfactual reasoning.

This present study attempted to present a convincing argument that could explain the nature of the relationship between pretence and counterfactual reasoning. A unique contribution of this present thesis is the empirical evidence supporting the unified theoretical claim that an underlying imaginative representational capacity underpins associations between pretence and counterfactual reasoning and by extension other cognitive skills involving generating alternative possible worlds or counterfactual thinking (Weisberg & Gopnik, 2013). No previous study has modelled the shared cognitive structure of pretence and counterfactual reasoning so the arguments made for a broad underlying imaginative representational capacity has strong, positive implications which supports the framing of the theoretical argument that early years pretence may play role in the development of counterfactual reasoning skills. Modelling the relationship between pretence and counterfactual reasoning as the presence of a broad, underlying, imaginative representational capacity explained how thinking about counterfactuals can take on different forms over the course of development. Additionally, the mental state model of imaginary representations is an original attempt to model how a general

imaginary workspace might interact across different form of hypothetical reasoning and real-world premises. Hence, this study supports at a computational level the claim that pretence and counterfactual reasoning share the same cognitive mechanisms.

A practical implication of the investigation carried to future research is the provision of a testable model which can be used for further empirical tests of the cognitive mechanisms shared by pretence and counterfactual reasoning in both child and adult populations. This study applied suggestions from the seminal paper by Lillard, Hopkins, Dore, Smith, and Palmquist (2013) about the role of pretend play on children's development for the use of modern statistical techniques which support causal inferences from designs with sufficiently large samples and numerous measures. It would be interesting to see if the structural model of pretence and counterfactual reasoning developed in this study can be replicated. Furthermore, would it uphold if the model is extended to include additional forms of counterfactual reasoning. A possible strategy would be an effort to replicate this study using a similar observational design. Additionally, having established that pretence and counterfactual reasoning are associated; this present study provides credibility for undertaking a longitudinal study that directly tests whether the quality of a child's pretence predicts their counterfactual reasoning skills later in development, as well as an experimental study that tests the causal relationship between pretence and counterfactual reasoning.

7.6.0 Chapter Summary

The goal of this chapter was to elucidate the claim that pretence and counterfactual reasoning share the similar cognitive mechanisms. The validity of the separate measures of pretence and counterfactual reasoning were assessed. It was found that for both pretence and counterfactual reasoning; the measures could be reduced to single latent constructs with pretence being referred to as 'child-initiated pretence' and counterfactual reasoning being referred to by its abbreviation 'CFR'. As latent constructs, child-initiated pretence and CFR were significantly correlated with each other. They also shared significant associations with receptive language and inhibition. Inhibition commonly accounted for unique variance in child-initiated pretence and CFR whereas, receptive language only uniquely predicted CFR. A structural equation model was used to test the theoretical model predicting that associations between child-initiated pretence and counterfactual reasoning could be explained by an underlying latent capacity to

generate imaginative representations. Support was found for a computational model which conceptualised that a second-order factor which was predicted by inhibition adequately explained the correlations shared between child-initiated pretence and counterfactual reasoning. The evidence generated from this present study, provides strong, empirical support for the theoretical proposal claiming that a unified theory where a common imaginative process could explain the conceptual similarities shared by pretence and counterfactual reasoning. I presented a theoretical model named 'A Mental State Model of Imaginative Representations' which depicted the interaction between cognitive processes which make it possible for humans to generate alternative representations to real-world premises. The chapter closes with a discussion of the limitations and implications of this research exercise.

Chapter 8 Conclusion

In this thesis, I have been concerned with understanding how it is that the cognitive skills of pretence and counterfactual reasoning both involve the ability to disengage with current reality, make inferences about an alternative representation of reality, and keep this inference representation separate from reality even though precocious pretend play precedes counterfactual reasoning. The impetus for this present study originated from the work of Walker and Gopnik (2013) and Weisberg and Gopnik (2013) who proposed a unified theoretical framework attributing that the similarities between pretence and counterfactual reasoning may exist so that pretend play functions as an opportunity to explicitly practice the cognitive skills responsible for its appearance; that is, learning generally within contexts of counterfactual reasoning, causal reasoning and in situations which rely on generating imaginative processes as alternatives to reality. Their essential argument is that pretend play is a form of counterfactual reasoning and since it precedes counterfactual reasoning in development; it initially functions as a naive form of counterfactual reasoning but over time the same cognitive skills used in pretence are applied to learning in similar domains which rely on imaginative processes.

Against this background, this study focused on unpacking two important questions: what is the shared cognitive dimensions or cognitive mechanisms which link pretence to counterfactual reasoning? Does an underlying cognitive dimension underpin the associations predicted to be shared by pretence and counterfactual reasoning? By asking these questions, this study took a step back from the discussion about the role of pretence in counterfactual reasoning which framed the discussion in the unified theoretical framework and instead aimed to generate evidence to the more fundamental question about; what specific cognitive processes are involved in pretence and counterfactual reasoning? In so doing, the foundational question of what cognitive processes are involved in pretence and counterfactual reasoning are answered first before moving on to design studies that attempt to explore the causal role of pretence in counterfactual reasoning.

The study makes a unique contribution that will help shed light on the nature of the relationship between pretence and counterfactual reasoning. It is original in its use of a large-scale observational research design which supported the use of advance statistical analyses that allowed cognitive models of the relationship between pretence and counterfactual reasoning to

be tested at a latent level. Typically, pretend play and counterfactual reasoning research usually explore associations between study variables at the observable level. Data was analysed for a sample of approximately one hundred and eighty-nine typically developing four to five-year-old children. In particular, my work makes the following contribution to the literature. It supported previous work which established that indicators of pretence like elaborate pretend play ideas and object substitutions are significantly correlated with each other. It extended to knowledge by showing that correlated indicators of pretence could yield a general latent construct of pretence. It provided confirmatory evidence that before the age of six children have difficulty with counterfactual reasoning in social-causal contexts and that children use an inconsistent pattern of applying both basic conditional reasoning and counterfactual reasoning to answer counterfactual questions. When both basic conditional reasoning and counterfactual reasoning responses resulted in correct answers they were significantly correlated with other and yielded a general latent construct of counterfactual reasoning. Inhibition is a cognitive skill common to both pretence and counterfactual reasoning above and beyond age and receptive language. Pretence and counterfactual reasoning were significantly correlated with each other at a latent level. The relationship between pretence and counterfactual reasoning could be explained by a common underlying capacity for imaginative representation which is predicted by inhibitory control. It proposed A Mental State Model of Imaginary Representations as a theoretical model which explains how imaginary processes might underpin counterfactual representations.

The results from my work supports the proposal that a unified theoretical framework may appropriately describes the relationship between pretence and counterfactual reasoning. There is support for the claims that pretence and counterfactual reasoning share cognitive mechanisms and an underlying cognitive dimension may be responsible for the relationship shared by two. The findings from my research makes a unique contribution to knowledge by building on an existing model of counterfactual reasoning and proposing the Mental State Model of Imaginative Representations. The model proposed depicts how the mechanism responsible for being able to transition between real world premises and false states of affairs is a general capacity for imaginative representations. This model is plausible within a framework of a unified theory of counterfactuals wherein they are generally underpinned by imaginative cognitive processes interacting with perceptual/sensory inputs, social cognitive contexts, and other relevant cognitive inputs like inhibition. The strength of these interactions influence success with reasoning from false premises.

I anticipate that the findings from my research will be of interest to the community of counterfactual reasoning researchers. To my knowledge, only a handful of published papers directly speak on the idea of a unified framework of pretence and counterfactual reasoning. The model proposed in this theory is fairly rudimentary and would benefit from critical feedback aligned with the science of theory building. Moreover, this present study is valuable as it contributes to the discussion that a possible role of pretence in early development is to practice the skills required for counterfactual reasoning which matures later in development.

