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Introduction

Preface: Extent of Contribution

I confirm that this PhD thesis is my own original work. It does not contain material published elsewhere or previously submitted for a degree or diploma at any other institution. To the best of my knowledge and belief, it does not contain any material previously written or published by another person, except where due reference is made in the text.

Abstract

Categorisation is the process by which items, behaviours and events are compartmentalised according to their defining attributes or properties. This may be based on simple perceptual similarities or on more complex conceptual webs. Whatever their selection criteria, categories expedite inferential capabilities, facilitating behavioural predictions and subsequently enabling response. Categorisation waives conscious effort whilst preserving that which is salient and as such, provides a highly efficient means of delineating and organising information within semantic memory. An ability to categorise is therefore fundamental to an individual's capacity to understand the world and a necessary precursor to academic achievement.

This thesis comprises a series of studies that were devised in order to investigate categorisational development in children. Study 1 involved the development of a theoretically and practically valid testing mechanism. A sample of 159 children, aged 30-50 months, participated in a series of investigations aimed at establishing the impact of test format and presentation dimensionality on categorisation performance. As a result of this, a new test battery was devised which enabled more fine grain differentiation than had been possible with the tests used by previous researchers. The battery measured four different aspects of preschool children's categorisational abilities -categorising according to shape; according to colour; when presented with drawings of items, and when presented with the same items in the form of toys. Results found that children's ability to categorise differed significantly according to their sex, socio-economic background and the dimensionality of the item.

Study 2 utilised the same battery with 190 participants from demographically diverse cohorts. Significant differences were found between high and low socio-economic groups and between boys and girls. A Mixed- Factorial ANOVA, with a post-hoc Bonferroni demonstrated a main effect of sex; a main effect of cohort and an interaction between sex and cohort. A Kruskal-Wallis Test also showed age to be significant, confirming the findings of previous researchers concerning a developmental trajectory. However, it also found that relatively sophisticated conceptual webs emerge earlier than had previously been thought.

Whilst the results from Study 2 had demonstrated relative homogeneity amongst socio-economic groups, it was noted that participants from the most disadvantaged neighbourhood

performed better than those from the other low socio-economic cohort. As the two Nurseries employed different approaches, with one offering a formal curriculum and the other emphasising child-led play, it was decided that the final study would focus on categorical development in these two cohorts. The final study therefore investigated conceptual development during 96 participants' first twelve weeks of nursery education. Forty-eight participants were drawn from a Community Nursery with a strong emphasis on child-led play and 48 were drawn from a Nursery attached to a Primary School, where the emphasis was on more formalised learning. Children's categorisational abilities were measured during their first week in Nursery using the test battery devised for Study 1. They were then re-tested using a matched battery twelve weeks later. Change scores were calculated and analysed using a series of one-way ANOVAs. As anticipated, all participants made gains but the children who had participated in play made significantly greater gains in three out of the four measures. It is thus asserted that play is a key conducer in cognitive development and a causal executant in establishing rudimentary automaticity and, as such, should be the polestar of preschool education. This is particularly important for boys from low socio-economic backgrounds who face contiguous disadvantage. Therefore, this research demonstrates that memory-based research with young children should be conducted with toys and objects, rather than images, and that the link between social and educational stratification has its roots in early childhood and is best addressed through the provision of high-quality play opportunities.

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Introduction

Due to extraneous and competing demands, humans are unable to consciously process all extrinsic stimuli (Broadbent, 1954, 1971; Isabella, Ferrari, Jobst, Cheyne & Cheyne, 2015; Kahneman 1973) and are therefore reliant upon automatic cognitive processing mechanisms such as schemata and categorisation to help regulate perceptual load (Rosch, 1975; Fiske and Dyer, 1985; Martin, Rubel and Szkrybalo, 2002; Tse, Takeuchi, Kakeyama, Kajii, Okuno, Tohyama, & Morris, 2011). An individual's schemata are unique to them and include a composite of knowledge and experiences that subsequently help guide expectations and behaviour (Augoustinos, Walker & Donaghue 2006; Steyvers & Hemmer, 2012). Schemata are initially fragmentary but coalesce and consolidate during the pre-school period to the extent that, by the time they begin school, children have many stable and abiding schemata (Riso, Laidlaw, Freeth., Foulsham & Kingstone, 2012; Rogoff, 1990; Ghosh & Gilboa, 2013; Tenenbaum, Hill, Joseph and Roche, 2010). Similarly, the ability to identify and label objects and to recognise their points of similarity and disparity emerges progressively (Althaus & Plunkett, 2015; Gopnik and Meltzoff, 1987; Mandler & McDonough, 2000), engendering increasing sophistication in categorisation during the years between birth and five (Blanchet, Dunham & Dunham, 2001; Blaye, Bernard-Peyron, Paour & Bonthoux, 2013).

The pre-school period is one of extensive change for the child. Changes in the structural architecture and functional organisation of the brain mean that physical maturation generally follows a distinctive pattern from vulnerable dependence through increasing levels of proficiency, dexterity and autonomy to self-reliance (Blair & Raver, 2012; Panksepp, 2013). Myelination, exuberant synaptogenesis and synaptic pruning serve to improve connectivity and regulate neurological processes (Jansen, Mous, White, Posthuma & Polderman, 2015; White, Su, Schmidt, Kao & Shapiro, 2010). Subsequently, the way in which children think and reason; their intellectual, emotional, ethical and lingual understanding develops cumulatively as dynamic changes occur in the cortical and subcortical regions (Lenroot & Giedd, 2006; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014). However, whilst this developmental trajectory exhibits strong elements of commonality, the speed and extent of cognitive development is inconsistent and appears inexorably linked to influences such as gender (Halpern, 2012; Mensah & Kiernan, 2009; Schoon, Jones, Cheng & Maughan, 2011), ethnicity (Emerson, 2012) and social and economic background (Bulut, 2013; Connolly, 2006; Ferguson, Cassells, MacAllister and Evans, 2013). It thus appears that cognitive development

occurs within sequentially predetermined parameters but is responsive to circumstantial exigencies (Fuster, 2014; Rosch, 1975; Weber and Crocker, 1983).

Social schemata comprise both the required information regarding social norms and the templates for appropriate conduct (Augoustinos, Walker & Donaghue 2006; Steyvers & Hemmer, 2012). An individual's social behaviour and successful integration are therefore substantially dependent upon the development and embedding of schemata (van Kesteren, Rijpkema, Ruiter, Morris & Fernandez, 2014). Similarly, categorisation is the basic unit of semantic memory, so not only do categories enable the child to make sense of life's "blooming, buzzing confusion" (James, 1890, p. 488), they are the corner-stone of all subsequent academic, cultural and individualised learning (Gopnik & Wellman, 1994; Gopnik & Meltzoff, 1997). The ability to categorise reduces cognitive load by condensing information; enables inference, and facilitates storage and retrieval (Barsalou, 2012; Gopnik & Meltzoff, 1997; Martin, Rubel and Szkrybalo, 2002). Given that schema and categorisation emerge so early and buttress so many aspects of cognition, it is possible that difficulties and shortcomings here may curtail or confine subsequent development.

A long history of academic study suggests that play is an executant in the developmental process. It is believed to enhance performance in a range of areas (Milteer & Ginsburg, 2012), including mathematical competencies (Pederson, Rook-Green & Elder, 1981; Wallace & Russ, 2015; Yawkey, 1983), cognitive skills (Ginsberg, 2006; Gmitrova & Gmitrova, 2003; Gmitrova, Podhajecka & Gmitrov, 2009; Nath & Szucs, 2014), language development (Holmes, Romeo, Ciraola, & Grushko, 2015; Orr & Geva, 2015; Pellegrini, 1980) and a vast array of social skills (Baker-Sennett, Matusov, & Rogoff, 1992; Hughes, 2011; Pellis, Pellis, & Bell, 2009; Savina, 2014). Play is of demonstrable importance to children's physical, emotional, social and cognitive development and is thus feasibly elemental to schematic and categorisational development. Schematic ontogeny has several points of contiguity with imaginative play. For instance, both play behaviours and schemata are augmented and verified through exposure, repetition and approbation from significant others (Weber and Crocker, 1983; Signorella and Frieze, 2008; Atherton and Nutbrown, 2013). As the points of convergence are features of imaginative play and conducers of cognitive change, it is plausible that the characteristics of children's play provide the ingredients for schematic and categorical development in a cognitively digestible form.

It is now widely agreed that, from early infancy, children begin to organise related experiences and information into clusters (Ferry, Hespos & Waxman, 2011; Quinn, Westerlund & Nelson, 2006; Rakison & Yermolayeva, 2010). Whilst the cognitive architecture is already in place (Alvarez & Sabatini, 2007; Nagy, Westerberg & Klinsberg, 2004) the "material" for organisation comes from the environment (Erzurumlu, Guido & Molnar, 2006). Neurological maturation thus enables progressive development in categorisational ability (Chau, Synnes, Grunau, Poskitt, Brant & Miller, 2013; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014; Raznahan, Greenstein, Lee, Clasen & Giedd, 2012). However, the speed and extent of this development is associated with both the quantity and quality of stimuli. Previous research suggests that girls progress more rapidly than boys (Mensah & Kiernan, 2009; Schachter, Shore, Hodapp, Chalfin & Bundy, 1978) and middle-class children out-perform those who are raised amidst multiple deprivations (Bulut, 2013; Snook & O'Neill, 2010); it was thus anticipated that categorisational ability would also evidence these trends. There is broad agreement amongst both classic and modern theorists that play promotes development in language, cognition and social skills and is thus a causal executant in developmental change (Cheng & Johnson, 2010; Holmes, Romeo, Ciraola, & Grushko, 2015; Russ, 2003; Wallace & Russ, 2015). It was therefore postulated that schematic and categorical development, being contingent upon exposure and experience, would be shown to be significantly facilitated by imaginative play.

In order to investigate each of these phenomena, a reliable and valid means of testing categorisational and schematic ability was required. An array of possibilities were considered and discounted before a new testing mechanism was devised. Having been tested for reliability and validity, the resultant toolkit was utilised with nearly 400 children aged between 30 and 60 months old. Results suggest that sex, socio-economic background and play (that is led by the child but supported by adults); all influence the emergence and embedding of categorisational abilities.

Summary of PhD Aims

Aim

To assess the extent to which sex, socio-economic status and participation in child-led play, facilitate the development of categorisation and schemata.

Objectives

1. To develop a means of testing pre-school children for schema-based automaticity.
2. To develop a means of testing pre-school children's ability to categorise.
3. To explore the role of sex / gender on the development of categorisation in pre-school children.
4. To assess whether socio-economic status impacts the development of categorisation in pre-school children.
5. To explore the impact of dimensionality on pre-school children's ability to categorise.
6. To extend psychological understanding of how differing forms of categorisation emerge and develop.
7. To explore the impact of play on the development of categorisation and schemata.

Hypotheses

1. Girls will perform better in categorisation tasks than boys.
2. Children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups.
3. All participants will perform better on categorisation tasks when presented with objects than when presented with images.
4. Children who engage in a curriculum based on child-led play will perform better in categorisation tasks than children who engage in a formal, instructional curriculum.

Chapter Contents

Chapter 1: Categorisation and Schemata

The initial aim of this research was to investigate the emergence and embedding of schemata in order to explore some progenitors of automatic processing. The research focus rapidly narrowed to categorisation, but participant responses to categorisation tests raised myriad issues relating to childhood cognition, particularly memory. This chapter therefore begins by providing a broad overview of pertinent cognitive theory, before moving on to consider schemata and categorisation in more detail. Theoretical perspectives are outlined, prior to an analysis of previous experimental research into category and concept development in childhood.

Chapter 2: Play

The chapter considers some classical perspectives on the importance of play and contextualises the history of play-research through consideration of the prevailing social and psychological landscape. A discussion of the hallmarks of play leads to an examination of potential sub-divisions. A chronological account of the features of early childhood demonstrates the links between cognitive development and the emergence of new play behaviours. In light of the gender differences highlighted elsewhere in this work, potential asymmetries in girl's and boy's play behaviours are considered. The chapter ends with a discussion of the functions of play and the conflicting arguments regarding the validity of claims made for its cognitive impact.

Chapter 3: Methodology

This chapter outlines the practical, methodological and ideological dilemmas that were addressed during the early stages of the research process and explains why the final decisions were considered the most conspicuously valid and expedient. The chapter begins by considering the particular demands and constraints of working with young children, including their cognitive limitations and behavioural proclivities. An explanation is provided as to how these determined the broad parameters of this research. Potential testing mechanisms that were considered and ultimately rejected are outlined, leading to a research design rationale.

Chapter 4: Study 1

Chapter Four, presents a chronological account of the initial stages of the research. It begins by describing the validation processes used during the development of materials.

The chapter then reports four small-scale studies that investigated factors impinging on pre-school children's ability to categorise. Results from Study 1(a) demonstrated a difference according to participant's sex, socio-economic background and the presentation modality. These results proved so compelling that they effectively shaped the remainder of the research. Subsequent studies (1b – 1d) considered the possibility of confounding variables, trialled alternative techniques and then investigated the findings in more detail.

Study 1(b) considered the impact of modality on children's ability to categorise. Children were presented with drawings, photographs and toys and the findings served to confirm those of Study 1(a). An addendum investigated recall as a potential confound but failed to find any link between item recall and item categorisation.

Study 1(c) / Study 1 (d). Previous childhood categorisation research has utilised a match-to-sample technique, two different formats of the technique were therefore trialled. Results suggest that the test developed for Study 1(a) is actually more sensitive and enables a greater range of responses.

Chapter 5: Study 2

Study 1(a) yielded some interesting results albeit with a relatively small sample; Study 2 increased the number of participants and the range of settings they were recruited from. In line with previous research in the field, it was discovered that the majority of participants were able to categorise on the basis of shape and colour. Those who were unable to do so were predominantly males from disadvantaged backgrounds. A significant difference was found between high and low socio-economic groups in terms of their ability to categorise images and toys; girls were also more able to create categories than boys and virtually every participant created more categories from toys than from images. Clear evidence was found of a developmental trajectory in terms of the order in which children learn to categorise.

Chapter 6: Study 3

Analysis of data from Study Two suggested access to child-led play may be a factor in the development of categorisation. This study returned to the two lower socio-economic groups, in anticipation of depressed base-line scores that would allow progress to be more easily measured. The entire September intake was tested in both settings during their first fortnight in Nursery. Each participant was then tested again twelve weeks later. The children who had spent the intervening period involved in child-led play made significantly greater gains in every measure than the children who had followed a more formal curriculum.

Chapter 7: Discussion

The findings of each of the studies are discussed in light of previous research and recommendations made for future investigations.

Studies 1 - 3

Table 1: Breakdown of Cohorts by Designation and Socio-Economic Status.

Cohort Label	Nature of Institution	Socio-economic status *
1	Nursery unit attached to Local Authority run Primary School	2,800
2	Pre-School Alliance Affiliated playgroup	30,657
3	Local Authority run Community Nursery	1,043
4	Pre-School Alliance Affiliated playgroup	29,964
5	Reception Class of Local Authority run Infant School	29,964

*Ranking based on the National Indices of Deprivation (2014), with 1 being the most deprived and 32,482 being the least deprived.

Table 2: Breakdown of Studies Conducted by Focus, Cohort Involvement, Participant Numbers, and Number of Tests in Battery

Study	Study Focus	Cohorts	Participant Numbers	Number Of Tests
1(a)	Impact of sex, socio-economic status and modality	1 & 2	52	4
1(b)	Impact of modality / dimensionality. Object / Image Recall	1 & 2 1	47 14	3 1
1(c)	Match-to-Sample Task	1 & 2	31	1
1(d)	Reduced Match-to-Sample Task	1 & 2	15	1
2	Impact of sex, socio-economic status and modality	1, 2, 3, 4,5	190	4
3	Impact of play on development of categorisation	1 & 3	102	8

Chapter 1

Categories, Concepts and Cognition

1.1. Chapter Overview

The initial aim of this study was to investigate the progenitors of automatic processing, specifically the means by which categories and schemata achieve salience, are conceptualised and ultimately embed during the pre-school period. The evolution of categorisation in early childhood is of central importance, not only in clarifying the child's understanding of the world but in terms of refining cognitive organisation and augmenting the development of semantic memory. Conceptualisation and categorisation enable items, behaviours and events to be compartmentalised according to their defining properties or attributes (Rosch, 1973, 1975 & 1978). During encoding, the conceptual system elaborates and interprets that which is perceived, prior to jointly storing the perceptual and conceptual information (Barsalou, 2012). Concepts and categories thus form the basic units of semantic memory, facilitating long-term conservation of knowledge about the world (Gopnik & Wellman, 1994; Gopnik & Meltzoff, 1997). Subsequent attempts to retrieve information regarding an individual concept activate stratified links, consolidating existing connections and augmenting retrieval. Categorisation thus reduces cognitive load whilst expediting all aspects of memory processing (Quinn & Bomba, 1986). The ability to categorise is therefore central to the child's apperception and to all levels of semantic memory. This chapter therefore begins by providing an overview of pertinent cognitive theory, particularly with regard to automatic processing and memory. Consideration is given to Schema Theory and to theoretical perspectives related to the organisation, format and use of categorisation. The chapter ends with an analysis of previous research into category and concept development in infancy and early childhood.

1. 2. Cognition and Automatic Processing: Background Information

There is broad general agreement amongst classic (Broadbent, 1954, 1971; Taylor and Fiske, 1978) and contemporary cognitive theorists (Isabella, Ferrari, Jobst, Cheyne & Cheyne, 2015) that it is neither feasible nor expedient for the human brain to consciously and simultaneously process all incoming sensory information (Corr, 2010; Macrae and Bodenhausen, 2001). Whilst complex, exacting and important tasks require conscious effort, much that is repetitious or inconsequential can be successfully accomplished by the "hard-wired" autonomic system

(Barnes, 2013; Romero, 2007) or by cognitive automatic-processing mechanisms (Crick & Dodge, 1994; Macrae, Milne & Bodenhausen, 1994; Tse, Takeuchi, Kakeyama, Kajii, Okuno, Tohyama, & Morris, 2011; Yang, Hu, Wu & Yang, 2015). Fiske and Taylor's (1991) classic theory suggests that automatic processes share several standard criteria, namely that they are unintentional, involuntary, effortless, autonomous and outside awareness. As such, they are initiated by environmental cues and fulfilled without encumbering processing capacity. Automatic processing is thus fast and non-strategic (Cheyne, Carriere, Soloman & Smilek, 2011). It is accomplished without mediation, attention or control (Kahneman, 2011; Malmberg & Shiffrin, 2005; Nelson & Shiffrin, 2013). It ensures efficient deployment of cognitive energy by dealing with the menial and flagging up any inconsistency or incertitude requiring conscious attention (Crick and Dodge, 1994; Macrae and Bodenhausen, 2001). In short, automaticity is essential to reduce cognitive load and ensure efficient functionality. Whilst some aspects of automatic processing are intrinsic and innate, others are enabled by repeated exposure to and re-enactment of patterns, attitudes and behaviours (Kramer, Strayer & Buckley, 1991). Over time, this gives rise to cognitively integrated structures such as schemata (Anderson & Lindsay, 1998; van Kesteren, Fernandez, Norris & Hermans, 2010) that help guide and determine actions. Similarly, categorisation judgements are frequently made without recourse to explicit criteria as the requisite associative principles have become sufficiently embedded to enable an extemporised response. So whilst categorisation is often construed as necessitating conscious control, in reality, by adulthood, much is achieved automatically. The main questions which this study sought to address were when and how these processes migrate from conscious to non-conscious control. In order to do so, it was necessary to first contextualise the theoretical background, for, whilst all perspectives are to some extent culturally and historically embedded, the current academic landscape and research paradigms have their bedrock there.

The origins of modern cognitive theory can be traced back to Wilhelm Wundt (1858; 1902/2001) who founded the Leipzig school and proposed a physiological hierarchy governed by a central self-control process. His assistant Kulpe accepted introspection as a valid means of studying conscious experience, but rejected the conclusions about perception that Wundt drew from it. Kulpe's subsequent creation of the Wurzburg school (1894) thus opened a debate which essentially established notions of top-down and bottom-up processing. After a period of dominance, introspectionism floundered after both James (1890/2001) and Dewey (1884/2001) proffered a persuasive rejection of structuralism and moved towards a functionalist focus on the role of environmental adaptation in processing. James (1890) further differentiated between

a temporary store, which he termed *primary memory* and a more enduring *secondary memory*. Ebbinghaus' (1885) innovative experimental research had also led him to posit the existence of a subconscious store. This nascent concept was, however, largely ignored in favour of a hierarchical single-store model until Hebb (1949) revived the notion of short- and long-term memory. The emergence of Gestalt (Koffka, Wertheimer & Kohler, 1912/2001) and Behaviourism (Watson, 1919/2001) provided two further, and widely divergent views of cognition; one stressing the unitary whole, the other seeking objectivity through experimental research. Lashley's (1951) rebuttal of the dominant stimulus-response paradigm and the support his assertions received from Chomsky (1959) eventually saw the tide begin to turn away from behaviourism towards a more cognitive approach. Throughout the 1960s, the two-component view of memory was hotly debated (Melton, 1963; Waugh & Norman, 1965) until neuropsychological evidence proved too compelling to dismiss (Baddeley & Warrington, 1970; Shallice & Warrington, 1970). Any lingering vestiges of behaviourism were discarded when seminal works by (amongst others), Atkinson and Shiffrin (1968), Baddeley and Hitch (1974) and Norman and Shallice (1980, 1986) shifted the focus decisively away from external and observable outcomes towards modern conceptions of internal information processing.

Atkinson and Shiffrin's (1968) multi-store or modal memory model provided the first truly comprehensive attempt to explain the architecture of memory. In it they postulated that stimuli are initially managed by the sensory register or sensory buffer. This detects and holds iconic (images), echoic (sound), haptic (touch) and olfactory (smell/taste) memories. Whilst the buffers do not process information contained within the stimulus, the holding facility prevents over-load of higher level cognitive processing mechanisms. Retention times are brief; items in iconic memory are generally believed to decay in under a second (Sperling, 1960); whereas (in the absence of competition), echoic memory can have a duration of up to 20 seconds (Posner, 1966). The information is then fed through attention, into short-term memory (STM), where it can be held for a further 30 seconds. Superfluous information is allowed to decay, but that which is worthy of retention is subject to rehearsal, encoding and transference to long term memory. For many years the Atkinson and Shiffrin (1968) model was pre-eminent but further work in the field precipitated criticisms regarding its lack of definitional precision (Tarnow, 2010), the emphasis on rehearsal and its assumption that items are perceived and transferred between memory stores as unitary wholes (Bjork & Whitten, 1974; Craik & Watkins, 1973; Tzeng, 1973). Neuropsychological evidence subsequently made it clear that the association between STM and LTM was not as robust as Atkinson and Shiffrin had assumed (Shallice,

Fletcher, Frith, Grasby, Frackowski & Dolan, 1994; Shallice & Warrington, 1970). Craik and Lockhart's (1972) influential *Level of Processing Hypothesis* disputed the propositions which underpinned the multi-store model. Instead they argued that it was the depth of processing an item received during encoding that determined its memorability, rather than the store in which it was held and they subsequently postulated two processing types appropriate to differing needs. The Craik and Lockhart model (1972) served to highlight the importance and complexity of encoding, subsequently expatiating memory research. However, it in turn was criticised for being unduly descriptive and ill-defined.

Baddeley and Hitch (1974) subsequently offered a number of influential amendments to the Atkinson-Shiffrin (1968) model, particularly with regard to STM, which they regarded as a dynamic process rather than a latent store. Their observation that participants were able to retain transient information whilst simultaneously completing other cognitive processing tasks, led them to assert that STM was actually a constituent of working memory (WM). Furthermore, they suggested that WM could be subdivided into a supervisory system, termed the *central executive,* and two initial slave systems, to which Baddeley added a third in 2000. The central executive was regarded as a modality-free, limited-capacity system, that controlled and co-ordinated all other components. By Baddeley's (1996, p.6) own admission, early specifications of the central executive were "so vague as to serve as little more than a ragbag into which could be stuffed all the complex strategy selection, planning and retrieval checking that clearly goes on." Hence the minutia has seen considerable refinement over the years but the general framework has remained intact (Baddeley, 2015; Cowan, 2005). The slave systems comprised the phonological loop, (which encompassed an articulatory control system and phonological store); the visuo-spatial scratchpad, (a non-verbal store, dedicated to visual and spatial information), and the episodic buffer, (which integrates information together with any additional information regarding chronology or timing).

There has been a subsequent proliferation of dual-processing theories within both cognitive and social psychology. Whilst some have been generalised (Norman and Shallice, 1986; Posner & DiGirolamo, 2000), others have focussed on specifics such as stereotyping (Devine, 1989); self-regulation (Baumeister & Heatherton, 1996; Metcalf & Mischel, 1999) or the mechanisms of control (Miller & Cohen, 2001; Wenzlaff & Wegner, 2000). Although terminology varies (for instance, what Baddeley and Hitch (1974) term the *central executive*, Norman and Shallice (1986) call the *Supervisory Attentional System*, and Posner and DiGirolamo (2000) refer to as

executive control), the over-riding principles are broadly similar. Sensory stimuli capture exogenous attention and activate contention scheduling (Norman & Shallice, 1986) or bottom-up processing. This automatic, default mode of processing is also sometimes termed *nonconscious, implicit* or *heuristic*. If necessary, top-down, endogenous attention will activate controlled or explicit processing.

1.3. Long Term Memory

Long term memory (LTM) is broadly divided into explicit or declarative memory and implicit or nondeclarative memory (Squire, 1992). Explicit memory has historically been subdivided into episodic (personal) and semantic (world knowledge) (Tulvig, 1983). The information held in explicit memory is subject to intentional retrieval, whilst that which is stored in implicit memory is generally made manifest through behaviour, having been retrieved without recourse to conscious thought. Episodic memory involves more conscious recollection; is frequently overlaid with emotional and sensory elements and can thus be facilitated by presentation of associated perceptual and sensory information (Irish & Piguet, 2013). However, several modern theorists are now suggesting the systems are interdependent (Baddeley, Eysenck & Anderson, 2015), as many long term memories have both an episodic and semantic component and utilise a common neural network (Burianova, McIntosh & Grady, 2010; Greenberg & Verfaellie, 2010). (See Collins & Quillian's (1969) model in section 1.4.4.)

Theories regarding the process by which material is transferred from short-term and/or working memory to long-term memory have varied over the years. Ebbinghaus (1885) advocated rote learning, whilst Bartlett (1935) stressed the importance of meaning, schematic understanding and the development of appropriate cognitive structures. Paivio's (1971) dual-coding hypothesis suggested that verbal and visual codes can be both stored and recalled either independently or simultaneously; consequently, items that have been subject to binal storage increase their chances of retrieval. As has been previously noted, Craik and Lockhart's Levels of Processing Hypothesis (1972) shifted the focus away from the mechanics of storage, stressing instead the importance of encoding and recall and thus laying the foundations for current understandings of transfer-appropriate processing. Information for transference to long term memory needs to be encoded in a manner that is organised, meaningful and relatively stable. Shallow processing is inclined to focus on structure or phonemics and involves only maintenance level rehearsal, which engenders relatively short-term retention of information.

Conversely, deep level processing involves semantic coding, more consequential analysis and greater elaborative rehearsal which improve accessibility (Craik & Tulving, 1975; Unsworth, 2015). Specificity of processing (Vaidya, Zhao, Desmond & Gabrieli, 2002) and self-reference (Symons & Thompson, 1997) also appear to aid recall, as does the use of chunking (Baars, 1988; Campoy & Baddeley, 2008) and elaborative questioning (Roediger & Pyc, 2012).

1.4. Working Memory

There is now a broad consensus amongst theorists that working memory (WM) is best explained as a limited capacity system within a multicomponent model (Chow & Conway, 2015; Sanchez-Torres, Elosua, Lorente-Omenaca, Moreno-Izco & Cuesta, 2015). Working memory both manipulates and stores information (Baddeley, 2007, 2012; Cowan, 2005), allowing it to play a crucial, functional role in complex cognitive tasks such as planning (Cohen, 1996; Gilhooly, Phillips, Wynn, Logie & Della Sala, 1999) comprehension (Gathercole & Baddeley, 1993), and problem solving (Robert & LeFevre, 2013). Short term memory, on the other hand, is only capable of temporarily storing small quantities of information and so is widely regarded as being a component of working memory rather than an independent entity. Complex tasks requiring the manipulation of information are governed by a limited attentional capacity control system; typically regarded as something akin to Baddeley's (1974) notion of a central executive (Engle, Carullo & Collins, 1999; Miyake, Friedman, Rettinger, Shah & Heggerty, 2001; Shallice, 2002). Baddeley's original (1974) model has been progressively refined (both by Baddeley and by other researchers) to take account of developments within the field. In more recent models (Baddeley, 2012/2015) WM is conceptualised as a complex interactive system which handles information across modalities, utilising links to the phonological and visuo-spatial subsystems and thence to the episodic buffer (Allen, Baddeley & Hitch, 2006; Cowan 2005; Langerock, Vergauwe, & Barrouillet, 2014; Vogel, Woodman & Luck, 2001; Wang, Allen, Lee & Hsieh, 2015). Furthermore, recent studies using fMRI suggest that WM tasks serve to simultaneously activate the areas responsible for LTM, perception and executive control (Chun, Golomb & Turk-Browne, 2011; Bush, Luu & Posner, 2000) allowing it to play an influential role in selective processing. Working memory therefore provides "an interface between cognition and action" (Baddeley, 2012, p18).

Cowen's (1999, 2005) *embedded process model,* accentuates the importance of attentional processing through its suggestion that working memory is dependent upon attention triggering and maintaining activation within the LTM. Whilst this has led some to cite Cowan's as an alternative theory, Baddeley (2015) regards the difference between the two theories as being fundamentally a matter of emphasis rather than substance.

"Attention" has a gamut of potential interpretations and therefore requires some further clarification here. Posner and Rothbart's (2007) influential study proposes three types of attention, connected to alerting, orientation and executive control respectively. Each form is associated with a separate neural network. Working memory and executive control share overlapping cortical and subcortical components and dependent neural correlates (Fedorenko, Duncan & Kanwisher, 2013; Harding, Harrison, Breakspear, Pantelis & Yucel, 2014) and are therefore associated with the dorsolateral prefrontal cortex (Burgess, Depue, Ruzic, Willcutt, Du & Bainich, 2010), ventrolateral prefrontal cortex, and anterior cingulate cortex (Griesmayr, Berger, Stelzig-Schoeler, Aichhorn, Bergmann & Sauseng, 2014). Recent research, however, suggests that future working memory capacity can be inferred from the structure and activity in children's basal ganglia and thalamus (Ullman, Almeida & Klingberg, 2014), thus linking basal ganglia functions such as voluntary motor movement, learning and memory (Foerde & Shohamy, 2011) with later WM capacity. As the basal ganglia is associated with human reasoning, empathy, emotional stability (Leisman, Braun-Benjamin & Melillo, 2014) and with certain forms of implicit learning, this relatively new conjunction is in accordance with previous neurological research. In the context of this study, it is notable that humans with cognitive disorders or dysfunctions affecting the basal ganglia (Soto, Waldschmidt, Helie & Ashby, 2013) and those with limited working memory capacity (Lewandowsky, Yang, Newell & Kalish, 2012) both struggle to complete probabilistic categorisation tasks.

Working memory develops progressively during childhood and is seen to be one of the strongest predictors of academic achievement and social functioning (Dumontheil & Klingberg, 2012). Capacity varies across the lifespan (Gilchrist, Cowan & Naveh-Benjamin, 2008) but also according to individual differences (Sanchez-Torres, Elosua, Lorente-Omenaca, Moreno-Izco & Cuesta, 2015; Vogel, McCollough & Machizawa, 2005) and intellectual ability (Cowan, 2005). It is responsive to processing strategies (Baddeley, Chincotta & Adlam, 2001); for instance, information can be retained if the individual employs sub-vocalisation techniques as these serve to incorporate the phonological loop (Saeki & Saito, 2004; Saeki, Baddeley,

Hitch & Saito, 2013), subsequently increasing span and word retention (Baddeley, Gathercole & Papagno, 1998; Gathercole & Baddeley, 1989).

However, working memory performance can also be inhibited. Attentional Control Theory (Eysenck, Derakshan, Santos & Calvo, 2007) and its precursor, Processing Efficiency Theory (Eysenck & Calvo, 1992) suggest that anxiety constrains performance on cognitive tasks, particularly those which are short-lived and conducted under laboratory conditions. Worry serves to hamper and constrain attentional resources whilst also depleting storage capacity. As it has a particular effect on the central executive and the phonological loop (but not the visuo-spatial sketchpad), anxiety, whether a personality dimension or an emotional state, typically impacts inner verbal activity and problem solving (Rapee, 1993). It is thus to be anticipated that participants involved in working memory research will be susceptible to some depression in performance. The existence of any additional anxiety-producing factors is liable to exacerbate this tendency.

1. 5. Schema

1.5.1. Schema Theory.

The concept of schema and heuristics was initiated by Bartlett (1935) and substantially developed by Allport (1954), Tajfel (1969) and Rosch (1973, 1975, 1978). Bartlett's work was strongly influenced by the elemental tradition of British philosophy (Hartley, 1749/1966; Hume, 1739/1978; Locke, 1690/1979), early memory research (Ebbinghaus, 1885/1964; Wundt, 1897) and the notions of cognition they engendered. The prevailing "associationist" model regarded memory as a composite of loose networks which could be strengthened through exposure and repetition; thus repeated use of dyads such as "cats and dogs" would serve to increase their mutual association.

Bartlett's (1935) divergent proposition was that humans seek to establish patterns in order to enrich understanding and help predict future behaviours. Whilst his theory received little attention at the time, it essentially laid the foundations for modern cognitive schema theories (Hastie, 1981; Markus & Zajonc, 1985; Wagoner, 2013).

"Schemata" are conceptualised cognitive structures that represent all knowledge about a percept from abstract, generalised notions to specific lived examples. Schemata thus integrate theoretical knowledge with autobiographical details, "lending organisation to experience"

(Augoustinos, Walker & Donaghue 2006, p73). Once developed, schemata are progressively fortified through use until they become cognitively integrated structures with strong associative links (Anderson & Lindsay, 1998; Fiske & Taylor, 1991; van Kesteren, Fernandez, Norris & Hermans, 2010). Subsequently, they are able to provide a serviceable cognitive inventory system which aids both encoding and recall (Fiske & Dyer, 1985; Tse, Takeuchi, Kakeyama, Kajii, Okuno, Tohyama, & Morris, 2011). They are, however, more than mere category files or collections of semantic information (Baron & Byrne, 1987). Schemata also document an item's attributes and inter-connecting relationships. Ultimately, evocation of one attribute is sufficient to activate either associated components or a unitary whole (Ghosh & Gilboa, 2014). Schemata thus provide a basis for analysis, interpretation and connotation; making sense of familiar situations, guiding expectations (Steyvers & Hemmer, 2012) and offering "best guesses" or "default options" to complete partial sensory information (Augoustinos et al, 2006; van Kesteren, Rijpkema, Ruiter, Morris & Fernandez, 2014). The schemas stored within semantic memory can be broadly sub-divided into *scripts* and *frames*. Scripts generally comprise information about specific situations and their ramifications and are remarkably consistent across populations. Bower, Black and Turner (1979), for instance discovered up to 73% participant agreement regarding the necessary components of a restaurant schema. Frames, on the other hand, are predominantly knowledge structures, holding compartmentalised information about individual topics. A rugby enthusiast may thus divide their knowledge about sport into general information about the rules of the game, with sub-divisions for tactics and laws, teams and players, right down to the minutia about specific matches. Alternatively, an expert in sports science may divide their sports frames into technical information about the respiratory system, carriage, training and performance.

1.5.2. Schema Activation

As has been shown, there is broad general consensus that attitudinal and behavioural control (beyond control of those processes which are driven purely by biomechanics) operates at two levels; the willed and the non-conscious (Bargh, Chen & Burrows, 1996; Norman and Shallice, 1986; Posner & DiGirolamo, 2000). Those behaviours and attitudes which have been rendered automatic by repeated and habitual usage are dealt with at the lower, contention scheduling (CS) level (Norman & Shallice, 1986). Internal motivations, environmental cues and affordances trigger sensorimotor (Schmidt, 1975), or social schema (Bargh & Chartrand, 1999; Bargh, Chen & Burrows, 1996) which then guide thoughts, actions and behaviours. Where incompatible schemata are simultaneously activated, the most comprehensively integrated

representations will laterally inhibit those which are loose or fragile (Barrett, Tugade & Engle, 2006). This enables much routine and repetitious behaviour to be conducted without recourse to attentional processing or depletion of cognitive energy and (in the majority of circumstances) prevents undue vacillation. When automatic control is insufficient, for instance in novel, complex or consequential situations, the executive component (Baddeley & Hitch, 1974; Posner & DiGirolamo, 2000), also termed the Supervisory Attentional System (SAS) (Norman & Shallice, 1986), intervenes and may subsequently modify, extend or replace existing schemata. During both encoding and retrieval, information is manipulated in order to meet the individual's needs and motivations and may consequentially be subject to a degree of flexure and distortion. Furthermore, schemas often rely on folk taxonomies (i.e. surface features) rather than any deep structural links and this may lead to internal inconsistencies (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). SAS is therefore sometimes required to inhibit inappropriate schema activation, redress problems associated with the simultaneous activation of conflicting schemas or deal with a paucity of information (Norman & Shallice, 1986).