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Appendix A – Pilot: Phase One Results

Results for Tasks Measured in Phase One Pilot

Including the Antecedent and Consequent Task by Guajardo and Turley-Ames (2004)

ID		Receptive Language		Inhibition	WM	CFR Tasks	
	Age	Concepts/ Following Directions	Sentence Structure	HTKS	#trials to win 10 stickers	*C-CF	*A-CF
Max scores		22	22	60	20	4	
01	5.6	22	16	38	18	4	8
04	5.1	19	20	40	10	4	7
05	5.1	20	18	33	9	3	5
07	5.2	16	19	17	10	4	4
02	4.3	Na	16	7	12	na	Na
03	4.6	7	15	na	11	1	4
06	4.8	15	18	58	7	4	13
08	3.10	14	15	na	12	4	5
09	3.3	10	9	na	10	0	0
10	3.9	2	5	na	12	1	0

*HTKS: Head Toes Knees and Shoulders Task

*WM: Working Memory Task (Spin the Pots)

*****C-CFR: Consequent Counterfactual Reasoning Task

*A-CFR: Antecedent Counterfactual Reasoning Task

*na: child did not do the task

Appendix B – Pilot: Phase Two Results

Results for the Travel Scenario Task

(A complex CFR task by Perner, Sprung, and Steinkogler (2004)

Participants	Scenario 1			Scenario 2			Scenario 3			Scenario 4		
	Control Question	CF-Alt Depart.	CF-Alt Transp.	Control Question	CF-Alt Depart.	CF-Alt Transp.	Control Question	CF-Alt Depart	CF-Alt Transp.	Control Question	CF-Alt Depart.	CF-Alt Transp.
T11	1	1	1	1	1	1	1	1	1	1	1	0
T13	1	0	1	1	1	1	1	1	1	1	1	0
T14	0	0	1	1	1	0	1	1	1	1	1	1
T15	1	0	1	1	1	0	1	1	1	1	1	0
T16	1	1	1	1	1	1	1	1	0	1	1	0
T17	1	0	1	1	1	1	1	1	1	1	1	1
T18	1	1	1	1	1	1	1	1	1	1	1	1
T19	1	1	1	1	1	1	1	1	0	1	1	0
T20	1	0	1	1	1	1	1	1	0	1	1	1

*T11: Trial participant number 11
*CF-Alt Depart.: Counterfactual Alternative Departure Question
*CF Alt Transp.: Counterfactual Alternative Departure Transport

Results for the Road Task

(An open CFR task by Beck & Crilly, 2009)

Participants	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Total	Total
	Standard CF	Open CF	Standard CF	Open CF	Standard CF	Open CF
T11	1	1	1	1	2	2
T12	1	1	1	1	2	2
T13	1	1	1	1	2	2
T14	1	0	1	1	2	1
T15	0	1	0	0	0	1
T16	1	0	1	1	2	1
T17	1	0	1	0	2	0
T18	1	1	1	0	2	1
T19	1	1	Na	na	1	1
T20	1	0	1	0	2	0

*na: participant did not respond to the question
*CF: Counterfactual

Results for the Sweet Story Task
(A nearest possible world CFR task by Rafetseder, Cristi-Vargas, & Perner, 2010)

Participants	Scenario 1			Scenario 2		
	Memory	TestQ	CFQ	Memory	TestQ	CFQ
T13	1	na	1	1	Na	1
T14	1	1	0	1	1	1
T15	1	1	1	1	1	0
T17	1	1	0	1	1	0
T18	1	1	0	1	1	1
T19	1	1	0	1	1	1

*na: participant did not respond or provide an answer to the question
*TestQ: Test Question
*CFQ: Counterfactual Question

Results for Sweet Story Task
(A nearest possible world CFR task by Rafetseder, Cristi-Vargas, & Perner, 2010)

Participants	Scenario 3			Scenario 4		
	Memory	TestQ	CFQ	Memory	TestQ	CFQ
	na	na	na	0	na	0
T13	1	1	0	1	1	1
T14	1	1	0	1	1	1
T15	1	1	0	1	1	0
T17	1	1	1	1	1	1
T18	1	1	1	1	1	1

*na: participant did not respond or provide an answer to the question
*TestQ: Test Question
*CFQ: Counterfactual Question

Results for the Location Change Task Doctor Story

(A nearest possible world task by Rafetseder & Perner, 2010)

Participants	Doctor Story - 1 Typical			Doctor Story - 1 Atypical			Doctor Story - 2 Typical			Doctor Story - 1 Atypical		
	NCQ	CFQ	BCQ	NCQ	CFQ	BCQ	NCQ	CFQ	BCQ	NCQ	CFQ	BCQ
14	1	0	1	1	1	0	1	1	0	1	1	0
18	1	1	1	1	0	1	1	1	0	1	0	1
21	1	1	na	1	0	na	1	1	na	1	0	na

*NCQ: Now Control Question
*CFQ: Counterfactual Question
*BCQ: Before Control Question

Results for the Location Change Task Firefighter Story

(A nearest possible world task by Rafetseder & Perner, 2010)

Participants	Fire Fighter Story - 1 Typical			Fire Fighter Story - 1 Atypical			Fire Fighter Story - 2 Typical			Fire Fighter Story - 1 Atypical		
	NCQ	CFQ	BCQ	NCQ	CFQ	BCQ	NCQ	CFQ	BCQ	NCQ	CFQ	BCQ
14	1	1	1	1	0	1	1	1	na	1	1	1
18	0	1	1	1	1	1	1	0	1	1	1	1
21	1	0	1	0	0	0	1	na	0	1	0	1

*NCQ: Now Control Question
*CFQ: Counterfactual Question
*BCQ: Before Control Question

Appendix C – Child Initiated Pretend Play Assessment

Child Initiated Pretend Play Assessment (CHIPPA) Coding Scheme removed for copyright reasons. The copyright holder is Coordinates Publishing.

Appendix D – Location Change Task

Name _____ **Date** _____

Doctor Story

***[1typ]* Set-up: swimming pool and hospital, but no park.**

Look what I've brought with me: *a hospital and a swimming pool* (*placing both locations on the table*). Could you show me; where the hospital is? And where the swimming pool is?

Look! I have a doctor and I would like to tell you a story about this doctor. This doctor works in this hospital (*point to hospital*). Look! In the hospital, he is attending to his patient giving her some medicine, so she will get better soon. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The doctor is called away to an emergency.
Look what has happened: Jacob has climbed up to the swimming pool and skid down the slide (Show how boy climbs up swimming pool and skids down. *boy exclaims*): "Ouch. My hand hurts!"
Look! The doctor gets his first-aid bag and runs to the swimming pool to attend to Jacob.

Now Control Question: "Where is the doctor now?" _____
Counterfactual Question: "If Jacob had not gotten hurt, where would the doctor be now?"
_____
If child does not provide answer, options are provided in a counterbalanced way:

a. "At the swimming pool or in the hospital?"
b. "In the hospital or at the swimming pool?"

Before Control Question: "Where was the doctor when he received the phone call that Jacob was hurt?" _____

***[1atyp]* Set-up: park and hospital, but no hospital.**

Look what I have brought with me: a park and a swimming pool. Show me, where the hospital is? And where the swimming pool is?

Look! I would like to tell you a story about this doctor. After work today, this doctor went to the park to read a book. Look! He's reading his book quietly in the park. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The doctor is called away to an emergency!
Look what has happened: Jacob has climbed up to the swimming pool and skid down the slide (Show how boy climbs up swimming pool and skids down. *boy exclaims*): "Ouch! My hand hurts!"
Look! The doctor gets his first-aid bag and runs to the swimming pool to attend to Jacob.

Now Control Question: "Where is the doctor now?" _____
Counterfactual Question: "If Jacob had not gotten hurt, where would the doctor be now?"
_____
If child does not provide answer, options are provided in a counterbalanced way:

c. "At the swimming pool or in the park?"
d. "In the park or at the swimming pool?"

Before Control Question: "Where was the doctor when he received the phone call that Jacob was hurt?" _____

***[2typ]* Set-up: swimming pool, park and hospital.**

Look what I have brought with me: a hospital, a park and a swimming pool. Show me again where the hospital is? And, where is the swimming pool? And where is the park?

Look! I would like to tell you a story about this doctor. Before work this doctor went to the park to read a book. Look! He's reading his book quietly in the park. Now it's time to go to work. This doctor works in this hospital (*point to hospital*). Look! In the hospital, he is attending to his patient giving her some medicine, so she will get better soon. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The doctor is called away to an emergency.
Look what has happened: Jacob has climbed up to the swimming pool and skid down the slide (Show how boy climbs up swimming pool and skids down. *boy exclaims*): "Ouch. My hand hurts!"
Look! The doctor gets his first-aid bag and runs to the swimming pool to attend to Jacob.