As schemata are assembled from both experiential and received information, they utilise both episodic and semantic memory (Johnson, Hashtroudi & Lindsay, 1993). The densely integrated structure, with myriad stratum, is stored in LTM but easily accessed by WM (Paas, 2003). Thus, whilst attempts to access the individual facets of a schema would far exceed WM capacity and create an unsustainable cognitive load, the consolidation of material means only a single element requires processing. Schemata thus ease cognitive load even when conscious processing is required.

1.6. Categorisation

1.6.1. Terminology

Categorisation is generally held to comprise both cognitive and behavioural aspects, with theorists making a terminological distinction between the two. Within modern cognitive science, "concepts" are generally regarded as being the defining psychological representation of attributes and subsequently, "conceptualisation" is taken to refer to internal processing. "Categorisation", on the other hand, refers to the means by which concepts, ideas, events or objects are identified, labelled and classified (Braisby, 2005; Gillibrand, Lam & O'Donnell, 2011; Rakison & Oakes, 2003). Conceptualisation and categorisation thus comprise an internal and an external aspect and are intrinsically linked; any discussion of one necessarily incorporates assumptions regarding the existence of the other.

Some terminological variations are found in psychological literature with regard to the internal representations which are variously labelled “schemas” (Anderson, 1991; Kagan, 2008; Mandler & McDonough, 1993), “concepts” (Murphy, 2002; Smith & Medin, 1981), and “categorical representations” (Quinn & Eimas, 1996). In the interests of clarity, within this work the term “schema” shall only be used to denote the broader cognitive structures outlined in Section 1.5.

1.6.2. Usage

As with schemata, categorisation enables codification of actions, experiences and phenomenon in accordance with their defining characteristics or qualities (Rosch, 1973, 1975 &1978), thus providing a highly efficient means of delineating information and waiving conscious effort whilst preserving that which is salient (Rosch, 1978). By enabling concepts to be grouped, categorisation reduces diversity; (pugs, terriers and wolfhounds can all be classified simply as “dogs”). Categorisation thus decreases the number of factors which need to be learnt, identified and recalled and so aids cognitive economy, preserving finite resources for when they are needed (Martin, Rubel and Szkrybalo, 2002).

During encoding, the conceptual system explicates and embellishes that which is perceived, then jointly stores the amalgamated perceptual and conceptual information (Barsalou, 2012). Subsequent exposure to associated stimuli or attempts at retrieval evoke classic reconstruction effects (Loftus & Palmer 1974) and serve to further strengthen the inferential links between disparate conceptual elements. Thus, “concepts enter ubiquitously into all phases of memory processing” (Barsalou, 2012 p244) and facilitate the efficient encoding, storage and subsequent retrieval of information (Quinn & Bomba, 1986). Without categorisation, storage would move towards a “laundry basket” model in which everything was randomly organised, leaving retrieval and recognition slow and error-prone.

Recognition of category membership thus opens up inferential capabilities which allow the individual not only to anticipate and respond but also to produce conceptual structures for things they have not previously experienced. As categorisation enables a process of deduction by triggering associated concepts, information about a single dog triggers links to a whole slew of affiliated information, such as the general properties of dogs and the general properties of mammals. Categorisation not only provides a checklist of the properties which category

members share; it carries an awareness of characteristics which they lack. The knowledge that orang-utans lack wings means that the possibility of them being classified as birds can be rejected. Category knowledge is thus continually enriched and developed; the individual gradually refines their expectations regarding the likely co-occurrence of attributes, ultimately coming to recognise that wings are more likely to occur with beaks and feathers than with fur and opposable thumbs.

Schemata and categorisation therefore not only provide an efficient filing system for that which is known, they facilitate behavioural predictions and enable individuals to respond rapidly and appropriately to new experiences. It is through this ability to utilise notions of category membership that a previously unseen breed can be recognised as a dog and a new restaurant entered with confident expectations. Categories therefore allow individuals to sort incidents, people and objects into groups rendering "discriminably different things equivalent" (Bruner, Goodnow & Austin, 1956, p.1) and allowing individuals to "respond to the novel as if it is familiar" (Quinn, 2002, p.86). Hence, the ability to categorise is fundamental to an individual's cognitive processing and to their ability to understand the world.

1.6.3. Types of Categories

Cognitive categories are arranged into taxonomies, (systematic principles for the classification and arrangement of items) and hierarchically ordered, with more abstract and general categories at the top and specifics at the bottom (Fiske, 1998; Macrae and Bodenhausen, 2001). Thus a superordinate category such as "birds" may be divided into a number of sub-categories or sub-types such as "gulls" or "garden-birds".

Superordinate level categories display high levels of abstraction and contain within them a number of basic level categories which are diverse and superficially distinct. For example, the superordinate category "animal" subsumes a vast array of demonstrably dissimilar creatures. However, the differences between category members are fewer and less significant than the differences between them and members of other categories - elephants and hamsters may be highly dissimilar, but they have more in common with each other than either has in common with a sofa.

Basic (or generic) level categories such as "dog" are the most recognisable and culturally salient. They display higher class inclusion than subordinate level categories and have more members than superordinate categories.

Subordinate level categories are a sub-division of basic level categories and display low generality and low levels of class inclusion. For instance, Portuguese Water Hounds and Border Collies are both subordinate level categories within the basic level category "dog". Subordinate categories have many specific, individuating features and are subsequently inclined to have polymorphemic composite labels.

Hence, whilst all categories are based on similarities, the type and extent of the similarity varies; superordinate or global categories have a low degree of similarity between items, whereas subordinate categories have very precise and specific areas of commonality. Basic categories lie between these two extremes and include items with a moderate degree of similarity.

1.6.4. Cognitive Organisation

Collins and Quillian (1969) provided the first systematic model of semantic memory, representing categorical information as being organised into a series of hierarchical networks. Superordinate properties are stored at one level, basics at another and the qualities peculiar to individuals at another. The stored representation for "pugs" would therefore only contain information about the characteristics of the breed, with the common characteristics of "dogs", "mammals" or "animals" accessible via a series of stratified links. This preserves cognitive economy by overcoming the need to store collective superordinate attributes with every category member. However, it creates a requirement for inferential links to be made between items at differing levels and this clearly has ramifications for processing speed (Collins and Quillian, 1969). According to their theory, statements such as "The Beatles made music", can be more easily, and more speedily corroborated than the statements "Paul McCartney can sit down", or "Ringo Starr has elbows". This is because the latter two statements necessitate recourse to information at a different hierarchical level; in this instance, the shared attributes of all humans. However, whilst verification speeds *are* demonstrably different, this may be attributable to familiarity rather than processing limitations, as discussions regarding the Beatles music are far more common-place that discussions regarding Ringo Starr's elbows (Conrad, 1972). The theory is therefore widely regarded as flawed and unsubstantiated.

Collins and Loftus' (1975) influential *spreading activation model* attempted to redress the issues associated with the Collins and Quillian (1969) theory. They proposed that consideration

of any item serves to activate the appropriate node within semantic memory. Activation spreads most strongly to those items which have a close semantic relationship; therefore, as "sunrise" is more closely associated with "sunset" than it is with "red", individuals will make the connection more rapidly (McNamara, 1992; Meyer & Schvaneveldt, 1976; Sanchez-Casas, Ferre, Garcia-Albea & Guasch, 2006). (See "Typicality Effect" below). Whilst the theory has garnered much support for its flexibility, it is neurologically inaccurate to assert that concepts are sited in a specific and exclusive region of the brain (Seger & Miller, 2010; Shallice, Fletcher, Frith, Grasby, Frackowski & Dolan, 1994; Soto, Waldschmidt, Helie & Ashby, 2013) and unduly simplistic to assert that concepts have a single representation (Blanchet, Dunham & Dunham, 2001; Blair & Raver, 2012). The visual stream is of particular importance when dealing with perceptual categorisation (Palmeri & Gauthier, 2004); the motor and premotor regions with habitual schematic responses (Seger & Miller, 2010) and the prefrontal cortex with categorisational planning and organisation (Ashby & Maddox, 2005; Freedman, Riesenhuber, Poggio, & Miller, 2003; Jurado & Rosselli, 2007; Miller, Freedman & Wallis, 2002). Rule-based categorisation, however, is coordinated by the frontal-striatal circuits (Ashby, Noble, Filoteo, Waldron & Ell, 2003). The theory, in its original form, has therefore now fallen out of favour.

Patterson, Nestor and Rogers (2007) proposed a *hub-and-spoke model,* which was further developed by Pobric, Jefferies & Lambon-Ralph, (2010) on the basis of work with semantic dementia patients (Mayberry, Sage & Lambon-Ralph, 2011). The model asserts that there are six modality-specific spokes to deal with olfaction - sound, verbal descriptors, visual features, somatosensory stimuli and praxis. The spokes process relevant motor and sensory input as it flows through to the hub, where it is integrated. The hub itself is modality-independent and located in the anterior temporal lobes. This theory is supported by neuroimaging studies (Binder, Desai, Graves & Conant, 2009) and appears to offer a plausible explanation. Research is still, however, in its infancy.

1.7. Major Theories

There are two major theories which attempt to explain categorisation; these are the Classical View and Prototype Theory.

1.7.1. The Classical View of Concepts

The "classical" or "defining attribute approach" has its roots in the philosophy of Plato and Aristotle and is founded on the premise of "necessary" and "sufficient" characteristics. If something belongs to a category, it necessarily shares characteristics with other category members. Similarly, possession of similar characteristics provides sufficient evidence to ensure confident placement within a category. The classic view thus regards everything as clear cut; if an item meets both the necessary and sufficient conditions of membership, then, and only then, does it belong within the category. Items are either members or non-members and all members are regarded as being equally representative of the category. Subordinate categories are thus seen as having the same attributes as the superordinate category. Early empirical investigations (Bruner, 1956; Hull, 1920) appeared to show that people do indeed categorise according to whether an item possesses the necessary and sufficient characteristics; however, subsequent researchers and theorists (Rey, 1983; Rosch & Mervis, 1975) have found good cause to doubt such a simplistic explanation. The reasons for this shall now be discussed.

1.7.2. The Classical View: Criticisms

1.7.2.1. Fuzzy Concepts

The most frequently cited criticisms state that the Classical View fails to take account of fuzzy concepts or to recognise the general perception that some category members are "better" or more typical than others (Rosch & Mervis, 1975). Furthermore, it assumes that concepts are static and unchanging, which is clearly not the case (Rey, 1983). If, as the classic view suggests, category membership is an all or nothing affair, then there can be no borderline cases. However, everyday life offers considerable evidence that category membership cannot always be neatly and definitively dichotomised. Colours, for instance, have no clear point of demarcation and are frequently referred to as being "a bluish-green" or an "orangey-red". Similarly, the suffix "ish" is appended to demonstrate approximations and similarities which place something on the periphery of a category.

McCloskey and Glucksberg's classic study (1979) found that, when asked to make categorisation judgements on highly typical and highly atypical items, participants agreed both amongst themselves and across time. Thus, a sofa was always classified as an item of furniture and an apple was always classified as a fruit. However, when judging items of intermediate typicality ("Are bookends an item of furniture?" "Is a pumpkin a fruit?"), participants disagreed

between themselves and frequently changed their minds when re-tested. It was acknowledged that some participants may have been hampered by a lack of knowledge and that, in some instances confusion regarding usage may have been an issue (for instance, a tomato is technically a fruit but is generally used as a vegetable). However, within the study, such ambiguities arose too infrequently to adequately explain participant's hesitation in borderline cases. It suggests that classical notions regarding the internal structure of categories are ultimately far too rigid. Instead, McCloskey and Glucksberg (1979) suggested that most people appear to utilise relatively fluid or fuzzy criteria clustered around a central prototype. This study was therefore widely regarded as providing sufficient empirical evidence to seriously undermine the Classical View. As a result, there has been relatively little research in the area, but Verheyen and Storms (2013) suggest that McCloskey and Glucksberg's (1979) study demonstrated that individuals sometimes vacillate because of the lack of clear definitional criteria. Wittgenstein's (1953/2001) famous example demonstrated the difficulty of defining what is meant by a "game", as rugby, Monopoly, archery, golf and Snap may share the label but few other properties. Furthermore, amongst any group of individuals, there are liable to be differences of opinion, meaning that categorisation judgements are often ham-strung by definitional vagueness.

1.7.2.2. Intransitivity

The Classical View suggests that transitive inference can be applied to all categories. Thus:

- Rabbits are mammals, mammals are animals therefore rabbits are animals.
- I prefer A to B and B to C, so I must prefer A to C.

However, as Hampton (1982) showed, not all categorization judgements are consistent with transitivity. For example, participants agreed that car seats are a kind of chair and that chairs are items of furniture but not that car seats are items of furniture. Similarly, they agreed that Big Ben is a clock and that clocks are furniture but not that Big Ben is an item of furniture. The fact that people so strongly reject the transitive inference in cases such as these further undermines the Classical View.

1.7.2.3. The Lack of Definitions

Finally, the Classical View assumes that all category members share common properties and therefore conform to a prescribed definition. However, most categories are actually indefinable as they contain some level of variation and, even if certain seemingly defining criteria were removed, they would still retain their essence. Using Pinker's (1997) example of a lion being defined as "a large ferocious cat that lives in Africa" it is clear that even if it is relatively tame and living in Croydon, it remains a lion.

The combined weight of evidence thus led theorists to accept that the Classical View was no longer plausible.

1.7.3. The "Typicality" or "Prototype" View of Concepts

The systemic inequalities found between category members which had caused the classic view to be brought in to question, highlighted the fact that all members do not necessarily fulfil the same membership criteria.

Rosch (1973) used a method generally termed "typicality ratings" to elicit participant's responses as to the 'goodness-of-exemplar' (GOE) of individual category members and how representative of a category they were perceived to be. She discovered that within each category some items were regarded as "better", or more prototypical, examples of the group than others. Sometimes this prototype represented a tangible item; robins, for instance, were generally regarded as more prototypical birds than penguins (Rosch, 1973; Rosch & Mervis, 1975). However, on other occasions prototypicality was based on the statistical aggregation of category examples or a distillation and abstraction of the main properties of the group (Minda & Smith, 2002). In a series of studies Barsalou (1985) established that this does not correlate with familiarity and has a limited correlation with frequency of exposure. Penguins were regarded as atypical birds and figs as atypical fruits regardless of where participants lived. Rosch took these findings to denote a generic internal structure to categories – an assertion which has been supported by other empirical work (Rips, Shoben & Smith, 1973). Rosch and Mervis (1975) used a property or attribute listing method wherein participants were asked to itemise properties for a series of category members. Results showed that typical items had a higher familial resemblance and shared a greater range of properties with other group members than atypical examples did. Rosch (1975) thus proposed that certain attributes and properties

are inclined to correlate or cluster together in the natural world and that these clusters form the attributes of the prototype. Other category members are subsequently evaluated in relation to their similarity to the prototype; if they are too dissimilar or have insufficient points of contiguity they are regarded as falling outside the category. There are therefore no defining or necessary attributes, just characteristic ones.

Rosch (1973; 1975) therefore postulated that prototypes provide a measure of central tendency and that it is these "best" or most prototypical examples that are stored in the memory to act as a cognitive reference point for other category members. For a time, prototype theory flourished as additional researchers provided empirical justification and clarified further points of theory (Homa, Sterling & Trepel, 1981; Posner & Keele, 1968, 1970; Reed, 1972). When new items are encountered, they suggested, they are judged against the existing criteria before being either incorporated into the category or rejected due to unacceptably high disparity or dissimilarity. Rosch (1975) utilised a category or sentence verification technique wherein participants were required to confirm whether typical and atypical items were category members. Participant responses to prototypical stimuli were significantly faster than for ambiguous or atypical examples (Rosch, 1975).

Smith, Otherson, Rips and Keane (1988) later formalized prototype theory by assigning values, diagnosticities and weightings to each attribute, claiming this offered an explanation for the typicality effects discovered by Rosch. They proposed that features are assigned a weighting dependent upon their importance; this weighting generally correlates with how widely the attribute is shared amongst category members. The ability to fly is weighted heavily for birds, which explains the low typicality rating assigned to penguins. Smith, Otherson, Rips and Keane (1988) thus asserted that apparent differences in typicality are actually a reflection of the importance assigned to key attributes. Their theory also addresses the disparity in processing speeds found between typical and atypical examples. Sentences such as 'a cat is a mammal' can be verified rapidly because the matching attributes are heavily weighted, meaning that the criterion for category membership can be rapidly reached. Conversely, statements such as 'a whale is a mammal' provide few high-weighed matches, a number of low-weighted matches and several apparent mismatches ("legs" are not a defining criterion for mammals, but are frequently believed to be so due to their common co-occurrence). With atypical examples, more matches have to be made in order to reach the criterion and this has the effect of slowing the processing speed.

Whether or not typicality explains categorisation, it appears to play a role in how categories and category members are viewed. Rogoff (1991, 2003), for instance, has demonstrated that when teaching concepts, parents are inclined to protect the prototype through exclusion of atypicalities. Hence penguins are generally referred to by their species name rather than as "birds" until the point where the child is felt to have grasped notions of typicality sufficiently to assimilate items that are outside the norm.

1.7.4. Exemplar Approach to Categorisation

The exemplar approach (Kruschke, 1992; Medin & Schaffer, 1978; Nosofsky, 1991) suggests that humans utilise the most accessible individual instance and, as such, are heavily reliant on memory storage systems. The theory suggests that rather than drawing upon a prototypical notion of "bird" from which the key defining features can be abstracted, the individual's first recourse is to a blackbird they saw that morning or a crow that frequently visits their garden. As such, the exemplar approach shares prototype theories' reliance on similarity but where prototype theory proposes comparison with a single abstracted instance, exemplar theory postulates that a host of exemplars are stored in memory. Participants' increased speed when affirming "a robin is a bird", as opposed to "a penguin is a bird", is regarded as evidence that personal experience has resulted in more stored representations of robins than penguins (Juslin & Persson, 2002; Kruschke, 1992). The theory thus suggests that, following exposure to stimuli, a search for similar items identifies the category with the most matches (Hintzman, 1986; Medin & Schaffer, 1978). Response behaviours are then determined by the matched exemplar (Estes, 1986; Lamberts, 2000).

The exemplar approach has been criticised for its lack of generalisability, as it is predicated on the assumption that, from an early age, humans are able to abstract the properties of "birds" from an encounter with a single species, then generalise and transfer them to all other birds. Furthermore, the success of this approach would be entirely dependent upon the individual selecting the right similarity measures from the exemplar on which to base all subsequent judgements. For instance, if the exemplar was a penguin, the criteria for birds would include webbed feet and an ability to swim. This approach is therefore generally held to have many strengths but too many flaws and omissions to stand alone.