Now Control Question: "Where is the doctor now?" _____
Counterfactual Question: "If Jacob had not gotten hurt, where would the doctor be now?"
_____
If child does not provide answer, options are provided in a counterbalanced way:

e. "In the park or in the hospital?"
f. "In the hospital or in the park?"

Before Control Question: "Where was the doctor when he received the phone call that Jacob was hurt?" _____

***[2atyp]* Set-up: swimming pool, park and hospital.**

Look what I have brought with me: a hospital, a park and a swimming pool. Show me again, where the hospital is? And where is the swimming pool? And where is the park?

Look! I would like to tell you a story about this doctor. After work today, this doctor went to the park. Look! He's reading his book quietly in the park. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The doctor is called away to an emergency.
Look what has happened: Jacob has climbed up to the swimming pool and skid down the slide. (Show how boy climbs up swimming pool and skids down. *boy exclaims*): "Ouch. My hand hurts!"
Look! The doctor now runs to the hospital to get his first-aid bag, "Ah, there it is!" and runs to the swimming pool to attend to Jacob.

Now Control Question: "Where is the doctor now?" _____
Counterfactual Question: "If Jacob had not gotten hurt, where would the doctor be now?"
_____
If child does not provide answer, options are provided in a counterbalanced way:

g. "In the park or in the hospital?"
h. "In the hospital or in the park?"

Before Control Question: "Where was the doctor when he received the phone call that Jacob was hurt?" _____

Name **Date**

Teacher Story

***[1typ]* Set-up: school and house, but no playground.**

Look what I have brought with me: a school and a house where a student lives (*placing both locations on the table*). Could you show me again, where the school is? And where the house is?

Look! I have a teacher and I would like to tell you a story about this teacher. This teacher works in this school (*point to school*). In the school, she teaches the children reading, writing and mathematics. Suddenly Lisa says: "Miss! Miss! I really don't feel well". Lisa has eaten too many sweets and now she is feeling sick.
Look! The teacher gives Lisa some medicine but Lisa is still not feeling well so, the teacher takes her home.

Now Control Question: "Where is the teacher now?" _____
Counterfactual Question: "If Lisa had not gotten sick, where would the teacher be now?" _____

If child does not reply provide answer options in a counterbalanced way:

i. "At school or at the house?"
j. "At the house or at school?"

Before Control Question: "Where was the teacher when Lisa said she felt sick?" _____

***[1atyp]* Set-up: playground and house, but no school.**

Look what I have brought with me: a playground and a house where a student lives. Show me where the playground is? And where the house is?

Look! I would like to tell you a story about this teacher. Because the weather is lovely, the teacher went to the playground with the children (*point to playground*). One child is playing football while Lisa is going down a slide (*have Lisa go down slide*).
Suddenly Lisa says: "Miss! Miss! I really don't feel well". Lisa has eaten too many sweets and now she is feeling sick.
Look! The teacher gives Lisa some medicine but Lisa is still not feeling well so, the teacher takes her home.

Now Control Question: "Where is the teacher now?" _____
Counterfactual Question: "If Lisa had not gotten sick, where would the teacher be now?" _____

If child does not reply provide answer options in a counterbalanced way:

k. "At the playground or at the house?"
l. "At the house or at the playground?"

Before Control Question: "Where was the teacher when Lisa said she felt sick?" _____

***[2typ]* Set-up: school, house, and playground.**

Look what I have brought with me: a school, a playground and a house where a student lives. Show me again, where the hospital is? And where is the playground? And where is the house?

Look! I would like to tell you a story about this teacher. Because the weather is lovely, the teacher went to the playground with the children (*point to playground*). One child is playing football while Lisa is going down a slide (*have Lisa go down slide*). But now it is time to go to school (*point to school*).
Look! The teaches the children reading, writing and mathematics. Suddenly Lisa says: "Miss! Miss! I really don't feel well". Lisa has eaten too many sweets and now she is feeling sick.
Look! The teacher gives Lisa medicine but Lisa is still not feeling well so, the teacher takes her home.

Now Control Question: "Where is the teacher now?" _____

Counterfactual Question: "If Lisa had not gotten sick, where would the teacher be now?" _____

If child does not reply provide answer options in a counterbalanced way:

m. "At the playground or at school?"
n. "At school or at the playground?"

Before Control Question: "Where was the teacher when Lisa said she felt sick?" _____

***[2atyp]* Set-up: school, house, and playground.**

Look what I have brought with me: a school, a playground and a house where a student lives. Show me again, where the school is? And which is the playground? And where is the house the house?

Look! I would like to tell you a story about this teacher. Because the weather is lovely, the teacher went to the playground with the children (*point to playground*). One child is playing football while Lisa is going down a slide (*have Lisa go down slide*). Suddenly Lisa says: "Miss! Miss! I really don't feel well". Lisa has eaten too many sweets and now she is feeling sick.

Look! The teacher takes Lisa back to the school where she gives Lisa some medicine but Lisa is still not feeling well so, the teacher takes her home.

Now Control Question: "Where is the teacher now?" _____
Counterfactual Question: "If Lisa had not gotten sick, where would the teacher be now?" _____

If child does not reply provide answer options in a counterbalanced way:

o. "At the playground or at school?"
p. "At school or at the playground?"

Before Control Question: "Where was the teacher when Lisa said she felt sick?" _____

Name **Date**

Fire-fighter Story

***[1typ]* Set-up: forest and fire-station, but no living room.**

Look what I have brought with me: a fire-station and a forest (*placing both locations on the table*). Could you show me, where the fire-station is? And where the forest is?

Here is a fire-fighter, and I would like to tell you a story about this fire-fighter. This fire-fighter works at this fire-station (*point to fire-station*). Look! At the fire-station he is making sure the fire extinguisher works well for when he needs it. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The fire-fighter is called away to an emergency.
Look what has happened: a fire has broken out in the forest. Some trees are already on fire!
Look! The fire-fighter takes his fire-extinguisher and runs to the forest to put out the fire (*take flames off the trees*).

Now Control Question: "Where is the fire-fighter now?" _____
Counterfactual Question: "If the fire had not broken out, where would the fire-fighter be now?"
_____
If child does not reply provide answer options in a counterbalanced way:

q. "In the forest or at the fire station?"
r. "At the fire station or in the forest?"

Before Control Question: "Where was the fire fighter when he received the phone call that some fire has broken out?" _____

***[1atyp]* Set-up: forest and living room, but no fire-station.**

Look what I have brought with me: a living room and a forest. Show me, where the living-room is? And where the forest is?

Look, I would like to tell you a story about this fire-fighter. Before work, this fire-fighter is at home in his living room (*point to living room*). Look! He is sitting on his sofa watching TV. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The fire-fighter is called to an emergency!
Look what has happened: a fire has broken out in the forest. Some trees are already on fire!
Look! The fire-fighter takes his fire-extinguisher and runs to the forest to put out the fire (*take flames off the trees*).

Now Control Question: "Where is the fire-fighter now?" _____
Counterfactual Question: "If the fire had not broken out, where would the fire-fighter be now?"
_____
If child does not reply provide answer options in a counterbalanced way:

s. "In the forest or the living-room?"
t. "In the living room or in the forest?"

Before Control Question: "Where was the fire-fighter when he received the phone call that some fire has broken out?" _____

***[2typ]* Set-up: forest, living room, and fire-station.**

Look what I have brought with me: a fire-station, a living room and a forest. Show me again, where the fire-station is? And where is the forest? And where is the living room?

Look! I would like to tell you a story about this fire-fighter. Before work, this fire-fighter is at home in his living room (*point to living room*). Look! He is sitting on his sofa watching TV. But now it is time to go to work.

This fire-fighter works at this fire-station (*point to fire-station*). At the fire-station he is making sure the fire extinguisher works well for when he needs it. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The fire-fighter is called away to an emergency.
Look what has happened: a fire has broken out in the forest. Some trees are already on fire!
Look! The fire-fighter takes his fire-extinguisher and runs to the forest to put out the fire (*take flames off the trees*).