1.7.5. Hybrid Explanations

Classical and prototype theories are both deemed to be "knowledge-lean" as they suggest that categorical representations are amenable to neat classification and delimitation provided that they possess a criterial number of features. Modern theorists agree that information regarding category membership is better represented as a continuum, as some members are considered to be better or more typical examples than others (Ashby & Maddox, 2005; Barsalou, 1985). However, typicality theory has erred on the side of vagueness and has been further criticised for its lack of application to some abstract concepts and goal-derived categories. Debate has therefore increasingly centred on whether any single approach is capable of fully explaining the process of categorisation. As a result, there have been numerous attempts to mesh complementary elements in order to produce a hybrid model (Herzog & von Helversen, 2013; Jakel, Scholkopf & Wichmann, 2009). Some hybrid models are explicit in their attempts to combine rule-based and exemplar theories (Erickson & Krusche, 1998; Nosofsky, Little & James, 2012); others integrate exemplars and prototypes through the formation of clustered representations (Love, Medin & Gureckis, 2004). Still yet another field has concentrated on providing explanations based on research with specific groups such as experts or patients with neuropsychological impairments. Matters are further clouded by the natural tendency amongst participants to change criteria dependent upon the perceived aims and purpose of categorisation. For instance, Ross and Murphy (1999) discovered that participants would sometimes categorise eggs with cereals and bacon in a grouping of "breakfast foods" and sometimes with milk and butter as a "dairy". Barsalou's (1983) famous example of ad *hoc* (i.e. non typical) categories being generated when people are asked list "items to be saved in cases of fire" further illustrates the fluidity and flexibility of categorisation strategies.

As Mandler (2003) concludes,

> We can categorise on the basis of single or multiple dimensions…, the behaviour of things…, abstract meaning… and even ad hoc basis. This range of content from perceptual dimensions to abstract ideas, combined with the fact that some categorization is deliberate and requires effortful retrieval, whereas other categorization occurs automatically without effort, makes it highly unlikely that all categorization rests on a single process. (Mandler, 2003, p 103)

This divergence is further compounded by the heterogeneity of fields and perspectives found within psychology. In many instances the field's ontological and epistemological basis generates its own theoretical perspectives and research paradigms. For social psychologists, the focus of categorisation investigations has primarily been the foundation and consequences of intergroup relations (Bodenhausen & Macrae, 2013; Smith, 2014). This has included consideration of racial, sexual and class-based stereotyping (Augoustinos & De Garis, 2012; Kloth, Shields & Rhodes, 2014); and self-classification, especially with regard to learning and performance (Margas, Fontayne & Brunel, 2006). Within biopsychology, the major focus has been the development and maintenance of the neural circuitry required by categorisation; whilst the processing of categories and concepts is central to cognitive psychologists. As each research field has grown, theories and processes of investigation have expanded and fragmented to the extent that it is impossible to do them all full justice within this thesis. Whilst each element shall be alluded to within this work, the major focus of the following section will be cognition and some of the mechanisms which underpin it.

1.7.6. Neurobiological Research

Neurobiological research has provided a valuable insight into the neural basis of categorisation and the means by which it develops in children. The majority of neuropsychological categorisation research has involved patients with Parkinson's or Huntington's disease, (or other conditions affecting the basal ganglia); patients with lesions to the frontal lobe and amnesiacs (primarily Korsakoff's syndrome) suffering damage to the medial temporal lobes. Such research is predicated on previous findings which have implicated these areas as being key to categorisational abilities; dysfunction thus provides clues as to conventional performance. Whilst there are substantial disparities in research findings, these are largely allied to the nature of the task presented to participants. Studies which are reliant on perceptual features have highlighted the importance of the visual stream (Palmeri & Gauthier, 2004). Where behavioural functions are reliant upon habitual schematic responses, the appropriate motor and premotor regions are utilised (Seger & Miller, 2010) but the planning, organisation and coordination of complex behavioural responses is associated with the prefrontal cortex (Ashby & Maddox, 2005; Freedman, Riesenhuber, Poggio, & Miller, 2003; Jurado & Rosselli, 2007; Miller, Freedman & Wallis, 2002). Frontal patients demonstrate impairment in rule-based categorisation (Ashby, Ell & Waldron, 2003; Brown & Marsden, 1988; Downes,

Roberts, Sahakian, Evenden, Morris & Robbins, 1989) with the reciprocal connection between the caudate nucleus and prefrontal cortex being implicated (van Domburg & ten Donkelaar, 1991), thus supporting the assertion that rule-based categorisation is coordinated by the frontal-striatal circuits (Ashby, Noble, Filoteo, Waldron & Ell, 2003). This is further validated by findings that patients with temporal lobe damage retain sufficient working memory to complete rule-based categorisation tasks (Janowsky, Shimamura, Kritchevsky & Squire, 1989). Recent temporal lobe research has suggested that the medial temporal lobe and regions of the striatum have a role in binding disparate perceptual information together with additional material (Davis, Love & Preston, 2012).

Categorisation research with neuro-typical adult participants suggests that a variety of different areas are utilised during both learning and performance dependent upon the nature of the task. Information-integration tasks which are able to employ procedural learning systems utilise only the body and tail of the caudate. Rule-based categorisation that necessitate declarative learning, however, activates the hippocampus, anterior cingulate cortex, middle frontal gyrus and body of the caudate (Nomura, Maddox, Filoteo, Ing, Gitelman, Parrish & Mesulam, 2007). Soto, Waldschmidt, Helie and Ashby (2013) demonstrated that once categories had been sufficiently learned to enable automaticity, both tasks then initiated similar cortical activity. For instance, the learning of patterns initially served to activate both the basal ganglia and motor regions, but once participants had achieved familiarity and competency, activation occurred only in the motor regions.

1.8. The Development of Categorisation in Children: Major Debates

The way in which young children think and reason develops progressively, partially due to external factors, partially as a result of synaptogenesis, the myelination of axons (Nagy, Westerberg & Klinsberg, 2004) and increased dendritic branching (Alvarez & Sabatini, 2007) in early childhood. Synaptogenesis within the prefrontal cortex is not maximal until the second year of life and this neural immaturity serves to restrict working memory and, subsequently, all cognitive activities that rely on it. Maturation of the prefrontal cortex is prolonged, meaning that the development of planning abilities, organisational capacity and some aspects of decision making are slow and progressive (Chau, Synnes, Grunau, Poskitt, Brant & Miller, 2013; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014; Raznahan, Greenstein, Lee, Clasen & Giedd, 2012). Aspects of the process are innate but it is clear that instructive experiences,

particularly during sensitive periods, have a role in the development of neural circuitry (Erzurumlu, Guido & Molnar, 2006). Furthermore, optimal functionality is dependent upon usage, with circuits that are not used being liable to inertia or decay (Hockfield & Kalb, 1993; Johnson, 2001). The rate and extent of developing categorisational abilities is thus both constrained and bolstered by biological capacity and environmental stimulus. Category and concept development are dynamic, progressive and potentially life-long.

Whilst there is still considerable controversy concerning both the sequence and nature of conceptual development, there is growing agreement that the process begins almost as soon as babies are able to perceive and track objects (Cohen & Caputo, 1978; Mandler, 2003; Quinn, 2004). Initial categories are necessarily broad and rudimentary but become increasingly refined as the child ages. Historic theories of linguistic relativity (popularly termed the Whorfian hypothesis) had suggested, in their strongest forms, that cognitive categories were determined by linguistic categories. Strong linguistic relativity has now been widely discredited (Berlin & Kay, 1969; Pinker, 1994), partially in light of the increasing evidence that infants can acquire primitive categories purely on the basis of perceptual information and with no lexical input (Quinn, Eimas and Rosenkrantz, 1993). Categorisational abilities thus begin to emerge long before the infant is able to speak and are based on discernible environmental stimuli (Mandler & McDonough, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997). Just as first words are generally used to name items (Swingley, 2008), categories formed as children are beginning to speak continue to have their basis in observable properties. However, adult instruction and the provision of labels help to build linguistic proficiency and bring additional layers of information regarding unobservable properties (Callanan, 1985; Gopnik & Meltzoff, 1997; Markman, 1989). As language use evolves, it thus enables conceptualisation to move through increasing levels of sophistication and abstraction (Anderson, 1991; Colunga & Smith, 2005). The child is able to make known their thoughts and elicit responses, substantially increasing the array and extent of received information and subsequently extending their conceptual awareness (Gelman, Coley, Rosengren, Hartman & Pappas, 1998; Millikan, 1998).

The debate regarding the nature and origins of early categorisation hinged for a time on a top-down, bottom-up dichotomy, with one position being based on the *Poverty of the Stimulus* argument. Poverty of the Stimulus originated within the language acquisition debate, but was subsequently generalised to incorporate perceptual and conceptual development. The theory was predicated on the notion that perceptual information is too limited and provisory to account for the rate and extent of children's conceptual gains (Gelman, 1990). It therefore proposed

that top-down processes must be responsible, with innate knowledge driving progress (Carey, 2009; Gorlinkoff, Mervis & Hirsh-Pasek, 1994; Spelke & Kinzer, 2007). The alternative position rejected this nativist reliance on innate knowledge, together with their assertions that environmental stimuli was impoverished; claiming instead that the environment is sufficiently rich to allow category formation on the basis of visual input alone (Quinn, 2004). In rejecting nativism, theorists also cite the demonstrable ability of not only babies, but also primates, rats and birds to learn categories and concepts solely on the basis of perceptual information (Cook & Smith, 2006; Rakison & Poulin-Dubois, 2001; Smith, Redford & Haas, 2008) thus demonstrating the superfluity of language.

1.9. Categorisation in Infancy

Many studies have been conducted with infants (Quinn, 2002) and whilst there is some variation in technique, the majority utilise a programme of habituation or familiarisation, followed by exposure to a novel item and analysis of the child's gaze or touch pattern (Bornstein and Arterberry, 2010; Mandler, Bauer & McDonough, 1991; Oakes, Plumert, Lansink & Merryman, 1996; Rakison & Butterworth, 1998). Typically, familiarisation involves the infant being presented with a range of stimuli from the same category. The child is then exposed to a novelty-preference test during which they are presented with two new stimuli – one from the category they were exposed to during familiarisation and one from a novel category. Gaze fixation is regarded as evidencing recognition of difference. Fixation on the novel item is thus taken to indicate that the infant has formulated a "category" during the familiarisation process and recognises the novel object to be outside this group.

Object-manipulation or sequential touching techniques were developed by Henry Ricciuti (1965) and further advanced by Katherine Nelson (1973) and Susan Sugarman (1983). This approach relies on children's spontaneous tendency to sequentially touch similar items when presented with a variety of objects (Mandler, 2004). This technique was initially devised in order to explore infant sensitivity to perceptual contrasts but evaluation procedures were largely intuitive and open to individual interpretation. Mandler and colleagues (Mandler, 2008; Mandler & McDonough, 1993, 1996) subsequently developed a range of statistical tools that allowed them to assess the significance of sequencing order and the grouping of touches. This allowed a more robust scientific evaluation of performance than had previously been the case. In a further augmentation of the familiarisation/preferential looking task, Mandler and

McDonough (1993, 1996) adapted a technique devised by Ruff (1986) and refined by Oakes, Madole and Cohen (1991). In this version pictures, which Mandler claimed evoked apathy amongst participants (Mandler, 2004), were replaced by small replicas of real world objects. She suggests that the freedom to physically manipulate objects both engages participants and increases understanding of the object and its properties; pictures, on the other hand, elicit a passivity which masks conceptual activity. The use of objects is thus regarded as producing more valid and reliable results (Oakes & Plumert, 2002). The process does, however, need to be carefully managed. Prior to 15 months, children are inclined to freeze if they are presented with too large a range of objects to examine, and are more responsive to individual presentation of items, with sufficient time built in for them to examine each object. Children above this age are happy to investigate a range of toys.

Meltzoff, (1988) and Mandler, Bauer and McDonough (1991) developed an ingenious experimental technique using deferred imitation, which utilises infants' adaptive tendency to replicate adult behaviours. Reasoning that recollection is dependent upon prior conceptualisation (Mandler, 2004, p10), Mandler tested pre-verbal infants on their ability to reproduce an event they had previously witnessed and discovered that babies as young as nine months were, even after a delay, able to remember and reproduce events that they had witnessed on only a single occasion. In a further adaptation, Mandler and McDonough (1996) developed a procedure that they termed *generalized imitation*, which she later explained as follows

> We model an event for the infants, again using little replicas, such as giving a dog a drink from a cup. Then we give the infants the cup, but instead of providing the dog, we substitute two other objects (say a bird and a car) and see which, if either, object they use to imitate drinking. This technique allows us to explore concept boundaries, effectively asking infants such questions as "what sort of things drink?" (Mandler, 2004, p 10).

These techniques have allowed researchers to investigate children's perception of events and subsequently, to make inductive generalisations regarding the nature and content of young children's categories (Oakes & Plumert; 2002). As a result, there is now substantial agreement that categorisation begins in infancy with a search for perceptual similarities (French,

Mareschal, Mermillod & Quinn, 2004; Mareschal, French & Quinn, 2000; Quinn, Eimas & Rosenkrantz, 1993) and that perceptual qualities continue to have greater salience for children than they do for adults, throughout the hierarchy of levels (Rakison, 2000). Novelty-preference techniques have demonstrated that infants as young as three months are able to detect basic categories such as colour and research is consistent in its finding that colour is the first abiding category for most children (Franklin & Davies, 2004; Bornstein, 2006).

Some degree of conceptualisation is necessary in order for infants to be able to learn from experience and thus recognition of similarity and difference, the precursor of full categorisation, emerges early. From as young as four-months-old, it is believed that children can discriminate between examples drawn from two superordinate categories such as furniture and animals (Mareschal & Quinn, 2001). Perceptual similarities amongst basic or natural category members, such as cats and dogs, may also lead to recognition of equivalence (Quinn & Eimas, 1996) if they share sufficient distinguishing features (Quinn, 2004) and conceptual coherence (Blanchet, Dunham & Dunham, 2001; Gelman & Davison, 2013). Indeed, Rosch (Rosch, 1978; Rosch, Mervis, Gray, Johnson & Boyes-Braem, 1976) believes that basic level categorisation is the first of the hierarchical levels to emerge. Just as natural categories such as "dog" generally feature amongst children's first words (Roberts & Cuff, 1989), so they are amongst their first categories. Rosch subsequently argued that all object categories are initially represented at a basic level ("dogs"; "cats"), then combined to form a superordinate layer ("animals") and finally differentiated into their subordinate constituents ("Pugs", "Corgis", "Collies"). Others, however, have suggested that many broad categories appear early and this has fuelled considerable debate as to the precise order in which basic and superordinate categories emerge (Keil, 2006, 2008; Mandler, 2003; Mandler & Bauer, 1988; Quinn, 2008; Quinn & Johnson, 2000). Some of this contention appears attributable to terminological and semantic differences and some to researcher's interpretation of observed participant behaviours. Mandler (2004) asserts that

> Infants have an idea of what an animal is but are hazy about the differences between one animal and another. They have an idea of what a container is but are hazy about the differences between a cup and a pan…. Right from the beginning, infants form concepts in a way that looks remarkably like using defining features rather than overall perceptual appearance. (Mandler, 2004 p22)

This is corroborated by other researchers in the field who have found evidence of an early distinction between items representing superordinate categories ("animals"), but a considerable delay before these can be differentiated on the basis of specific properties, such as creatures of the land and creatures of the sea (Mareschal & Quinn, 2001). Quinn (2004) therefore asserts that children are heavily reliant upon visual input to formulate their early categories and this leads them to move from the general to the specific as they learn how to refine their search mechanisms.

Experimental results are thus ambiguous, contradictory and prevent the formulation of any hard and fast rules. Furthermore, there appears to be evidence of infants swapping between hierarchical levels depending upon the nature of the task (Oakes, Plumert, Lansink & Merryman, 1996). It would appear feasible that categories emerge in accordance with the extent of cognitive effort and specialist information they require; as subordinate categories are generally specific and precise, these would clearly be the last to embed but the emergence of basic and superordinate categorisation is probably at least partially shaped by their accessibility and salience.

Mandler (2004), rejects top-down and Piagetian notions of innate concept construction and, whilst partially accepting the importance of perceptual knowledge, refutes any claims that this alone can explain the onset of categorisation. She thus proposes a dual-representation theory, suggesting that babies are born with the capacity to form both sensorimotor and analytical representations. Sensorimotor representations are based on kinaesthetic and visual information which is then formed into a perceptual depiction of a physical object, or utilised as motor schemas to drive behaviour. These representations are the result of procedural learning and the schemas they create are not accessible to conscious thought. The second mechanism abstracts information from the stimuli and condenses it into one or more simple concepts which can then be stored and utilised in the future. These concepts result from attentive and conscious processing of information and require a degree of active analysis and learning. Infants are thus regarded as agents of their own cognitive construction rather than passive recipients of information, or physical beings driven solely by perceptual and motor learning.

Even in young children, recognition of physical equivalence engenders a degree of abstraction, in that category members are expected to behave in fundamentally the same way. The observation of dogs eating or dogs barking, fosters assumptions that all other dogs share these

traits (Rakison & Poulin-Dubois, 2001). Hence a conceptual web, which incorporates both physical and abstracted or inferred information, begins to form.

It has been suggested that the absence of language in early childhood has misled adults to assume that this denotes an absence of understanding. In an antithetical proposition to the Whorfian hypothesis, Mandler (2004) proposes that the innate human desire to create categories originates first and provides the basis on to which words are then mapped. Words and concepts subsequently work to complement and enrich one another; older infants are better able to identify category members when they share a name than when they simply share characteristics (Graham & Kilbreath, 2007). As linguistic ability increases, the mental lexicon expands; lexical concepts are thus available for retrieval by different means, thus improving their accessibility and usage.

1.10. Developments during the Pre-School Period

Whilst categorisation in infancy has been the subject of considerable research interest in recent years, the pre-school period has garnered far less attention. Interest in children's spontaneous categorisation choices (Bjorklund & Jacobs, 1985; Fang, Fang & Xi, 1991; Olmsted, Parks & Rickel, 1970) abated at the turn of the century as the focus shifted towards specific elements of categorisation behaviour such as the use of taxonomic / thematic criteria (Blanchet, Dunham & Dunham, 2001; Blaye, Bernard-Peyron & Bonthoux, 2000) the impact of similarity (Diesendruck, Hammer & Catz, 2003; Sloutsky, 2003) or the importance of stereotypical beliefs (Hayes, Foster & Gadd, 2002). In recent years there has been an increasing desire to establish a trajectory for all typically developing children and to isolate how all children can be enabled to achieve these norms (Badger & Shapiro, 2015; Badham & Maylor, 2015; Chow & Conway, 2015; Gleason, 2014; Liu, Song & Seger, 2012; Soto, Waldschmidt, Helie & Ashby, 2013).