Now Control Question: "Where is the fire-fighter now?" _____
Counterfactual Question: "If the fire had not broken out, where would the fire-fighter be now?"
_____

If child does not reply provide answer options in a counterbalanced way:

u. "At the fire-station or the living-room?"
v. "In the living room or at the fire station?"

Before Control Question: "Where was the fire-fighter when he received the phone call that fire has broken out?" _____

***[2atyp]* Set-up: forest, living room, and fire-station.**

Look what I have brought with me: a fire-station, a living room and a forest. Show me again, where the fire-station is? And where is the forest? And where is the living room?

Look! I would like to tell you a story about this fire-fighter. After work, the fire-fighter walked home and is now in his living room (*point to living room*). Look! He's sitting on his sofa watching TV. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The fire-fighter is called away to an emergency.
Look what has happened: a fire has broken out in the forest. Some trees are already on fire!
Look! The fire-fighter takes his fire-extinguisher and runs to the forest to put out the fire (*take flames off the trees*).

Now Control Question: "Where is the fire-fighter now?" _____
Counterfactual Question: "If the fire had not broken out, where would the fire-fighter be now?"
_____

If child does not reply provide answer options in a counterbalanced way:

w. "At the fire-station or the living-room?"
x. "In the living room or at the fire station?"

Before Control Question: "Where was the fire-fighter when he received the phone call that some fire has broken out?" _____

Name **Date**

Policeman Story

***[1typ]* Set-up: police station and car park.**

Look what I have brought with me: a police station and a car park (*placing both locations on the table*). Could you show me; where the police station is? And where the car park is?

Look! Here is a policeman. I would like to tell you a story about this policeman. This policeman works in this police station (*point to police station*). Look! In the police station, he has to do a lot of work on the computer. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The policeman is called away to an emergency.
Look what has happened: In the car park the blue car reversed and the yellow car "Crassshed!" into the blue car.
Look! The policeman gets his motor bike and drives fast to the car park, "Nee Nah Nee Nah!" to see what has happened.

Now Control Question: "Where is the policeman now?" _____
Counterfactual Question: "If accident had not happened, where would the policeman be now?"
_____

If child does not reply provide answer options in a counterbalanced way:

y. "At the car park or at the police station?"
z. "At the police station or at the car park?"

Before Control Question: "Where was the police man when he received the phone call that an accident happened?" _____

***[1atyp]* Set-up: shopping centre and car park.**

Look what I brought with me: a shopping centre and a car park. Show me, where the shopping centre is? And where the car park is?

Look! I would like to tell you a story about this policeman. After work today, this policeman went to the shopping centre (*point to shopping centre*). He is buying some food for his dinner at the shopping centre. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The policeman is called away to an emergency.
Look what has happened: In the car park the blue car reversed and the yellow car "Crassshed!" into the blue car.
Look! The policeman gets his bike and drives fast to the car park, "Nee Nah Nee Nah!" to see what has happened.

Now Control Question: "Where is the policeman now?" _____
Counterfactual Question: "If the accident had not happened, where would the policeman be now?"
_____

If child does not reply provide answer options in a counterbalanced way:

aa. "At the car park or at the shopping centre?"
bb. "At the shopping centre or at the car park?"

Before Control Question: "Where was the police man when he received the phone call that an accident happened?" _____

***[2typ]* Set-up: police station, shopping centre and car park.**

Look what I brought with me: a police station, a shopping centre and a car park. Show me again, where the car park is? And where the police station is? And where the shopping centre is?

Look! I would like to tell you a story about this policeman. Before work this policeman has gone to the shopping centre (*point to shopping centre*). Look! He is buying some food for lunch at the shopping centre. But now it is time to go to work. This policeman works in this police station (*point to police station*).
Look! In the police station, he has to do a lot of work on the computer. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The policeman is called away to an emergency.
Look what has happened: In the car park the blue car reversed and the yellow car "Crassshed!" into the blue car.
Look! The policeman gets his bike and drives fast to the car park, "Nee Nah Nee Nah!" to see what has happened.

Now Control Question: "Where is the policeman now?" _____
Counterfactual Question: "If accident had not happened, where would the policeman be now?" _____

If child does not reply provide answer options in a counterbalanced way:

cc. "At the shopping centre or at the police station?"
dd. "At the police station or at the shopping centre?"

Before Control Question: "Where was the police man when he received the phone call that an accident happened?" _____

***[2atyp]* Set-up: police station, shopping centre and car park.**

Look what I have brought with me: a police station, a shopping centre and a car park. Show me again, where the car park is? And where the police station is? And which the shopping centre is?

Look! I would like to tell you a story about this policeman. After work today, this policeman walked to the shopping centre (point to the shopping centre). Look! He is buying some food for his dinner at the shopping centre. Suddenly, his phone rings (r-i-n-g, r-i-n-g). The policeman is called away to an emergency.
Look what has happened: In the car park the blue car reversed and the yellow car "Crassshed!" into the blue car.
Look! The policeman gets his bike and drives fast to the car park, "Nee Nah Nee Nah!" to see what has happened.

Now Control Question: "Where is the policeman now?" _____
Counterfactual Question: "If the accident had not happened, where would the policeman be now?" _____

If child does not reply provide answer options in a counterbalanced way:

ee. "At the shopping centre or at the police station?"
ff. "In the police station or at the shopping centre?"

Before Control Question: "Where was the police man when he received the phone call that an accident happened?" _____

Appendix E - Head Toes Knees and Shoulder Task

Head Toes Knees and Shoulders Task (HTKS) Coding Scheme removed for copyright reasons. The copyright holders are Megan McClelland (megan.mcclelland@oregonstate.edu) or Claire Cameron (ccp2n@virginia.edu).

Appendix F – CELF Receptive Language Assessment

The Clinical Evaluation of Language Fundamentals (CELF) Receptive Language Coding Scheme removed for copyright reasons. The copyright holders are Pearson

Appendix G – School Information Letter

Pretend Play and Counterfactual Reasoning in the First Years of Primary School

15 January, 2017

Dear _____,

You are invited to participate in a research project exploring the link between pretend play and counterfactual reasoning in the first years of primary school, conducted by the Centre for Research on Play in Education, Development & Learning (PEDAL) at the Faculty of Education, University of Cambridge.

What is this project about?

This research project aims to explore an observed link between children's pretend play tendencies and their ability to engage in counterfactual reasoning. Counterfactual reasoning is the ability to think of possible ways a situation or an experience could have turned out differently. We often get children to engage in counterfactual reasoning when we ask "what if" questions that lead to them think about how a situation could have turned out differently if a different course of action is chosen. For example, "When Tom is well-behaved, mommy rewards him with an ice cream. If Tom is not well-behaved, will he get an ice-cream?". To answer the question the child must imagine a world where an alternative scenario to what is presented is played out. Researchers have observed that imagining counterfactual alternatives resembles imagining in pretend play because in both contexts children entertain, generate and reason about imaginary, made up or hypothetical scenarios.

This study is important because in recent times, researchers are asking, "what contribution does pretend play make to children's development?". The similarities between pretence and counterfactual reasoning suggests that pretence may underpin children's development of higher order thinking and reasoning skills. Therefore, this study examines these observed relationships.

PEDAL is serious about play research and the findings from this research initiative will contribute to addressing one of our goals which is to answer the question "what is play?" as well as to inform the development of child-centred, playful pedagogies that support teaching and learning in schools. (https://www.educ.cam.ac.uk/centres/pedal/research/)

What does this study entail?

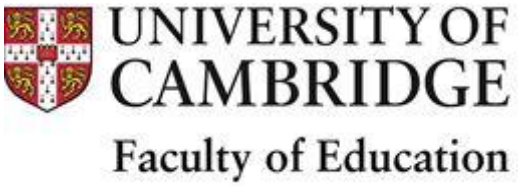
This study will utilize a range of assessments and observations all of which have been used in other published research projects with reception age children. The general feedback is that children actually enjoy participating in the tasks. For a given child, the assessment periods are relatively short to minimise their time away from the classroom. We anticipate that each child will spend approximately 20-30 minutes completing tasks one-to-one with an experienced researcher, for three sessions. Overall, we anticipate children will miss approximately one hour and twenty minutes of class time.

Whilst we endeavour to keep classroom disruption to a minimum, it will be necessary for me to spend a number of days in the school, so it is important that the teacher is comfortable with my presence and is supportive of the research. However, I would like to stress that there is no sense in which we wish to *evaluate* the teacher or the classroom environment.

Please do not hesitate to contact me if you have any further questions regarding this project.

Yours sincerely,
Gill Francis
PhD Student
PEDAL Research Centre
Faculty of Education
University of Cambridge
Email: gaf36@cam.ac.uk
Tel: 07438 344175

Appendix H – Parent Consent Letter



Pretend Play and Counterfactual Reasoning Skills in the First Years of Primary School
Parent/Carer Information Statement

15th January, 2017

Dear Parent/Carer,

The Head Teacher and reception teachers at your school, has kindly given me permission to contact you regarding a research project carried out by the Centre for Research on Play in Education, Development & Learning (PEDAL) at the Faculty of Education at the University of Cambridge. All children in Reception are invited to participate. This research, funded by the LEGO foundation, seeks to explore how children's pretend play tendencies might relate to their ability to engage in counterfactual reasoning.

Counterfactual reasoning is the ability to think of possible ways a situation or an experience could have turned out differently. We often get children to engage in counterfactual reasoning by asking them how a situation could have turned out differently if they had chosen a different course of action. For example, "When Tom is well-behaved, mommy rewards him with an ice cream. If Tom is not well-behaved, will he get an ice-cream?". To answer the question children must imagine a world where an alternative scenario to what is presented is played out. Researchers have observed that imagining counterfactual alternatives resembles imagining in pretend play because in both contexts children entertain, generate and reason about imaginary, or hypothetical scenarios.

This study is important because in recent times, researchers are asking, "what contribution does pretend play make to children's development?". The similarities between pretence and counterfactual reasoning suggest that pretence may underpin children's development of higher order thinking and reasoning skills. Therefore, this study examines these observed relationships. PEDAL is serious about play research and the findings from this research initiative may contribute to informing policy about the development of child-centred, playful pedagogies that support teaching and learning in schools. (https://www.educ.cam.ac.uk/centres/pedal/research/)

Please take time to read the following information carefully and discuss it with others if you wish. A member of the team can be contacted if there is anything that is not clear or if you would like more information.

Yours sincerely,
Gill Francis
PhD Student
PEDAL Research Centre
Faculty of Education
University of Cambridge

What does the project involve?

Participation in this project involves your child participating in a playful pretend play session and completing brief one-on-one tasks with an experienced researcher. The tasks are aimed at drawing inferences about children's cognitive ability. These tasks have been used with children many times before and they usually enjoy doing them very much. Children will be taken out of lesson times for approximately one hour and twenty minutes, across two 30 minute sessions and one 20 minute session.

Video and audio recordings of your child will be made as part of this study. These recording will only be accessible to the investigators of this study and will be used only for the purpose of research. Your child's identity will be protected at all times. The project has received ethical approval from the Research Ethics Committee of the Faculty of Education University of Cambridge.

If you would like further information about the procedures outlined here, please do not hesitate to get in touch using the contact details below.

Do I have to take part?

Participation is voluntary and your child will take part only if you give consent. Your decision whether or not to permit your child to participate will not prejudice you or your child's future relations with the University of Cambridge. If you decide to permit your child to participate, you are free to withdraw your consent and to discontinue your child's participation at any time without jeopardising you or your child's relationship with the University of Cambridge or the school. In addition, because of your child's age, the teacher and/or researcher will terminate any aspect of the study if they have any concerns about your child's welfare, although this is not at all expected to occur.

Will the study benefit me or my child?

We do not anticipate that there will be any adverse consequences for your child by taking part in our study. There is some evidence, in fact, that children benefit from doing the tasks described above but we cannot give any assurances that your child will receive any benefits from the study.

Will my taking part in this project be kept confidential?

All aspects of the study, including results, will be strictly confidential. *All data will be identified only by a code, with personal details kept in a locked file with access only by the immediate research team.* A report(s) of the study may be submitted for publication and the findings presented at national and international conferences related to this area of research, but individual participants or schools will not be identifiable in such a report(s). Furthermore, schools will not have access to information on individual children's scores on any tasks they complete in the project.

What if I require further information?

If you have any questions about the study or require further information you are welcome to contact Gill Francis (PhD Student at the University of Cambridge, Faculty of Education) on: 07438 344175 (cellular phone) or gaf36@cam.ac.uk (email). This information sheet is for you to keep.

Pretend Play and Counterfactual Reasoning In Young Children

Consent Form

If you agree for your child's participation in this study, then lease complete this consent form:

Name of Child: ……..

Child's Date of Birth …… Child's Gender ……..

Languages spoken in the home ……..

Please tick box:

1. I give permission for my child to participate in this study ☐
2. I confirm that I have read the information sheet for this project, have had an opportunity to consider the information, ask questions and received satisfactory answers ☐
3. I understand that my child's participation is voluntary and that I am free to withdraw their participation at any time without giving any reason ☐
4. I understand that my child's responses may be audio/video recorded to ensure accuracy of results. Any recording will be kept confidential and will be kept in a secure location. ☐
5. I understand that anonymous information collected about my child may be used to support other research and that these data may be presented at professional conferences or in academic manuscripts. ☐

Signature of Parent/Carer:**……..**

Name (Please PRINT): **……..**

Date: **……..**

This study has been approved by the Faculty of Education Research Ethics Committee.