The pre-school period is notable as a time of rapid and substantial language development, so it is unsurprising that many testing techniques harness children's new found productive or comprehensive vocabulary. Novelty-preference techniques remain relatively common with verbal labels replacing the gaze or touch patterns of infant testing. Other researchers have analysed lexicons (Smith, Colunga & Yoshida, 2003), linguistic extensions and overextensions (Mervis, Pani & Pani, 2003) and labelling techniques (Gelman & Markman, 1986, 1987) as a means of investigating children's use and understanding of categories.

Match-to-sample tasks (which were initially devised during the era of behaviourism before being expanded for use in cognitive test-batteries in the 1980s), remain the procedure of choice for the majority of researchers (Blaye, Bernard-Peyron & Bonthoux, 2000; Diesendruck, Hammer & Catz, 2003; Fang, Fang & Xi, 1991; Gelman & Markman, 1986; Liu, Song & Seger, 2012; Scheuner, Bonthoux & Cannard, 2004; Yao & Sloutsky, 2010). These tests provide participants with a category exemplar and a selection of items from which to select the most appropriate match. In the majority of instances, these utilise simple drawings (Fig. 1 provides an example from Duffy & Wishart, (1994) on the next page).

Figure 1: Category Exemplars adapted from Duffy and Wishart, 1994

Illustration removed for copyright reasons

As children age, their increased competencies are reflected in more demanding test procedures, often utilising techniques that have been widely and successfully used with adults. Thus, match-to-sample tests are inclined to utilise words and then written words instead of pictures as participants age. With children over the age of four years, it is also common to teach a concept and then examine the extent to which they are able to generalise their learning to other examples (Bonthoux & Kalenine, 2007; Deng & Sloutsky, 2015; Gelman & Davison, 2013). The efficacy and reliability of some of these testing mechanisms is discussed in Chapter 3 of this thesis.

Throughout this period of shifting research focus, the cognitive mechanics of categorisation have remained hotly contested. The majority of theoreticians and researchers have asserted that children move from reliance on perceptual features towards greater abstraction (French, Mareschal, Mermillod & Quinn, 2004; Mareschal, French & Quinn, 2000; Quinn, Eimas & Rosenkrantz, 1993), but a minority have maintained that unobservable conceptual properties play a role in categorisation judgements from infancy (Gelman, Coley, Rosengren, Hartman &

Pappas, 1998; Gelman & Davidson, 2013). Keil (1989; Keil & Batterman, 1984) proposed a staged process of change which he termed the "characteristic-to-defining shift", a perspective largely echoed by exponents of theory change (Carey, 1999; Inagaki & Hatano, 2002). He suggested that four-year-olds are more concerned with classifying items (he gave the example of a zebra) on the basis of relatively superficial aspects of appearance than seven-year-olds are. Murphy (2002), on the other hand, suggested that younger and older children necessarily have qualitatively different styles of categorisation as young children lack the world knowledge to classify on any basis other than perceptual qualities. Blaye, Bernard-Peyron, Paour & Bonthoux (2006) suggested that categorical flexibility emerges, and is evident in both children's natural categorisation behaviours and their responses to tests, when they are between five- and nine-years-of age. At the lower end of this age band, they noted that participants appeared unable to group items which are "the same sort of thing", an assertion which was echoed by Fang, Fang and Xi (1991) and Liu, Song and Seger (2012) who suggest that superordinate categorisation does not emerge until the sixth year.

Mandler (2003), however, proposes that whilst perceptual categories are formed as a natural part of the perceptual process, conceptual or thematic categorisation is able to draw on a whole range of different features which utilise sensory modalities. She subsequently contends that conceptual categories are more easily accessible to young children. Further indications of conceptual complexity amongst young children have emerged from research that suggests infants as young as nine months are able to classify on the basis of animacy (Poulin-Dubois, Lepage & Ferland, 1996) or biological needs (Mandler & McDonough, 1996). Using an eye-tracking study (albeit with a small sample), Yao & Sloutsky (2010) discovered that three- and four-year-olds were unable to inhibit attention to perceptual features even though they were behaviourally able to do so at the older end of the spectrum. This raises the possibility that the apparent reliance on perceptual features noted by some researchers may be attributable to the immaturity of selective attention which renders visual similarities more salient. The more information participants need to inform their choices, the higher the demand on executive function and working memory.

The exponential rise in research interest and the insights offered by increasingly sophisticated techniques, have served to extend psychological conceptions of cognition, memory and categorisation. The pervasive use of the hypothetical-deductive model means that, whilst there have been few unequivocal conclusions, researchers have inched ever closer to an understanding of structure, function and developmental norms. In many instances, intellection

has proved cumulative, or emerged from the melding of disparate perspectives and diverse disciplines. The research documented in this thesis thus draws on an array of previous work within cognitive science but attempts to quantify the impact of some previously untested intrinsic and extrinsic factors, certain of which are rooted in developmental theory or in education. It is intended that this will augment what is already known about the emergence and embedding of categorisation and key factors influencing and regulating the process.

1.11 Summary

This chapter has considered some key theoretical perspectives relating to cognition and automatic processing, paying particular attention to schemata and categorisation. Early attempts to explain the cognitive organisation of categories by means of a hierarchical model (Collins and Quillian, 1969) were widely regarded as being flawed and unsubstantiated, whilst Collins and Loftus' Spreading Activation Model (1975) is now considered to be both simplistic and neurologically inaccurate. Current thinking favours a hub-and-spoke-model (Patterson, Nestor & Rogers, 2007) although research is still in its infancy.

Theories regarding concept acquisition and activation have proved equally controversial. The Classic View is widely regarded as being fatally undermined by arguments pertaining to fuzzy concepts, intransitivity and definitional ambiguity. Similarly, whilst both Typicality or Prototype Theory (Rosch, 1973, 1975) and Exemplar Theory have attracted considerable attention, they are now regarded as being knowledge-lean and lacking generalisability. Current thinking favours a hybrid model because, as Mandler (2004) concludes, it is unlikely that categorisation is reliant on a single process.

Historically, categorisation research with infants has utilised a novelty-preference technique. The innovative research techniques utilised by Mandler and colleagues (e.g. 2004) have demonstrated that rudimentary categorisation emerges in early infancy and that, whilst infants tend towards cognitive economy, they implement a range of strategies. The pre-school period has garnered far less research attention in recent years. However, novelty-preference and behaviourist-inspired match-to-sample tests have continued to find favour amongst researchers. These tests have indicated a progressive move from reliance on perceptual features towards abstraction and thematic categorisation when the child is around six-years-old.

Previous researchers have suggested play to be a causal executant in cognitive development, although there has been little attempt to investigate the association between play and

categorisation per se. The next chapter therefore considers the nature and attributes of play and explores whether playful activity may feasibly contribute to the development of categorisation in early childhood.

Chapter 2

Play

2.1. Chapter Overview

The role of play in cognitive development had not been foreseen as a facet of the research, however, as the unfolding picture suggested it as both a potential causal executant in the evolution of categorisation and also as a means of counteracting some of the educationally detrimental effects of deprivation. Whilst the relationship between, for instance, pretend play and social cognition is generally affirmed to be self-evident (Kelly & Hammond, 2011, Xu, 2010), there is lesser agreement regarding its impact on cognitive functions such as reasoning, memory and attention. This chapter therefore considers the nature, development and functions of play and playful activity in childhood and examines its contribution to cognitive development. As no previous researchers have explicitly investigated the relationship between play and the development of categorisation, the chapter examines empirical evidence concerning possible cognitive links and considers points of apparent developmental contiguity. Consideration is also given to current educational ideology and pedagogical practice regarding play in Early Years education and to the assertion that guided play or playful learning (Hirsh-Pasek, Golinkoff, Berk & Singer, 2009) provides a viable middle ground between the strictures of didactic instruction and the latitude of free play.

2.2. Play Theory and Research: Background Information

The more intricate and protean an organism, the longer is its period of vulnerability and reliance (Bjorklund, 2006). The period of immaturity in human beings (generally held to be the developmental stages prior to sexual maturity) is therefore longer than in any other species (Cameron & Bogin, 2012; Rayner, Joyce, Rose, Twyman & Clulow, 2005). It has been widely claimed that this protracted childhood is adaptive, as an extended supportive instructional period safeguards the young whilst also allowing time to prepare them for their potentially dangerous and demanding adult responsibilities (Pellegrini, Dupuis & Smith, 2007). In the majority of vertebrates, including humans, much of juvenility is given over to a heterogeneous mix of unconstrained and adult-guided play activities (Sutton-Smith, 1997). These support the

development of motor coordination and physical dexterity (White, 2013) whilst also introducing productive activities (Bock, 2005) and required norms (Schmidt & Tomasello, 2012). This loose configuration of play activities further allows the young to explore their environment and enact new behaviours without undue risk or cost. The incidence of play in all sexually-reproducing species has thus led to claims that play is also adaptive (Auerbach, Kanarek & Burghardt, 2015; Durand & Schank, 2015), providing the young with skills that are requisite to health, survival and successful social integration. Bruner (1972) further extended this argument, postulating that the development of higher-order skills in primates is largely attributable to the development of cognitive flexibility in play.

Urbanisation (Thompson & Philo, 2004), social changes (Evans 2004; Livingstone 2006) and the increasing strictures of early years' education (Chitty, 2014), have served to reduce opportunities for free play (Whitebread, Basilio, Kuvalja & Verma, 2012). Simultaneously, technological developments (Wooldridge & Shapka, 2012), the loss of play spaces (Children's Society, 2006; Dunn, Moore & Murray, 2004) and parental anxiety (Boyd, Lee & Holt, 2013) have progressively changed its nature. Sections of the public, some educators and members of the academic community (Gleave & Cole-Hamilton, 2012), have expressed concern at the current trajectory, provoking an increase in awareness-raising (e.g. Play England and the Save Childhood Movement) and interest in childhood play. The resurgence of debate around play has generated something of an attitudinal polarisation regarding how it is perceived and the manner in which it should be capacitated within the Early Years curriculum (Brock, Dodds, Jarvis & Olusoga, 2009; DfE, 2014; Drake, 2014; Stirrup, Evans & Davies, 2016). The following section attempts to contextualise current thinking and practice by detailing the evolution of play theory and exploring how developments within psychology have shaped research into children's play.

2.3. Historical Perspectives

Whilst there have clearly been exceptions and variations, certain patterns have been apparent in play research. This section seeks to outline and contextualise these trends.

Prior to the mid-1700s, children in Britain were raised predominantly in extended family groups located in rural communities. From an early age they were encouraged to help with chores, meaning that any play activities were centred on these tasks and the materials they required. The Industrial Revolution increased urbanisation, fragmented the family and created a chasm between rich and poor (Hopkins, 2000). Whilst moneyed children had an option on

play and education, working class children faced greater constrictions, often working long hours with limited opportunities for free expression (Humphries, 2011). During this period, adult perceptions regarding the necessity of play therefore incorporated broad dismissal (often from those who reaped the benefits of child labour), and strongly-worded advocacy from reformists (Kirby, 2003). Thus, whilst Froebel (1782-1852) proposed "Play is the highest expression of human development in childhood, for it alone is the free expression of what is in a child's soul"; the eighteenth-century philosopher Schiller (1759-1805) countered with the suggestion that play's only value was as an outlet for children's excessive energy. This idea was popularised by Curtis (1916) in the *surplus energy theory*, reflecting the position of early psychologists such as Herbert Spencer (1855). It was, however, decisively condemned by other prominent theorists including Groos (1861-1946) and Erikson (1903-1994). These early advocates of play proposed that it developed skills and allowed children to practice social situations in preparation for adult life. Groos (1901) and Isaacs (1885-1948) further postulated that play was "critical" in shaping social, emotional and cognitive development – a notion that was to influence and shape both Piaget's (1962) and Vygotsky's (1967) later theories. Interest in pretend play as a specific format emerged in the 1920s when Parten (1932, 1933) began using naturalistic sampling methods to observe children during group play situations. Initial findings were included in academic writing about child development, leading Isaac (1929, p210) to propose that "play is indeed the child's work, and the means by which he grows and develops". Parten's (1932) subsequent taxonomy of social interaction introduced the notions of solitary and parallel play, providing a foundation for many later developmental perspectives.

The emergence, during the 1940s of personality theory and play therapy, further increased interest in the social and emotional benefits of play, a trend which was enhanced by Piaget's observations regarding his own children's play. Piaget echoed Mead's (1934) belief that interaction during play develops perspective taking, as peer responses cause children to see themselves as others see them. The child is thus exposed to their "looking glass self" (Cooley, 1902; Shaffer, 2005) and begins to understand them self as both subject and object.

The following decades were largely dominated by the work of a handful of key theorists. Piaget (1962) and Smilansky (1968) developed Parten's (1932) nascent theories, each postulating a form of genetic epistemology wherein the interaction between child and environment enables progression through a series of stages. Piaget proposed that children generally utilise their existing scripts and frameworks (in a manner he termed *assimilation*) even when dealing with new or novel situations. However, if these frameworks prove non-functional, a process of

equilibration and accommodation is required in order to amend existing notions or formulate new ones. Whilst Piaget recognised the importance of play, he regarded it primarily as a means of compounding assimilated concepts, rather than a learning mechanism liable to result in accommodation. For Piaget, play is thus a mark of immature cognition which is yet to fully grasp reality (Lilliard, 2012).

Vygotsky was primarily interested in understanding "higher" mental processes (such as voluntary attention and memory) rather than focussing on those aspects more closely linked to phylogenetic development (Wertsch, 1985). In looking beyond involuntary processing, he recognised that many of the processes which set humans apart use cultural tools to transmit cultural norms from adults to children. Such transference is necessarily conducted within a social context. Bruner similarly emphasised the social nature of learning and the importance of active support through "scaffolding" (Wood, Bruner, & Ross, 1976). The concept has achieved prominence within several teaching ideologies (for instance Reggio Emilia), often in conjunction with notions of guided play or playful learning (Hirsh-Pasek, Golinkoff, Berk & Singer, 2009).

A key tenet of Vygotsky's theories is the Zone of Proximal Development (ZPD) which he defined as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined by independent problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p86). He suggested that optimal functionality was achieved if the process guided children through the manipulation and internalising of new ideas. This, he believed, was most likely if they were actively engaged in a joint activity which utilised their intrinsic interests and motivations and incorporated both verbal and non-verbal communication. Each of these criteria are met when children play with another who is more skilled in terms of experience, knowledge and understanding. This knowledgeable other can be either a proficient peer or an adult. Vygotsky (1967) therefore advocated play as the optimum means of enabling children to actualise their ZPD. He wrote "In play a child is always above his average age, above his daily behaviour; in play it is as though he were a head taller than himself" (Vygotsky 1967, p 552).

The 1970s saw an increased interest in pretend play, specifically its stages, and the use of object substitutions and the application of agency (Rosenblatt, 1977; Watson & Fischer, 1977). The role of pretend play in developing language (Bates, Benigni, Bretherton, Camaioni & Volterra, 1977; McCune-Nicolich, 1981) and cognition (Saltz, Dixon & Johnson, 1977; Smith & Dutton,

1979) were also subject to inchoate investigation. However, methodological difficulties and weaknesses undermined a number of studies (Rubin, Fein & Vandenberg, 1983; Smith, 1988). Thus compromised, interest in pretend play diminished and faltered for a time.

The late 80s and early 90s witnessed the emergence of some influential new psychological perspectives and research methodologies including Pinker's (1991/1994) language acquisition hypothesis, behavioural genetics (Loehlin, 1992; Scarr, 1986) and the rise of neuroimaging through positron emission tomography (Posner & Raichle, 1994). Together they offered a new slant on the old nature-nurture debate and innervated developmental research. With regard to play, interest focussed on its potential contribution to cognitive development (Fischer, 1992; Kim, 1999; Krafft & Berk, 1998) and skill acquisition (Roskos & Neuman, 1998; Stone & Christie, 1996) as part of the broader discussion on the relative importance of environmental influences.

The 1988 Education Act laid the groundwork for the National Curriculum and the introduction of Standard Assessment Tests (SATs). This was later mirrored in America's Standardized Tests (U.S. Department of Education, 2008). The resultant emphasis on evaluating English, Mathematics and Science abilities and the clear disparities in performance the tests revealed, promoted widespread debate regarding learning and potential means of accelerating progress (Byrne & McGavin, 2004; Drummond, 2003) in both Britain and America. The increasingly didactic nature of Early Years Education (Singer & Singer, 2006; Broadhead, 2009) similarly led many play researchers to focus on intellectual development (Cheng and Johnson, 2010) in order to better understand its educational benefits. Whilst some researchers considered generalised enhancement (Alfieri, Brooks, Aldrich & Tenenbaum, 2011; Gmitrova, Podhajecka & Gmitrova, 2009; Wallace & Russ, 2015), others focussed on specific components including maths (Nath & Szucs, 2014), problem-solving (Russ, 2003), language (Orr & Geva, 2015) and cognitive competencies (Uren and Stagnitti, 2009). However, some theorists, academics and practitioners have argued that the emphasis on accountability and measurable learning outcomes that is so apparent within current educational ideology not only restricts learning, it has also misinterpreted play (Bradbury, 2013; Weisberg, Hirsh-Pasek & Golinkoff, 2013) as the format on offer lacks the joy and spontaneity which characterise true play. Furthermore, it is asserted that play has an intrinsic value far in excess of pedagogical fashions (Bartlett, 2011; Dent, 2013; Hewes, 2006; Whitebread, Basilio, Kuvalja & Verma, 2012) and to manipulate it "instrumentalises" play (Kellett, 2010; Lester & Russell, 2008) and

ignores its true value. The role and enactment of play in educational settings is considered in greater detail later.

2.4. Definitions and Hallmarks of Play

The majority of modern definitions continue to circumvallate the influential theories of Parten (1932), Piaget (1962), Smilansky (1968) and Vygotsky (1978) (Bartlett, 2011; Broadhead, 2009; Nicolopoulou, Barbosa, Ilgaz & Brockmeyer, 2010; Xu, 2010). However, as research into play has emerged from such an extensive range of theoretical perspectives and employed such disparate methodology, there is limited accord regarding definitions, delimitation and developmental progression (Fagen, 1981; Garner & Bergen, 2006) with much appearing determined by the research's agenda and objectives (Bartlett, 2011; Cheng & Johnson, 2010; Dent, 2013). Several attempts have been made to synthesise and simplify definitions (Rubin, Fein and Vandenberg, 1983; Spinka, Newbury & Bekoff, 2001), resulting in broad agreement concerning some key characteristics of childhood play. These are outlined below.

- Play is spontaneous, free from externally imposed rules, inducements or sanctions and from expectations of compliance with social demands. It is intrinsically motivated with self-imposed goals. Its concerns are of the moment rather than determined by prospective results.