Appendix I – Results of Normality Distributions: Pretence Scores

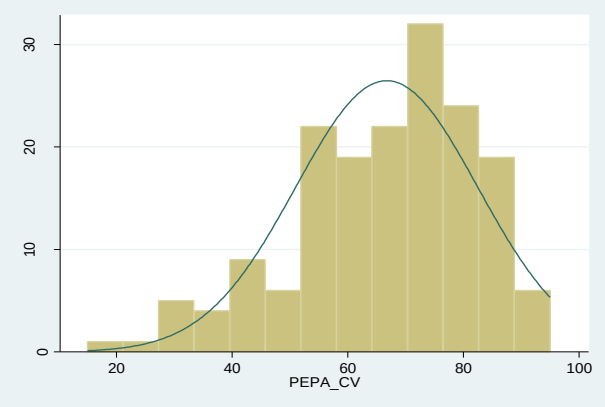


Figure I-1. Histogram PEPA-CV Scores

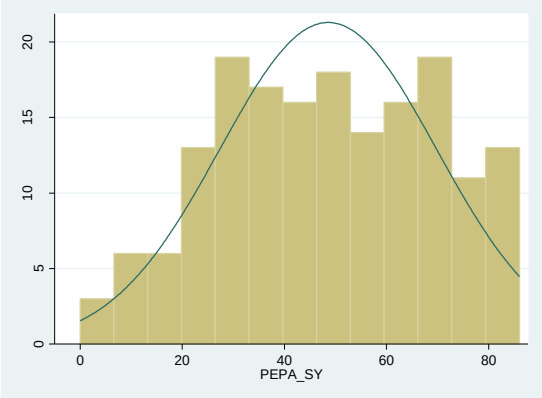


Figure I-2. Histogram PEPA-SY Scores

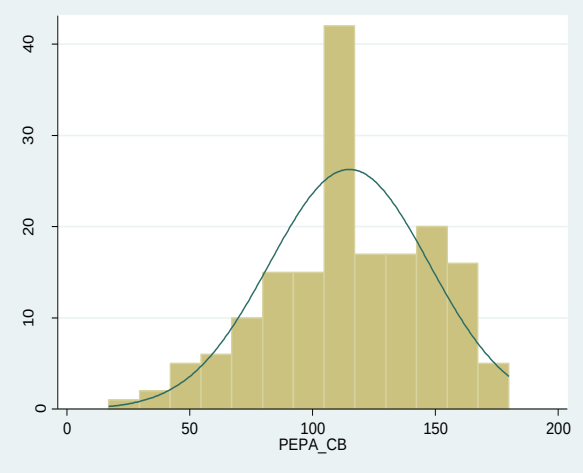


Figure I-3. Histogram PEPA-CB Scores

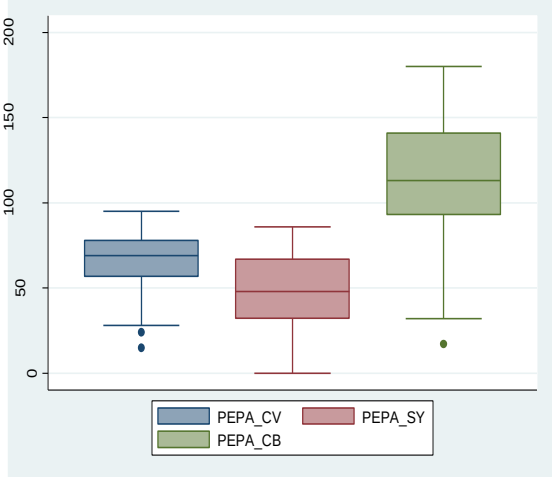


Figure I-4. Box Plot PEPA Sub-scales

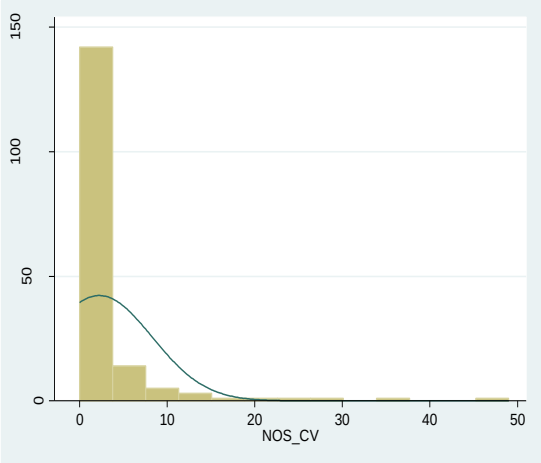


Figure I-5. Histogram NOS-CV Scores

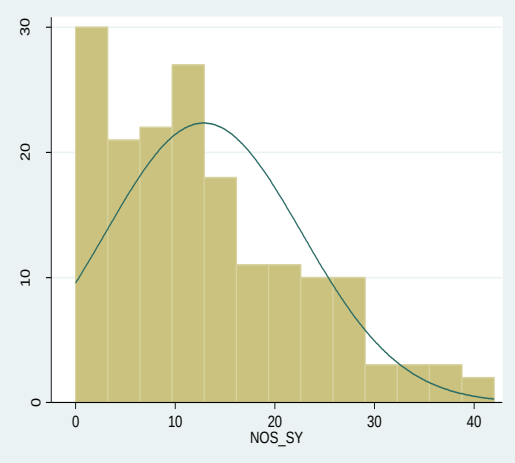


Figure I-6. Histogram NOS-SY Scores

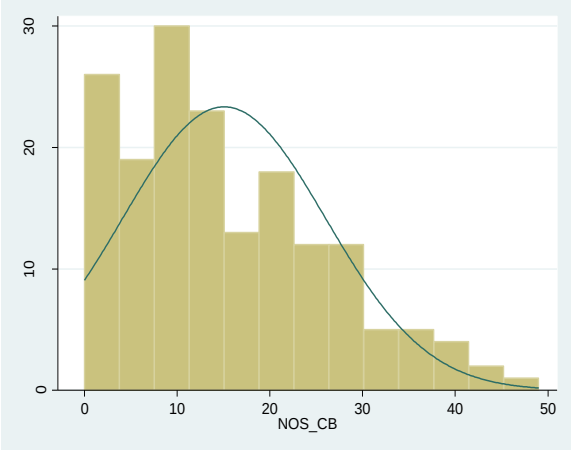


Figure I-7. Histogram NOS-CB Scores

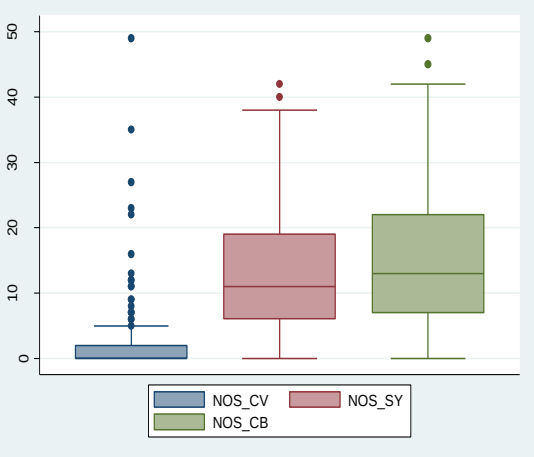


Figure I-8. Box Plot NOS Sub-scales

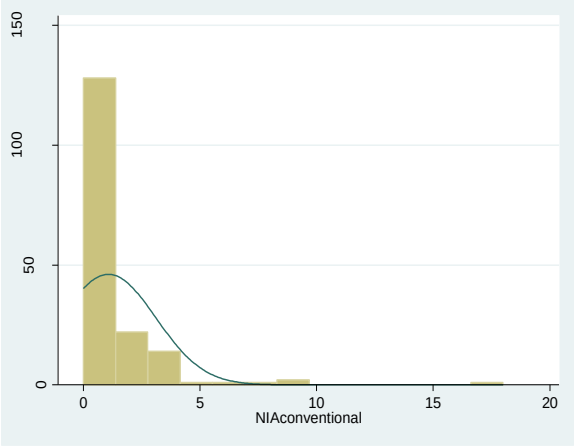


Figure I-9. Histogram NIA-CB Scores

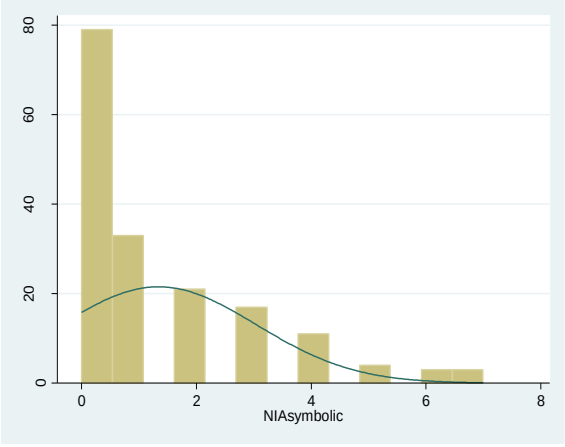


Figure I-10. Histogram NIA-SY Scores

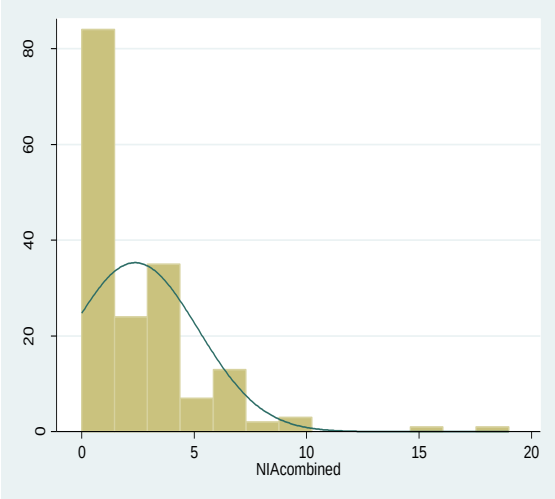


Figure I-11. Histogram NOS-CB Scores