- Whilst play may comprise representations of serious behaviours or have legitimate learning outcomes, it is not intended as a serious portrayal of the activity or practice it depicts. The enactment is inclined towards exaggeration, with voices, movements and narrative content all being subject to elaboration and amplification (Pellegrini & Smith, 2002).

- Play involves active engagement (and is thus discernible from aimless puttering).

2.5. The Development of Play Behaviours

As there has been a paucity of research looking explicitly at the relationship between play and categorisation, the current researcher has extrapolated information regarding facets of categorisational behaviour (such as relational patterning) and/ or requisite cognitive skills, and

attempted to map them on to acknowledged developments in play behaviours. This has been done in order to highlight points of apparent contiguity and consider whether it is theoretically plausible that developments in children's play behaviours may conduce or reflect developments in cognition that would link to the emergence of categorisation.

From the first weeks of life, children are encouraged to become involved in play activities by the adults who care for them. Early play behaviours are necessarily individual and repetitious, with games of tickle, peek-a-boo and give-and-take being the most common. Throughout the course of the first year, motor control grows incrementally with children gradually learning to manipulate objects, leading to a period during which most play activities are object-centred. Whilst items are initially grouped or utilised indiscriminately (for instance a spoon and a train may form the components of a "game"), as categorisation becomes increasingly refined (Bornstein, 2006; French, Mareschal, Mermillod & Quinn, 2004; Mareschal, French & Quinn, 2000; Quinn, Eimas & Rosenkrantz, 1993), objects are accessed and used in traditional relational patterns. At this point the spoon goes into the teacup and the train goes on the track. This behavioural shift reflects the infant's growing social awareness (Trevarthen, 2015) and suggests cortical development has reached a level which supports nascent planning ability and organisational capacity (Chau, Synnes, Grunau, Poskitt, Brant & Miller, 2013; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014; Raznahan, Greenstein, Lee, Clasen & Giedd, 2012). Responsive toys which pop-up, pop out or respond to the pushing of a button and the pulling of a string are particularly favourites towards the end of the first year and help to dispel any lingering uncertainty regarding object permanence (Baillargeon, 1986; Piaget, 1896-1980). Symbolic play emerges, in its most rudimentary form, at about this time. Whilst theoretical viewpoints vary (Bialystok, 1992; Mandler, 1992; Palacios & Rodriguez, 2015; Piaget, 1952), making it difficult to pinpoint a precise time, it is clearly contingent upon the possession of certain cognitive abilities such as representational and symbolic thought, which places it between nine to thirteen months (Bates, Benigni, Bretherton, Camaioni & Volterra, 1979; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014). Initially, it retains the solitary, object-focussed nature of earlier stages but gradually develops, as part of the process of decentration (Fenson & Ramsey, 1980; Lowe, 1974; Watson & Fisher, 1977) to involve dolls or soft toys and then other people. As such, it demonstrates the child's evolving shift from regarding the self as sole agent to using another object (e.g. a doll) or person as the agent of the play (Gillespie, 2012).

This interest in others, particularly other babies, begins early. Interactions are initially limited to a look but gradually develop into the exchange of smiles and then of objects. By the second year of life, children are able to engage in the sort of complementary and reciprocal social behaviours that form the foundations of social interaction and allow cooperative play to emerge at around fifteen months (Muller & Carpendale, 2004). In order to fully engage in coordinated role play, individuals must have the facility to recognise themselves as separate, rather than symbiotic beings. Whilst some semblance of imaginative symbolic play emerges during this second year (Fein, 1981; Howes & Matheson, 1992; Howes, Unger & Seidner, 1989), it is not until the child has an operative Theory of Mind that true reciprocity is possible with playmates. Thus, by the time of the child's second birthday, pretend play is usually well established (Bates, Benigni, Bretherton, Camaioni & Volterra 1979; Bretherton, 1984; Dunn & Wooding, 1977; Fein, 1981; Nicolich, 1977; Tamis-LeMonda & Bornstein, 1991). However, at this stage it is generally conducted in parallel, with the main focus being the manipulation and exploration of objects (Vondra & Belsky, 1989). The emergence of pretend play occurs universally when children are aged between eighteen and twenty-four months old, regardless of whether it has been modelled or actively discouraged, fostering claims that it is innate and adaptive (Carlson, Taylor & Levin, 1998; Gaskins,1999; Taylor & Carlson, 2000).

In the third year, children's mastery over their environment increases substantially and their choice of play behaviours moves from repetitious, to individual and creative. This is the age of play dough, finger paints, building blocks, creatures and dolls. Their pretend play shows an increasing awareness of social roles (Howes, Unger & Seidner, 1989) and an ability to combine sequences of play in order to enact social situations (Hughes, 1991). Thus, whilst play retains some vestiges of earlier stages, for instance in the use of symbolic tools, they are utilised in an increasingly sociable manner (Fromberg & Bergen, 2006).

True socio-dramatic pretend play emerges when the child is around four years old, although it may be apparent earlier if the child has a more proficient playmate such as a parent or older sibling (Dale, 1989; DeLoache & Plaetzer, 1985; Dunn & Dale, 1984; Fiese, 1990; Haight & Miller, 1993; Kavanaugh, Whittington & Cerbone, 1983; Miller & Garvey, 1984; O'Connell & Bretherton, 1984; Farver & Wimbarti, 1995). Imaginative pretend-play thus peaks during the late pre-school period and declines as children approach six (Fein, 1981; Kelly and Hammond, 2011; Rogers, 2008; Singer and Singer, 2006).

It can be seen that as children develop, their play becomes more flexible and creative. It evolves from the exploration of the sensory properties of objects to simple repetitive play and from there to relational and constructive play with objects, to functional play, and finally to play that is symbolic in nature (Piaget, 1962; Smilansky, 1968). As Garner and Bergen (2006, p126) note "As significant developmental changes occur during the first four years of life in children's social, emotional, physical and cognitive domains, concomitant progressive changes occur in play".

2.6. Play and Gender

Whilst research into sex differences in play once proliferated, investigations have now waned. Consequently, there is relatively little reliable contemporary research into male and female play behaviours, making it difficult to ascertain to what extent historical asymmetries hold true in a changing society. Influential others such as peers (Fabes, Hanish, Martin, Moss & Reesing, 2012; Mulvey & Killen, 2014), parents (Caldera, Huston and O'Brien, 1989, Endendijk, Groeneveld, van Berkel, Hallers-Haalboom, Mesman & Bakermans-Kranenburg, 2013; Fagot and Leinbach, 1991) and teachers (Chapman, 2015) all affect the timing and intensity of the gender identification process and the incidence of gender conformist play.

During the toddler period, fathers initiate more play episodes with infants than do mothers (Clark-Stewart, 1977); fathers encourage toddlers to engage in symbolic play, although the themes fathers use differ stereotypically with boys and girls (Farver & Wimbarti, 1995). Parents are inclined to buy gender-traditional toys for their children (Etaugh and Liss, 1992). Girls are thus provided with dolls and toys directed towards domestic activities, whilst boys receive a greater range, including more educational toys which orientate their focus outside the home (Parsons and Howe, 2006). Parents also tend to select gender-stereotypic toys when interacting with their children (Eisenberg, Wolchick, Hernandez & Pasternack, 1985) and the toys, in turn, shape the nature of the intercommunication. Masculine toys generally evoke less conversation, teaching and physical proximity (Caldera, Huston & O'Brien, 1989), whilst stereotypically female toys elicit greater levels of complexity (Cherney, Kelly-Vance, Glover, Ruane & Ryalls, 2003).The type of toys children are provided with subsequently does much to influence their perceptions of both their present and future self (Auster & Mansbach, 2012; Halim, Rubel & Tamis-LeMonda, 2013), for instance girls who play with Mrs Potato Head see

women as having far greater career options than those who play with Barbie (Sherman & Zubriggen, 2014).

Clearly, children's attitudes and beliefs are shaped not only by the items on offer, but also by parental attitudes and behaviours. Parental affective responses do much to shape play even amongst pre-verbal children, with gestures of approval or disapproval determining whether play continues or halts (Bandura, 1992, Feinman, Roberts, Hsieh, Sawyer & Swanson, 1992). Fathers also tend to engage in more physically rousing play, (roughhousing, tossing infants in the air and run and chase games) than do mothers (Hughes, 2009). Instead, mothers' play tends to involve a teaching component and to be more verbal than that of fathers. They spend more time naming objects, labelling and pointing than they do in physically active play (Hughes, 2009). Parents are more likely to encourage daughters than sons to engage in pretend-play (Gleason, 2005), with mothers being more likely than fathers to join in (Lindsey & Mize, 2001). Girls are therefore significantly more likely to participate in pretend-play than boys (Gmitrova, Podhajecka, & Gmiitrov, 2009). However, play is less stereotypical and less dichotomised amongst the adopted children of lesbian and gay parents (Goldberg, Kashy & Smith, 2012).

Who and what children play with also changes in accordance with their level of gender awareness. Leinbach and Fagot, (1986) found that two-year-old boys who could provide accurate gender labels for people in photographs rarely played with dolls, but those who were unable to provide gender labels played with dolls at a rate roughly equal to girls. Similarly, children who could accurately label headshot photos were more likely to have same sex playmates (Fagot, Leinbach & Hagan, 1986). However, contradictory research evidence (Caldera, Huston & O'Brien, 1989; Maccoby, 1998) raises questions regarding the direction of influence, as it is equally plausible that having same-sex playmates fosters gender awareness, as it is that awareness precipitates segregation (Ayres, Khan & Leve, 2006). Once children reach school age, they are heavily inclined to maintain gender group boundaries; girls who attempt to join a boy's play group are generally ignored, whilst boys who attempt to join in with girls' play are frequently ridiculed by both males and females (Fagot, 1989). When children cluster into same-sex groupings, girl groups are usually more socially skilled than all-boy groups (Serbin, Moller, Powlishta & Gulko, 1991). However, socially skilled children generally choose to play with other socially skilled children (Fabes, Hanish, Martin, Moss & Reesing, 2012); it is therefore possible that early gender segregation during play is determined by behavioural style rather than toy or activity preferences. As dramatic play increases during

the pre-school years, boys are more likely to focus on dangerous or heroic themes, whilst girls engage in more family-focussed play (Anggard, 2011).

2.7. Play and Socio-Economic Status

For reasons of parental health (Chen & Miller, 2013; Williams Shanks, 2007), education (Office of National Statistics, 2014) and working hours (Barnardo's, 2007; Hill & Ybarra, 2014), children from homes with lower SES generally experience less parental involvement during the pre-school period (Bornstein & Bradley, 2012; Evans, 2004; Hoff, 2003) including lower levels of interactive play (Dilworth-Bart, Poehlmann, Hilgendorf, Miller & Lambert, 2010). A lack of money in the home usually also means that children have less toys and less educative experiences (Snook & O'Neill, 2010; Stirrup, Evans, & Davies, 2016; Trawick-Smith, Wolff, Koschel & Vallarelli, 2015). A lack of money in the neighbourhood is associated with an absence of play facilities and increased levels of crime (Gottfried, Gottfried, Bathurst, Wright-Guerin, & Parramore, 2012; Van Ham, Manley, Bailey, Simpson & Maclennan, 2013). As a result, parents are less likely to allow their children to play outside, having genuine (and often well founded) fears for their safety (Children's Society, 2009; Hooper, Gorin, Cabral & Dyson, 2007). The area surrounding Cohort 3 (see Chapters 5 & 6), for instance, is ringed by several busy major roads and is the worst area in the authority for fouling, needles, violence and crime.

Children from lower SES families have more screen time than their middle class peers (Stamatakis, Coombs, Rowlands, Shelton & Hillsdon, 2014). This includes an increased likelihood of televisions, DVD players, iPad and gaming facilities in their bedrooms (Tandon, Zhou, Sallis, Cain, Frank & Saelens, 2012). Lower SES families also hold television in higher regard than do the middle classes and consequently spend more time watching television programmes and videos as a family (Tandon, Zhou, Sallis, Cain, Frank & Saelens, 2012). Low-income parents are less likely to value play or believe it to be associated with academic development (LaForett & Mendez, 2016). These parental attitudes further impact children's play opportunities (Gustafson & Rhodes, 2006). Children living near the poverty threshold spend less time in physical play (Stone, Faulkner, Mitra, & Buliung, 2014) and are more likely to suffer from adiposity, obesity (Faulkner, Bluing, Flora & Fusco, 2009), respiratory problems (Twisk, 2001) and a range of associated health problems (Loprinzi, Cardinal, Loprinzi & Lee, 2012).

Children from low SES homes thus have less opportunities to engage in both indoor and outdoor play, have less guided play with adults but have more screen time.

2.8. Types of Play

Over the years, various attempts have been made to delineate forms of play. Some have based their criteria on the quality of play (Bruce, 1991) its developmental associations and stages (Moyles, 1989, 2015; Smilansky, 1968) or its defining features (Burghardt, 2005; Fagen, 1981; Groos, 1901, Hughes, 2002, 2011). Modern theorists generally contend that there are five dominant forms - physical, symbolic, object-centred, pretend (or socio-dramatic) play and games with rules. However, it is recognised that the myriad overlaps create a gamut of potential sub-divisions (rough-and-tumble play, for instance, comprises both locomotor and social aspects, and play with objects can either be symbolic or sociable). The major defining features of each form are briefly detailed below.

Physical Play involves running, jumping and rough-and-tumble. It may be solitary or comprise a social element.

Symbolic play involves a deliberate distortion of reality in play (Fein, 1981; Jarrold, Boucher & Smith, 1993), when children act 'as if something is the case when it is not' (Leslie, 1987, p. 413), even though they are generally well aware that it is all fabrication (Wellman & Estes, 1986). Leslie (1987) contends that there are three fundamental forms: the substitution of one object for another, the attribution of absent/false properties, and the imagination of absent objects. However, it is generally accepted that this description is too narrow as symbolic play can also involve the attribution of animacy (Jefree & McConkey, 1976; Lillard, 1993; Watson & Fisher, 1977), and role-play (Brown, Prescott, Rickards & Patterson, 1997).

Object-centred play focusses on the properties of items or on their manipulation. Toys or other items may be used in a symbolic or representational manner.

Socio-dramatic play reflects, explores and develops understanding of life experiences and also the second-hand experiences offered by stories and the media in popular culture. It may therefore involve aspects of role play, in that children may imitate the actions or characteristics of another individual. Socio-dramatic play invariably involves interaction with one or more partners and is sustained for more than ten minutes, usually with an on-going theme or story which is verbalised between the participants. Within play, roles may be negotiated or swapped

in order to sustain the play; thus the protagonist may become the antagonist and the victim the aggressor. Whilst older children are inclined to build their socio-dramatic play around fantasy or media characters, pre-school children tend to enact familiar scenarios "of an intense personal, social, domestic or interpersonal nature [which] involves plots, props and roles" (Moyles, 2012 p134). The majority of scenarios are therefore based around the home and family.

2.9. Play in Early Years Education

2.9.1. Play and the Early Years Foundation Stage

As noted in 2.3, The 1988 Education Act prepared the way for the National Curriculum and Standard Assessment Tests (SATs); a move that was mirrored in America. The subsequent emphasis on measuring English, Mathematics and Science abilities and the discrepancies revealed by the tests, ignited both political discussion and academic interest on both sides of the Atlantic (Byrne & McGavin, 2004; Drummond, 2003). Since 2010, the prevailing educational ideology in England has been motivated by a belief that standards are below those of other countries (DfE 2010b), that expectations are too low (DfES, 2014a) and that changes are necessary in order to improve outcomes for all pupils. Consequently, a pedagogic recontextualising (Bernstein, 1975) within the Early Years has replaced child-centred approaches (Rogers & Lapping, 2012) with "too much formality, testing and assessment, as government ministers in England have, with increasing persistence, viewed it simply as preparation for school" (Stirrup, Evans & Davies, 2016 p1467). This has resulted in the introduction of measures such as baseline testing in the reception year and more rigorous assessment of traditional skills and knowledge throughout the years of compulsory schooling (DfES, 2014b). However, it has been argued that young children's apparent failure at school (DfE 2010b), is a reflection, not of their abilities, but of an irrelevant, imbalanced and imposed curriculum that fails to harness their natural interests and enthusiasm (Whitebread, 2012). Furthermore, the undue emphasis on literacy and numeracy favours girls (Eriksson, Marschik, Tulviste, Almgren, Pereira, Wehberg & Gallego, 2011; Goldin-Meadow, Levine, Hedges, Huttenlocher, Raudenbush & Small, 2014; Gopnik & Meltzoff, 1987; Gopnik & Meltzoff, 1997; Schaadt, Hesse & Friederici, 2015) and children from middle-class backgrounds (Fernald, Marchman & Weisleder, 2013; Mensah & Kiernan, 2010; Save the Children, 2014).

For Preschool and Nursery Units such as those utilised in this research, The Statutory Framework for the Early Years Foundation Stage (EYFS) (DfE, 2014) provides mandatory guidance regarding the areas of learning and development which must underpin all activities and experiences. It recognises that:

> Play is essential for children's development, building their confidence as they learn to explore, think about problems, and relate to others. Children learn by leading their own play, and by taking part in play that is guided by adults. There is an ongoing judgement to be made by practitioners about the balance between activities led by children, and activities led or guided by adults. Practitioners must respond to each child's emerging needs and interests, guiding their development through warm, positive interaction. As children grow older, and as their development allows, it is expected that the balance will gradually shift towards more activities led by adults, to help children prepare for more formal learning, ready for Year 1. (DfE, 2014, p 9)

However, despite decades of research and theoretical musing, the complex and multi-facetted nature of play has rendered it impervious to anything approaching definitional precision. The EYFS is thus unclear in its guidance as to what "play" comprises, leaving provision and enactment open to the interpretation and potential vagaries of individual settings or practitioners (Rogers, 2011; Powell, 2008). It is clear from the above quotation, however, that children are expected to move progressively from autonomous and self-directed play towards acceptance of increasing guidance and instruction in preparation for formal learning. Furthermore, the pervasive motif throughout EYFS documentation is an endorsement of play that is purposeful and instructive rather than spontaneous and unbridled (Rogers & Evans, 2008). For some, this is emblematic of a false dichotomising of work and play within education (Hirsh-Pasek, Golinkoff, Berk & Singer, 2009; Kochuk & Ratnaya, 2007; Thomas, Howard & Miles, 2006). In a system increasingly driven by assessment and standardisation (Singer, Singer, Plaskon & Schweder, 2003), it is perhaps unsurprising that in many instances, evaluation of play provision relies on observational data focussed on the actions, rather than the intentions of the child (Howard, Bellin & Rees, 2002). Within this, attempts are made to delineate and classify actions according to pre-determined (and adult-specified) criteria, instead of considering the motivations and intentions of the child. However, a child instructed

by a teacher to colour a shape, may regard it as work, whereas for the child who has selected to colour, it is play. Furthermore, if the educational benefits of the "play" achieve centrality, children's autonomy and pleasure in the activity – the very features that make it "play", are liable to get lost (Lepper & Henderlong, 2000; Singer, 2013). Play and playfulness, it may therefore be argued, is a construct and not merely an act (Hirsh-Pasek, Golinkoff, Berk, & Singer, 2009). In order to be truly classified as play, it must carry the hallmarks of intrinsic motivation, engagement, and spontaneity mentioned in 2.4.