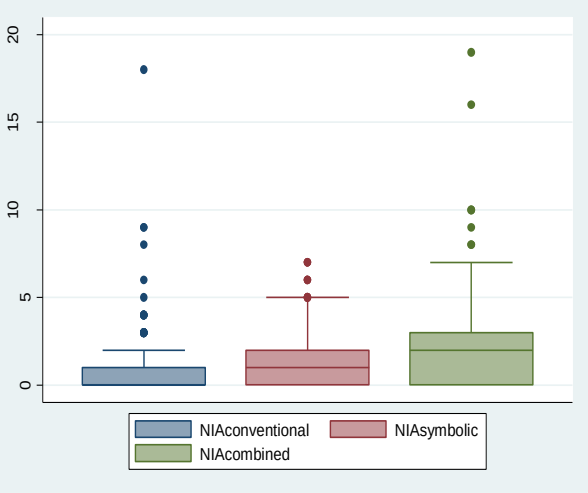


Figure I-12 Box Plot NIA Sub-scales

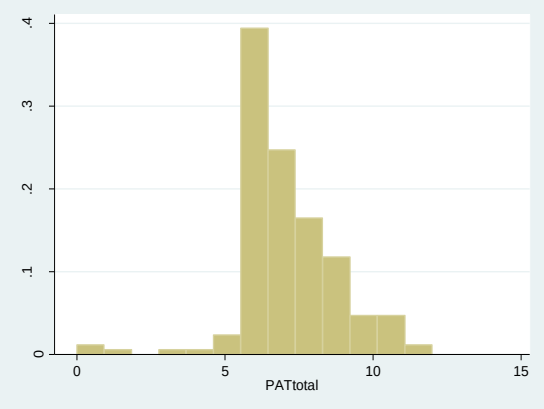


Figure I-13 Histogram Symbolic Representation Scores

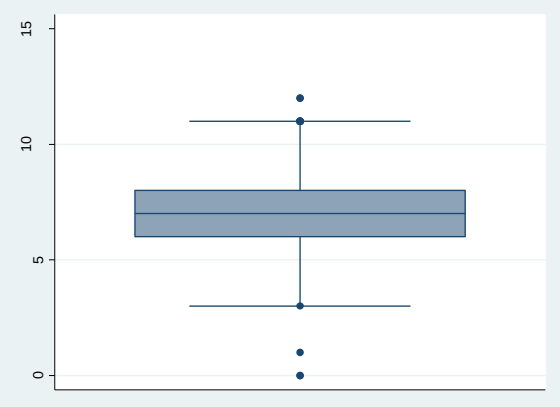


Figure I-14 Box Plot Symbolic Representation scores

Appendix J – Results of Normality Distributions: CFR Scores by Story Themes

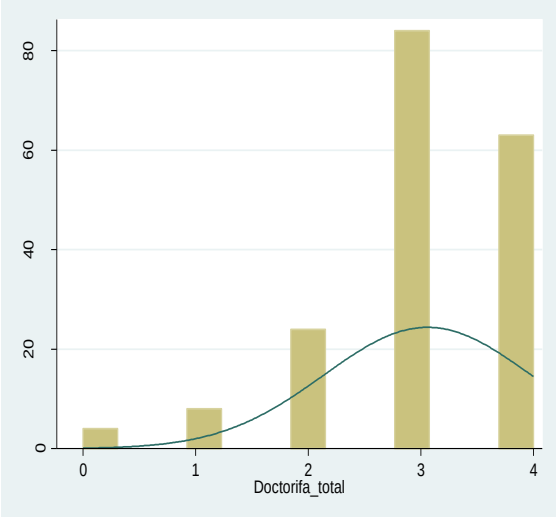


Figure J-1 Histogram Doctor Story Scores

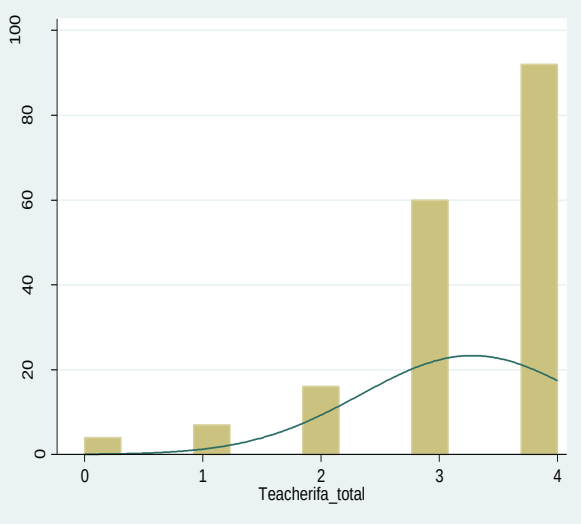


Figure J-2 Histogram Teacher Story Scores

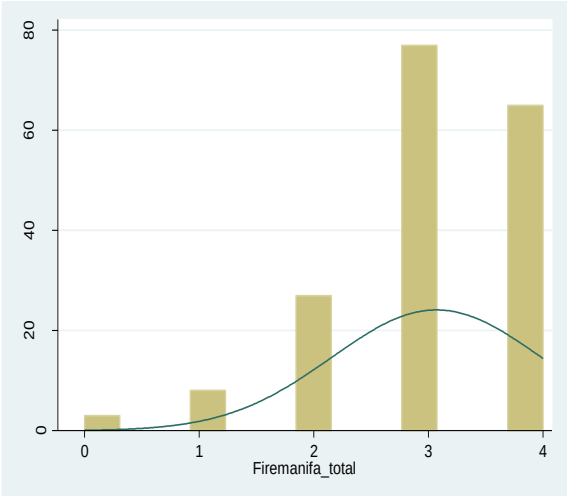


Figure J-3 Histogram Fireman Story Scores

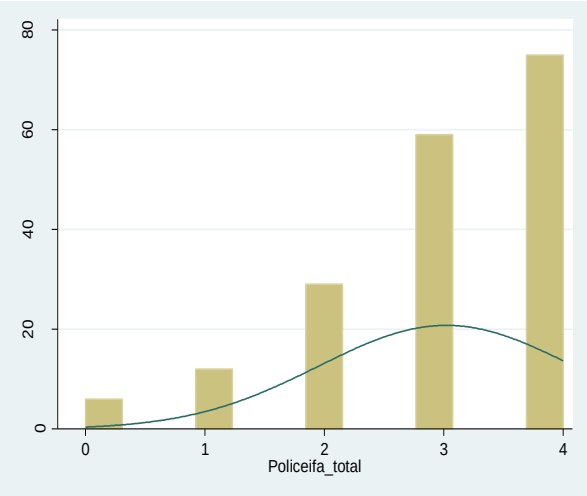


Figure J-4 Histogram Police Story Scores

Appendix K – Results of Normality Distributions: CFR Scores by Story Conditions

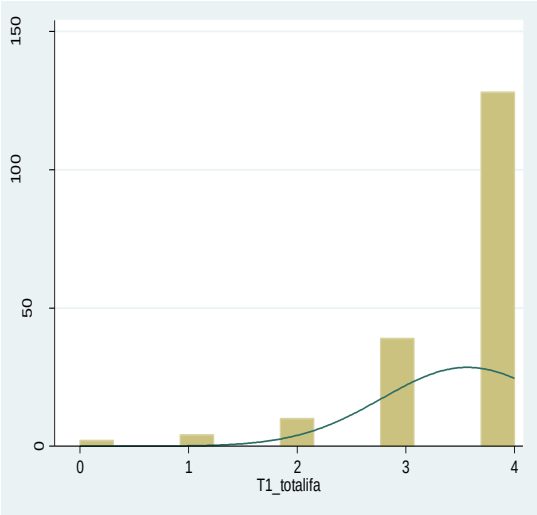


Figure K-1 Histogram Typical-1 CFR Scores

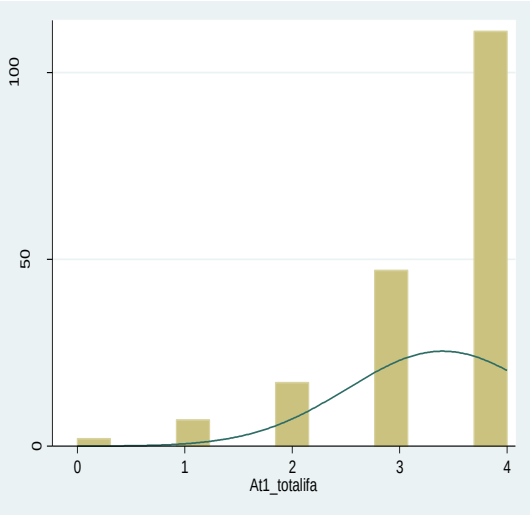


Figure K-2 Histogram Atypical-1 CFR Scores