As the field work for this thesis was all conducted in Nursery and Preschool units under the auspices of the Department for Education, they were all governed by the Early Years Foundation Stage Statutory Framework. However, during the two years that the researcher was visiting Cohorts 1-3, a very marked difference in interpretation was apparent. The Cohort 1 Nursery, being attached to a Primary School, was subject to the same "inevitable downward pressure… to teach formal literacy and numeracy lessons to prepare children for KS1" (Whitebread & Coltman, 2014, xxv) that is experienced by many nurseries in this position (Lillard, 2013: Zigler & Bishop-Josef, 2004). During the two years the researcher was visiting, every morning and afternoon session included time spent in small groups (segregated according to ability), working on number or pre-reading skills with a member of staff. The remainder of each session comprised periods of directed, guided and free play; "wiggle and jiggle" and some whole group time. (Appendices "James" and "Kamaya" provide an illustration of the daily routines observed by the Nursery and witnessed by the researcher during each of the many visits she made there). Cohorts 2 and 3 conversely, concentrated on guided play or playful learning (Hirsh-Pasek, Golinkoff, Berk, & Singer, 2009), with no formal, taught literacy or numeracy sessions being observed in either setting at any point over the two years (Appendices for "Makayla", "Nolan", "Sam" and "Scarlett" are provided to illustrate the approach adopted by Cohort 3). It is therefore these differences in how play is perceived, resourced and supported within Nursery and Preschool Units that will inform the remainder of this chapter.

2.9.2. Playful Learning

As previously noted, within the EYFS, practitioners are at liberty to determine the extent of their involvement in children's play and, as a result, provision varies from simply enabling autonomous free play, to imposing very structured direction. This continuum is generally reflective of the differing philosophical notions of childhood and learning, from a

predominantly constructivist "whole-child" approach (Hirsh-Pasek, Golinkoff, Berk & Singer, 2009), to more empiricist notions of the child as an "empty vessel" needing to be filled with information (Kagan & Lowenstein, 2004). The concept of "playful learning" or "the playful approach" is frequently (and some would argue, erroneously) mentioned in association with Montessori education but has garnered an enthusiastic following amongst a range of Early Years practitioners (Broadhead & Burt, 2012; Stewart, 2011; Walsh, Sproule, McGuinness & Trew, 2011; Wood, 2013). Guided play and Montessori education both contain an element of structure, emphasise the individual and eschew extrinsic reward. However, Montessori utilises structured materials, each of which requires a specific form of interaction (Lillard, 2013). Montessori education is also notable for the absence of pretend play activities and the rejection of any "imposition of adult fantasies" (Montessori, 1997, p47) from object substitution pretence to Santa, and for its description of all activities as "work" rather than "play".

Lillard (2013, p 157) explains guided play thus:

> "Along a line running from free play (in which the children play independently), through guided play (where an adult oversees and gently directs – or scaffolds - their play), to didactic instruction (where a teacher directly instructs children), playful learning occupies space between free play and guided play,"

2.9.3. Free Play

Free-play is characterised as being without intrinsic reward or oversight and may comprise any of the formats detailed previously (see 2.4). The following excerpt, taken from field notes during a visit to Cohort 3 exemplifies some of the features of free-play:

> "Olga has a baby doll in a buggy. Sam takes the baby, and then takes the buggy from her. He runs with the buggy, Lacey has a buggy too and starts to race him. Lana also joins in racing with a trolley. Karley takes over from Lacey and the racing continues". (Appendix Sam: Cohort 3)

2.9.4. Guided Play

This was the form of play observed primarily in Cohort 3. Future references to playful learning and guided play in that setting, refer to the types of behaviours and interactions explained here.

Guided play is shaped by the supervising adult in order to achieve specific ends and includes an assumption that children will seek adult knowledge and skills when they recognise a need (Saracho, 2012). The balance between child- and adult-initiated activities is therefore fluid and responsive to circumstantial exegesis (Wood, 2013). For instance, during another visit to Cohort 3, the field notes record the following example of guided play in which the adults scaffold and support learning but allow the child to lead and discover for themselves:

> "Saffron is pretending to be a baby and is crying again. Ms N asks what will make the baby happy. Saffron says she needs a rattle. Ms N suggests she could make one – Saffron goes inside to the craft table and tells Ms D she wants to make a rattle. Ms D suggest she should look for containers they could use to make a rattle. Saffron finds yogurt pots and Ms D says they will need things that could hold the pots together and things that would make a noise. Other children have also come inside – Shay wants to make a bear mask, Lewis is making a Buzz Lightyear outfit and Jamie-Lee is making a welders mask. Saffron tries sticking the pots together using a glue stick and tells Ms D that "glue doesn't work". She decides to try sticky tape and pulls a length off but it sticks to itself. Ms D shows her the cutting teeth on the dispenser and demonstrates how to push the tape down on to the teeth. She then asks Saffron "Which side is sticky? The sticky side has to go on to the tub". Saffron tries again. She pulls some tape off and puts in on the pots and it works! Ms D holds the pots and provides verbal guidance about pressing down on the cutting teeth whilst Saffron pulls the tape. Some bits of tape are coming off the pot so Ms D and Saffron discuss why this is happening. Ms D says, "Look, my piece is smooth and flat" Saffron needs more tape. She touches the teeth and says "Ouch! Sharp" Ms D. replies "Yes, it is sharp. Things need to be sharp to cut". Saffron tries again and is successful. She is delighted and says "I did it!"…Saffron shakes the rattle and is pleased that it makes the noise she wanted. She goes back outside and shows Ms N. Ms N dances when Saffron shakes the rattle and says "I like that sound!" Saffron wants Ms H to come round the corner to the shelter to play house. Ms H says "We could make a house". Ms H goes to get some plastic bread crates and is quickly joined by Olga and Elise". (Appendix, Saffron: Cohort 3).

Guided play thus has two primary aspects (Fisher, 2009; Hirsh-Pasek, Golinkoff, Berk & Singer, 2009;Weisberg, Hirsh-Pasek & Golinkoff, 2013b; Weisberg, Hirsh-Pasek, Golinkoff, Kittredge & Klahr, 2016), the first being the provision of a stimulating environment that will vitalise the child's senses and encourage exploration (Lillard, 2013). Within this, the child should be actively engaged and retain a substantial degree of control over their own learning. The second concerns the role of the adult, who should support, guide and inform as required. It is suggested that, whilst this level of adult involvement actively encourages creative play (Hakkarainen, Brediyte, Jakkula & Munter, 2013), over-involvement and management frequently serve to terminate it (Thompson, 2014; Weldermariam, 2014). The teacher must therefore sustain the momentum of the play and scaffold development whilst leaving the locus of control with the child. This extends to the adult's language use with open questions such as "What is this for?" being used to extend and augment the child's investigations without disrupting the flow of their activity (Haden, Cohen, Uttal & Marcus, 2016). The term "scaffolding" is thus used in a Vygotskian sense, to denote co-construction and inter-subjectivity, rather than the current populist interpretation of a transmission model, wherein the *expert other* controls and shapes the process. Although the "tutor" can aid the internalisation of external knowledge, the child's own interests, behaviours and predispositions will necessarily mould the interaction (Bruner, Jolly & Sylva, 1976).

2.9.5. Didactic Instruction

Didactic instruction is predicated on broadly behaviourist concepts of teachers delivering to (potentially passive) learners. Wood (2013, p73) suggests that the pedagogical characteristics are those where children "have to conform to regulatory practices such as sitting still, putting up their hands to answer, not calling out, taking turns or waiting to answer." The following example is taken from field notes during a visit to Cohort 1:

> Ms M "We're going to do some counting" Small plastic bears are put out on a tray. Ms M says "I want you all to take two bears" James does this straight away. All children choose bears that are the same colour. Ms M "Put them down in front of you and count them". She goes round the children in turn and every child counts how many bears they have in front of them. (Appendix James: Cohort 1).

Whilst children can derive enormous pleasure from working closely with adults, overtly

didactic approaches had largely fallen out of fashion, particularly with pre-school aged children, being deemed both inappropriate and demonstrably less effective (Ferreira, Caires & Pitarma, 2015; Howes, Fuligni, Hong, Huang, & Lara-Cinisoms, 2013). However, the requirement to prepare children for formal learning at an earlier and earlier age, has occasioned something of a resurgence in its use (Austin, 2014; Bodrova & Leong, 2003).

2.10. The Functions of Play

2.10.1. Overview

"Play is not a luxury to be considered after other rights; it is an essential and integral component underpinning the four principles of the UNCRC – non-discrimination, survival and development, the best interests of the child and participation" (The United Nations Conventions of the Rights of the Child)

There is broad agreement amongst both classic (Bruner, 1961; Piaget, 1945; Vygotsky, 1962, 1978, 1987) and modern theorists (Bergen, 2002; Lillard, 2012; Moyles, 1989, 2015; Whitebread, 2012) that play promotes development in language (Holmes, Romeo, Ciraola, & Grushko, 2015; Orr & Geva, 2015; Pellegrini, 1980; Vedeler, 1997), cognition (Gmitrova & Gmitrova, 2003; Gmitrova, Podhajecka & Gmitrov, 2009; Singer & Singer, 2006) and social skills (Baker-Sennett & Matusov, 2008; Hughes, 2011; Pellis & Pellis, 2009; Savina, 2014) and is thus a causal executant in developmental change rather than a merely pleasurable diversion (Russ, 2003; Wenner, 2009). In Britain, this position is largely supported by Government (gov.uk. /play), parents (e.g. Parenting Science) and pressure groups (Save Childhood).

Academic discussions regarding the adaptive and functional nature of play owe much to the work of the evolutionary biologist Karl Groos (1874-1936) who proposed, "The very existence of youth is due in part to the necessity for play; the animal does not play because he is young, he has a period of youth because he must play" (Groos, 1898, xviii). This assertion has subsequently been expanded and qualified by many influential psychologists. Piaget (1945) proposed that play is an agent in the development of (Piagetian) schema, symbolic thought and the child's emergent sense of efficacy. Furthermore, play with objects encourages manipulative skills and play with people enhances social development. This assertion was echoed by Sullivan (1953) who suggested that relationships with others during play were essential to the development of co-operation, compromise, empathy and altruism. Vygotsky (1978) went

further, suggesting that, not only does play promote social competence; interaction with older, more experienced playmates aids the development of cognition and language through ZPD (Goncu 1993, Haight & Miller, 1993; Howes, Unger & Matheson, 1992). Many subsequent researchers have investigated these assertions further and concluded that during play children demonstrate higher levels of verbal communication, creative thinking, imagination and problem solving (Wood & Attfield, 1996, 2005; Anning, 2004). As pretend play has garnered the most research interest, this shall be considered in detail first.

2.10.2. Play and Cognition

Assertions regarding the cognitive benefits of play have proliferated for decades with, some suggest, remarkably little empirical evidence to support them (Bulotsky-Shearer, Bell, Romero & Carter, 2012). Lillard's controversial meta-analysis, for instance, brought the validity and reliability of many previous studies into question (Lillard, Lerner, Hopkins, Dore, Smith & Palmquist, 2013). Their analysis suggest that most prior research into the impact of play has been inconclusive, inconsistent, non-replicable or attributable to epiphenomenal constituents driving a slew of associated factors. They therefore conclude:

> Despite over 40 years of research examining how pretend play might help development, there is little evidence that it has a crucial role; equifinality and epiphenomenalism have as much if not more support.…Because the literature is riddled with weak methods …. and unrigorous statistical approaches, we cannot definitively state which of these models is most supported. In many areas the current research base is clearly inconsistent with the causal model, but leaves open the other two. The methodological problems must be remedied with sound experiments and longitudinal studies before we can know whether and how pretend play helps development.
>
> (Lillard, Lerner, Hopkins, Dore, Smith & Palmquist, 2013, p. 27).

For Lillard et al, much of the apparent provenance is actually little more than theoretical musings, Type 1 errors and wishful thinking driven by acceptance of the *play ethos* (Smith, 1988). Lillard, Lerner, Hopkins, Dore, Smith and Palmquist (2013) contend that this

unquestioning belief in the merits of play has rendered researchers susceptible to experimenter bias, particularly with regard to the interpretation of correlational data. However, their attempts to evidence bias variously critique a gamut of different considerations including participants (Baumer, Ferholt, & Lecusay, 2005), inadequate or apparently inappropriate control conditions (Howard-Jones, Taylor & Sutton, 2002), unproven replicability (Dansky & Silverman, 1975) and inconsistency of focus. Rejection stems, therefore, not from a pervasive methodological flaw or an endemic design weakness but from a diffuse range of individualised concerns. Although the criticisms patently do not hold true of all research conducted in the field, and no one study is guilty of all reported concerns, Lillard's (2013) assertions served to seriously undermine the credibility of much pre-2012 work and precipitate a reduction in published psychological research regarding the cognitive benefits of childhood play. Whilst other theorists have applauded the call for greater ethical probity and methodological rigour when investigating play, (Weisberg, Hirsh-Pasek, & Golinkoff, 2013) they have also questioned the validity of rejecting a field of study on the basis of such disparate, localised concerns (Weisberg, Zosh, Hirsh-Pasek & Golinkoff, 2013). Furthermore, the suggestion that equifinality or epiphenomenalism are necessarily the product of flawed methodology or sloppy thinking, suggests that linear causality is an indisputable truth of cognitive development. In fact, as Gopnik and Walker (2013 p36) posit:

> "Although X may be crucial for Y, we should not expect a simple correlation between the two, nor, in the absence of an observed correlation, are we entitled to conclude that X is not crucial for Y. According to the alterative view, development can be reasonably considered as the successive acquisition of related skills."

It is thus suggested that nebulous criticisms, such as those offered by Lillard et al (2013), not only overstate the case, (particularly given that the criticisms of pretend-play have so frequently been generalised to the entire field), they also serve to constrain rather than to inspire future research (Weiseberg, Zosh, Hirsh-Pasek & Golinkoff, 2013).

Imaginative or pretend play involves the acting out of familiar scenarios and frequently incorporates props and other players (Moyles, 2012). Vygotsky (1978) suggested that all forms of play, including the apparently autonomous imaginative play, are governed by explicit or implicit rules. During social play an interactive behavioural process occurs, wherein appropriate responses and socially accepted norms are "scaffolded" for the child by more

competent individuals, moving performance to a functionally more sophisticated level (Nicolopoulou, 2010; Stone & Stone, 2015; Sutherland & Friedman, 2013). Thus, just as object-centred play with a more knowledgeable playmate may increase awareness of its properties and usage, in socio-dramatic play it serves to increase social competencies (Lindsey, & Cowell, 2013; Uren & Stagnitti, 2009) and promote associated cognitive development.

Given the centrality and importance of language, it is unsurprising that much theoretical and research interest has centred on optimising its acquisition and development (Golinkoff & Hirsh-Pasek, 1999), with many focussing on the role of play. Bruner's (1983, p65) contention that "the most complicated grammatical and pragmatic forms of language appear first in play activity" appears to be supported by evidence of the use of complex mental-state verbs during preschoolers pretend play (Pellegrini & Galda, 1990). The amount of time infants spend engaged in pretend play (Tamis-LeMonda & Bornstein, 1994) and talking to peers during play (Dickinson & Moreton, 1991) has also been shown to correlate positively with subsequent linguistic understanding and use (Holmes, Romeo, Ciraola & Grushko, 2015).

As imaginative play regularly involves the symbolic representation of objects or actions, it enables children to move away from the constraints of immediacy and concrete representations towards symbolism and voluntary cognitive control (Smith, 1993). This subsequently facilitates the growth of meta-cognition (Lillard, 2012; Montessori, 1967), abstraction (Bergen, 2002) and independent, internalised thought (Nicolopoulou, Barbosa, Ilgaz, & Brockmeyer, 2010). By these means, play enables children to reconcile their internal and external lives (Plowden, 1967).

Interactive pretend play, with its deliberate distortion of object- or role-realities is therefore particularly influential in the development of social cognition (Kelly and Hammond, 2011). Moreover, the centrality of social dialogue regularises language and provides strategies for successful social interaction. Indeed, Bussey and Bandura (1999, p695) propose that "much early role-learning occurs in play", because when playing games such as "families", socially competent participants provide the yardstick for role enactment and guide the behaviours of other children (Xu, 2010). Vygotsky stressed that play has two essential and interrelated components – an imaginary situation and the rules governing the imaginary situation. Thus, when children play "Mummies and Daddies" their play is necessarily restricted by their attempts to grasp the rules surrounding the roles. They attempt to reproduce maternal/paternal behaviour as they and others perceive it. This involves conscious cognitive effort. In this

respect play is always a learning activity for the very young as they attempt to make explicit the normally implicit rules concerning role-enactment. Thus, as Nicolopoulou, Barbosa, Ilgaz and Brockmeyer (2010, p44) state, "inserting elements from the larger culture into the symbolic universe of the play world forces the child to try to make sense of them, even as they are stylized and transformed".

Vygotsky (1978) argued that it is through fantasy play that the child is first able to emancipate his or her thinking from the constraints of the immediate external environment and take the first steps toward organising thought in a coherent and independent way. By fostering the development of symbolic imagination, play prepares the way for abstract, internalised thought. As pretend play draws upon social dialogue and observed behaviours from both within the child's environment and beyond, participation facilitates the emergence of decentration, (Lillard, 2012; Piaget, 1945) leading to the rise of empathy and emotional regulation (Galyer & Evans, 2001). Indeed, highly impulsive children have shown significant gains in self-regulation and inhibitory control following socio-dramatic play interventions (Elias and Berk, 2002). Role-enactment, coupled with the approbation of more socially-skilled individuals subsequently feeds schematic-development, leading to assimilation and acceptance of socially normative roles (Broadhead, 2009). Furthermore, it has been suggested that the creation of story-lines and virtual reality situations may serve to organise novel schemas.

The design and execution of this thesis has been informed by both the successes and failures of the past. It seeks to quantify the impact of guided play or playful learning on the development of categorisation in a manner that is both valid and reliable. Furthermore, it investigates potential explanations for observed phenomena through consideration of empirical evidence from a diverse range of theoretical perspectives. In doing so, it addresses a clear research need through use of a robust design framework and painstaking attention to methodological detail. The key factors underpinning these methodological decisions are considered in the next chapter.