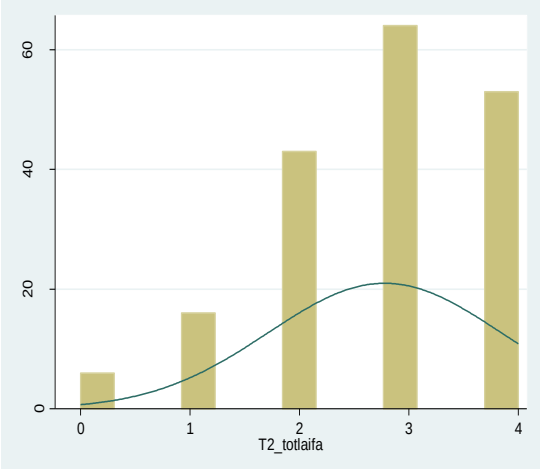


Figure K-3 Histogram Typical-2 CFR Scores

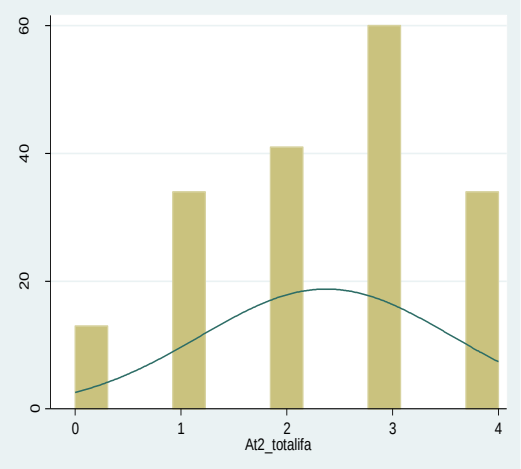


Figure K-4 Histogram Atypical-2 CFR Scores

Appendix L – Results of Normality Distributions: Executive Functions and Receptive Language Scores

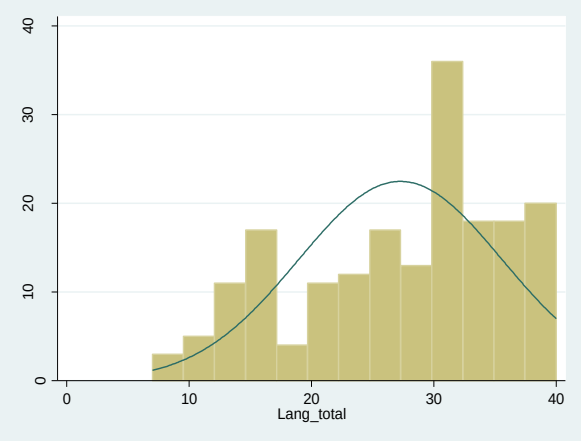


Figure L-1 Histogram Receptive-Language Scores

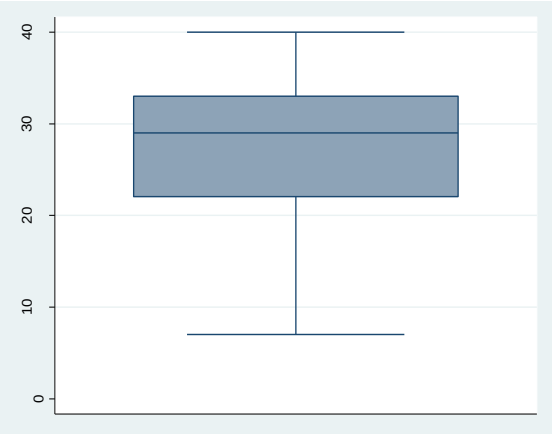


Figure L-2 Boxplot Receptive Language Scores

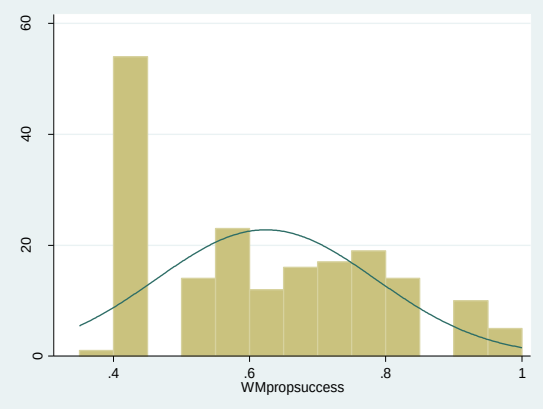


Figure L-3 Histogram working memory Scores

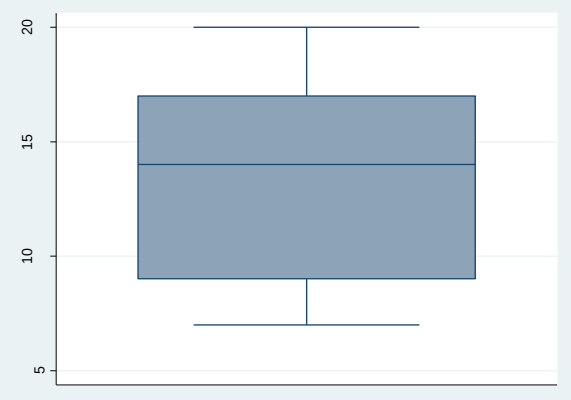


Figure L-4 Boxplot Working Memory Scores

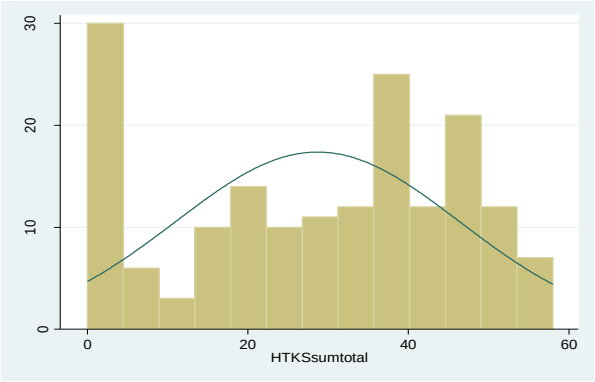


Figure L-5 Histogram Inhibition Scores

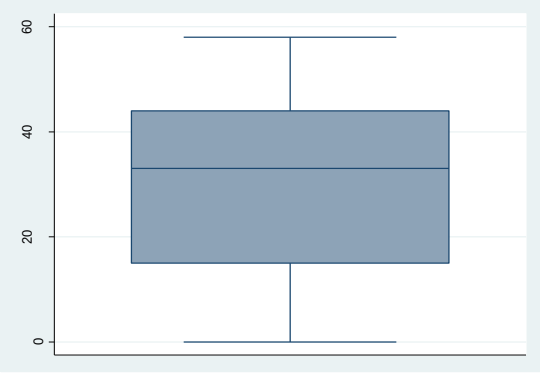


Figure L-6 Box Plot Histogram Scores

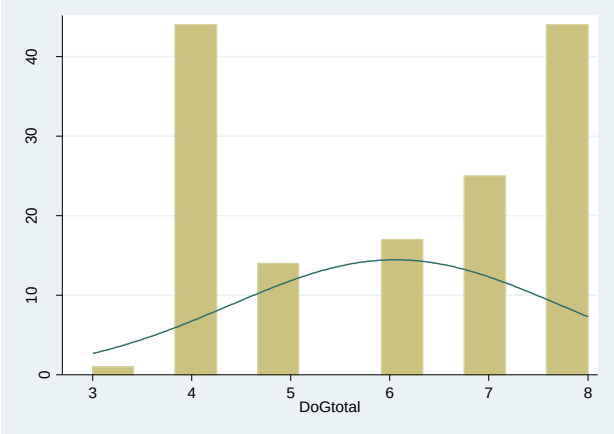


Figure L-7 Histogram Delay of Gratification scores

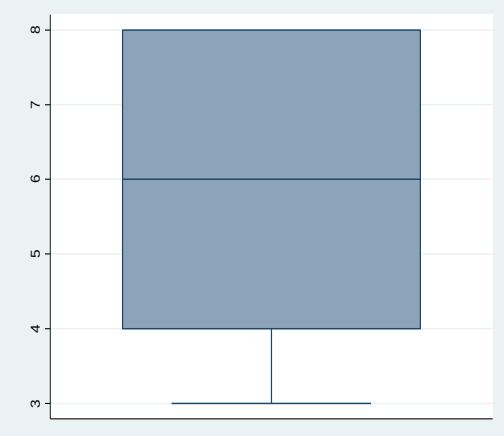


Figure L-8 Box Plot Delay of Gratification Scores