Summary

This chapter has presented an account of play theory and research, detailing some of the main formats and developmental stages. Gender and socio-economic status have both been shown to impact children's play opportunities and experience. It has been demonstrated that a

combination of definitional imprecision and external pressures to “drive up standards” have presented practitioners with a real dilemma regarding play in the EYFS. Despite this fractionating of opinion and the reported schism amongst researchers, it is contended that play has a positive impact on many aspects of cognitive development. It is, however, accepted that this may not always be attributable to linear causality. In light of the claims made for the benefits of guided play, it is postulated that guided play in a pre-school setting may aid the development of categorisational abilities more than a formal curriculum. Study 3 will therefore be exploratory and consider the impact of guided play (as compared to a more didactic approach) on the development of categorisation.

Chapter 3

Overall Methodology

3.1. Chapter Overview.

This chapter outlines the practical, methodological and ideological dilemmas that were addressed during the early stages of the research process and explains why the final decisions were considered the most conspicuously valid and expedient. The chapter begins by considering the particular demands and constraints of working with young children, including their cognitive limitations and behavioural proclivities. An explanation is provided of how these determined the broad parameters of this research. Potential testing mechanisms which were considered and ultimately rejected are outlined, leading to a research design rationale.

The considerations outlined in this chapter informed the methodology for the three studies into factors influencing pre-school categorisational abilities that are documented within this thesis. Chapter 4 details the four components of Study 1 that informed the production of a valid and reliable toolkit to test categorisational behaviour. Study 1(a) involved the preliminary use of the test battery that was later (with some minor modifications) to be used in Studies 2 and 3. This included colour and shape matching, images cards and toys. Both the images and the toys were selected to enable categorisation in a variety of different relational patterns. Study 1(b) once again used toys but introduced photographs as well as drawings in order to explore the importance of modality and whether visual realism augmented children's ability to categorise. Studies 1(c) and 1(d) utilised the match-to-sample technique (that has been widely used by other researchers in the field), to investigate both the validity and reliability of the new battery and the importance of perceptual similarity and typicality in shaping participant's matching decisions. Study 2 (Chapter 5) outlines the research into four facets of categorisational abilities (shape, colour, using images and using objects) that was subsequently conducted with children in five different locations. This study sought to investigate whether there was evidence of a developmental trajectory in categorisational development and if the speed or extend of development was impacted by socioeconomic status, gender and / or presentation modality. Chapter 6 outlines an exploratory study into the possibility that involvement in guided play (rather than more formal teaching methods) during the pre-school period, aids the development

of categorisational abilities. It involved the testing of 102 children in two different locations during their first fortnight in Nursery and again twelve weeks later.

Table 3: Summary of Studies Conducted by Focus, Participant Numbers, and Participant Age Range

Study	Study Focus	Participant Numbers	Participant Age Range (months)
1(a)	Impact of sex, socio-economic status and modality (image and object)	52	30 - 50
1(b)	Impact of modality / dimensionality (drawings, photographs and objects). Object / Image Recall	47 14	31 - 50
1(c)	Match-to-Sample Task	31	30 - 48
1(d)	Reduced Match-to-Sample Task	15	36 - 52
2	Impact of sex, socio-economic status and modality. Consideration of a developmental trajectory for categorisational abilities.	190	30 - 60
3	Impact of differing Nursery approaches on the development of categorisation	102	36 - 48

3.2. Introduction

Conventional wisdom holds that the antecedents of cognitive development are generally contiguous (Augoustinos, Walker and Donaghue, 2006; Garton, 2004); subsequently there has been relatively little attempt to isolate and evaluate the contribution of specific components. Most theorists, for instance, acknowledge the probable role of social interaction and environment in building a child's schemata but provide little quantified scrutiny of elemental factors (Arnold, 2013; Atherton & Nutbrown, 2013). One of the initial aims of this study was therefore to address this apparent research gap by investigating whether play has a measurable impact on the development of schemata.

As discussed in Chapter 1, prior research has demonstrated that rudimentary categorisation emerges in infancy (Bornstein, 2006; Bussey & Bandura, 1999) and evolves progressively during the pre-school period (Althaus & Plunkett, 2015; Franklin & Davies, 2004; Mareschal & Quinn, 2001). Research further suggests that physical categorisation cues (Bussey & Bandura, 1999; Intons-Peterson, 1988; Signorella & Frieze, 1993), behavioural norms (Martin, Rubel & Szkrybalo, 2006; Tenenbaum, Hill, Joseph & Roche, 2010), and structural

atypicalities (Althaus & Plunkett, 2015; Poulin-Dubois, Serbin, Eichstedt, Sen, & Beissel, 2002) are recognised even by very young children. Being primarily reliant on observable material properties, perceptual categorisation thus appears first (Mandler & McDonough, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997). As perceptual categories are primarily ocular and can develop in a basic form regardless of lexical input (Quinn, Eimas & Rosenkrantz, 1993), they begin to formulate as soon as the baby is able to perceive and track objects (Cohen & Caputo, 1978; Mandler, 2003; Quinn, 2004). Thematic categorisation, on the other hand, is reliant upon a successful amalgam of biological, cognitive and experiential factors (Colunga & Smith, 2005; Gopnik & Wellman, 1994; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014) and so necessarily emerges later and somewhat fitfully. The development of thematic categorisation is progressive, with each new experience serving to corroborate and augment known connections, steadily assembling enmeshed conceptual webs (Blanchet, Dunham & Dunham, 2001; Gelman & Koenig, 2003). Schemata similarly originate early and are continuously validated and extended throughout childhood (Rogoff, 1990; Tenenbaum, Hill, Joseph & Roche, 2010). Much of the infrastructure for social cognition (Augoustinos, Walker & Donaghue, 2006: Leonard & Hill, 2014; Rochat, 2015) and semantic memory (Binder & Desai, 2011; Binder, Desai, Graves & Conant, 2011; Collins & Quillian, 1969) thus originates in early infancy but expands and solidifies during childhood (Martin-Ordas, Atance & Caza, 2014).

Whilst theorists remain divided as to precise timings, there is a general consensus that, by the time they begin Infant's school, children have many stable schemas and some relatively sophisticated notions regarding categorisation. Given that schema and categorisation expand exponentially during the third and fourth year of life, this study sought to investigate their onset and expansion during the pre-school period.

3.3. Methodological Considerations and Rationale.

3.3.1. Conducting Research with Young Children.

Psychological research with humans is underpinned by a number of shared orthodoxies and principles designed to ensure empirical legitimacy and the protection of participants (British Psychological Society, [BPS] 2014). When research involves vulnerable participants such as children, the risk of harm is magnified, necessitating a proportionate augmentation of ethical

protocols, all of which should be "in accordance with the Principle of Respect for the Autonomy and Dignity of Persons and the *Code of Ethics and Conduct"* (BPS, 2014, p 31). Evidentially, all BPS conventions regarding recruitment, consent, data-collection, storage and confidentiality were to be observed but the dilemmas and issues associated with child participants extend far beyond these basic tenets.

Developmental research is an essentially adult construct (Fraser & Robinson, 2004), predicated on prevailing notions of childhood. Historically, child development was conceived as a series of invariant and universal stages marking the route to adult competency (Piaget & Inhelder, 1932). When measured against adult criteria child participants were generally regarded as unreliable, unduly vulnerable (Twum-Danso, 2009) or prohibitively lacking in skills and knowledge (Fargas-Malet, McSherry, Larkin & Robinson, 2010). Deficit models such as this frequently regarded diluted, truncated or mildly entertaining versions of adult tasks as acceptable testing mechanisms and utilised "children's schooled docility" (Gallacher & Gallagher, 2008, p507) in order to achieve their goals. Children were thus "subject to" rather than "participants in" research which exploited their lack of autonomy and largely ignored their perspectives (Chrousos, Loriaux & Gold, 1988; Watson, 1920). Such approaches were contextually embedded in, what are now recognised to be, outmoded ontological and epistemological positions which are clearly abrogated when the research concerns childhood. Without children's input, research into childhood is at least partially incomplete and at risk of compromised validity (Okoli & Chinyere, 2015). Since the UN Convention on the Rights of the Child (1989) established children's right to seek and communicate relevant information, gradual transformations in social and cultural perspectives have given credence to the notion of children as intrinsically unique social actors (Bergstrom, Jonsson & Shanahan, 2010; Pinter, 2014) and experts in their own lives (Davies, 2014). Subsequently, there has been an ideological shift and a trend towards children's active involvement in research (Kellett, 2011).

Whilst active participation has now become both theoretically and politically viable, children have remained practically hindered by their lack of rights and status. The British Psychological Society (2014) acknowledges that children, along with other vulnerable groups, are disadvantaged in terms of functional relations and exist in an unequal power relationship with adults. In research this may mean that gatekeepers use their role to silence or exclude (Alderson, 2004); that researchers impose their views or that the research itself is conducted in adult spaces, using adult language and adult rules (Buscemi, Blumstein, Kong, Stolley, Schiffer, Odoms-Young, Bittner & Fitzgibbon, 2015). Furthermore, power imbalances and

associated generational issues greatly increase the possibility of coercion, which may effectively compel participation despite real discomfort or unhappiness. Imbalances can also lead to researchers being viewed as authority figures expecting compliance; thus fostering demand characteristics and subsequently skewing data (Bergman, 2011). Indeed, Murray (2013) believes the construct validity and ethical verisimilitude of "lab-based" studies with young children to be compromised on a whole range of fronts. Unfamiliar places and people can heighten emotional valence (Evans, 2001), create stress (Jorm, Kelly & Morgan, 2007), compromise ecological validity (Riso, Laidlaw, Freeth, Foulsham & Kingstone, 2012) and generate uncharacteristic behaviour such as fear-responses (Bruce and Meggitt, 2002). Research which generates negative affective states in participants (Bandura, 1965) is subsequently more likely to be encoded, retained in detail (Storbeck, 2014; Van Bergen, Wall & Salmon, 2015) and later recalled in an exaggerated form (Sato & Kawahara, 2011). The risk of ill-conceived or unethical procedures causing long-term psychological damage, particularly if there is a perceived focus on the child's limitations, is thus increased. It appears that test reliability improves (Mayall, 2008) and child participants are most at ease when they are in familiar places, with familiar people interacting in a familiar way (Buscemi, Blumstein, Kong, Stolley, Schiffer, Odoms-Young, Bittner & Fitzgibbon, 2015).

However, the presence of parents can have a (sometimes unintentionally) confounding effect on experimental work with young children (Budinger, Drazdowski & Ginsberg, 2012); and, due to their associations with behavioural conformity, formal school settings may increase compliance and demand characteristics (Waterman & Blades, 2011). With regard to this research, it was recognised that Nursery units with a professed focus on academic development were unlikely to be sympathetic to play-based research. Research conducted in the child's home was liable to introduce a range of logistical difficulties and potentially confounding variables. It was therefore decided to carry out the research in playgroups, pre-schools and nurseries with an avowed child-centred focus. It was believed that this would improve ecological validity and increase the participant's sense of ease, subsequently promoting test reliability and validity.

The decision to involve, rather than merely observe, child participants was preeminent, definitive and central to all planning. The research therefore needed to be conducted by a familiar adult who would make it an enjoyable and positive experience. Given the existing demands on staff time, their anticipated lack of investment in the project and the difficulties associated with inter-rater reliability, it did not appear viable to recruit and train staff from each

setting as researchers. It was clear that greater reliability would result from this researcher conducting every test in every location. In order to augment familiarity and subsequently reliability, validity and participant well-being, the researcher decided to undertake a period of voluntary teaching-assistant work in each location prior to the commencement of testing. This would serve to familiarise the researcher with the staff, children and parents as well as with the ethos and routines of the setting. By the time pupils became participants, they would be familiar with the researcher and regarded her as a member of staff. The researcher, in turn, would know each child as an individual and would be able to respond appropriately to their demeanour and specific style of communication.

The questions of where and by whom the research was to be conducted had thus been addressed. The next set of questions pertained to the most appropriate testing mechanism.

The period from birth to five-years is one of tremendous cognitive, somatic and personal change; whereby growth and maturation generally follow a distinctive pattern from immature reliance to independence (Blair & Raver, 2012; Panksepp, 2013; Woodhead, 2005). Similarly, the way in which children think and reason; their emotional, moral, linguistic and intellectual understanding develop incrementally as synaptic links increase and the organisation of behaviours move from subcortical to cortical levels (Chau, Synnes, Grunau, Poskitt, Brant & Miller, 2013; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014; Raznahan, Greenstein, Lee, Clasen & Giedd, 2012; Toates, 2001). However, whilst children's development has strong elements of commonality, the speed and extent of change is inconsistent. A child's sex (Halpern, 2012; Junaid & Fellows, 2006; Mensah & Kiernan, 2009; Schoon, Jones, Cheng & Maughan, 2011), ethnicity (Emerson, 2012; Strand, 2014), social and economic background (Bulut, 2013; Connolly, 2006; Ferguson, Cassells, MacAllister and Evans, 2013; McKinney, McClung, Hall, Cameron & Lowden, 2012) all impact their developmental trajectory and, as both theorists and practitioners have demonstrated, appropriate stimulation and support can augment achievement beyond the apparent constraints of developmental stages (Garton, 2004; Goldin-Meadow, Levine, Hedges, Huttenlocher, Raudenbush & Small, 2014; Rogoff, 1990). Chronological age therefore suggests likely parameters rather than denoting homogeneity; with young children being partially bound by their phenotype but differentiated by their genotype and environment. This means that, within any sample of pre-school children, there are liable to be considerable variations in linguistic competencies, motor skills, disposition and interests even when children are chronologically matched. Research designed for use with child participants must therefore acknowledge conventional developmental boundaries but have

sufficient flexibility to accommodate aberrations and individual vagaries (Mack, Giareli & Bernhardt, 2009). Failure to prepare for both norms and anomalies, within either the design or execution of the research, has the potential to derail the process or substantially skew the results.

Any limitation in language, cognitive function or motor-control amongst participants necessarily constrains methodology, and multiple limitations have a cumulative effect, severely restricting the range of appropriate materials and strategies. Thus, research dilemmas and methodological bear-traps are, to a large extent, inversely proportionate to age. Whilst pre-linguistic, immobile infants provide the greatest challenge, the limitations and predispositions of three-year-old children create their own specific demands.

Amongst three-year-olds, immaturity of the frontal cortex serves to constrain working memory (Darki & Klingberg, 2015; Osaka, Osaka, Kondo, Morishita, Fukuyama & Shibasaki, 2004), executive function (Carlson, Moses & Breton, 2002; Kane & Engle, 2002; Putko, 2010) and first- and second-order Theory of Mind (Lillard & Kavanaugh, 2014; Sabbagh, Hopkins, Benson, & Randall, 2010; Sabbagh, Xu, Carlson, Moses & Lee, 2006). Clearly, this has implications for social understanding (Hughes & Leekam, 2004; Sebastian, Fontaine, Bird, Blakemore, De Brito, McCrory & Viding, 2011) and social interactions (Frith & Frith, 2001; Pruett, Kandala, Petersen & Povinelli, 2015); increasing the possibility of communicative error or confusion and constraining performance in some receptive tasks. Furthermore, whilst three-year-olds are typically affable and gregarious, social ambivalence may impact their approach to novel situations and unfamiliar researchers. Cortical immaturity additionally impacts abstraction (Badre, Kayser & D'Esposito, 2010; Bennett, 2010; Pasamanick, 1983), planning, organization and inhibitory control (Cuevas & Bell, 2014; Fuster, 2014), leaving most three-year-olds cognitively unsuited to any experimental tasks requiring reasoning or the coding of representations in working memory.

Language acquisition involves the development of many diverse and complex skills such as segmentation, lexical learning, semantics and morphology along with pragmatic and discourse skills (Ambridge & Lieven, 2011; Saffran, Senghas & Trueswell, 2001). Whilst this is sequentially inflexible, the pace and extent of language acquisition is substantially affected by environmental and cognitive factors (Boeckx, 2010; Gottfried, Schlackman, Gottfried & Boutin-Martinez, 2015). Poverty of stimulus may have left some pre-school children reliant on holophrases and telegraphic speech (Rowland, 2014) whilst those who have been exposed to

language-rich environments are more likely to possess a substantial mental lexicon and exhibit high level receptive and expressive skills (Feiring & Lewis, 2014; Hoff, 2013; Snow, 1991). Further disparities are probable between the sexes; girls generally acquire language earlier (Schachter, Shore, Hodapp, Chalfin & Bundy, 1978), demonstrate greater ease and rapidity in their learning (Eriksson, Marschik, Tulviste, Almgren, Pereira, Wehberg & Gallego, 2011) and continue to out-perform boys linguistically throughout early childhood (Schaadt, Hesse & Friederici, 2015; Schachter & Coll, 1978). Clearly, vocabulary expansion is cumulative, so whilst functionally bilingual children are unlikely to differ substantially from their monolingual English-speaking peers (Pearson, Fernandez & Oller, 2006), recent settlers could be expected to have a more limited lexical and syntactic range. It is therefore feasible that these children would be constrained by extensive use of spoken English (Durgunoglu & Verhoeven, 2013; Ellis, 1997), rendering any task that relied too heavily on oral instructions or responses at risk from confounding variables. Given the intention to recruit from a broad demographic, considerable variation in linguistic ability was expected (Fernald, Marchman & Weisleder, 2013). Furthermore, it was recognised that if early research findings showed evidence of functionally embedded schemata in three-year-olds, it would be necessary to recruit still younger participants where linguistic difficulties were likely to multiply. As a result, it was considered judicious to avoid oral tasks where lexical or syntactic limitations may prove confounding, or where wrongly attributed meanings could compromise validity.

This acknowledgement of participant's biological and cognitive development served to establish the initial theoretical boundaries of the research and to exclude testing mechanisms which involved complex volitional activities; required the use of interpretative frameworks, or demanded high-level spoken and receptive English (see section 3.2.2.). It was recognised, however, that individual variations in participant performance were still to be anticipated.

Children's behaviour is impacted by a variety of factors including their environment (Bartholomew, 2015), family upbringing (Heberle, Thomas, Wagmiller, Briggs-Gowan, & Carter, 2014), peer relationships (Bertran, 2015) life experiences (Lindon, 2012) and developmental level (Augustine & Stifter, 2015; Giltaij, Sterkenburg, & Schuengel, 2015; Skotarczak & Lee, 2014). Behavioural differences are therefore likely amongst any group of child participants; but at the age of three, children are also learning social norms and adapting to the requirements of their Nursery setting. As a result, their behaviour is still more unpredictable. For many in this age-range, sustained concentration is an issue (Coates, 2004: Ma & Wei, 2015; Murray, Scratch, Thompson, Inder, Doyle, Anderson & Anderson, 2014),

meaning that they are temperamentally unsuited to lengthy or dreary experiments. It was therefore acknowledged that the tasks needed to be engaging as well as developmentally-appropriate (Buscemi, Blumstein, Kong, Stolley, Schiffer, Odoms-Young, Bittner & Fitzgibbon, 2015). Kellett (2005) discovered a strong correlation between benevolent adult support and positive outcomes; with much being determined by the adults' disposition and research ethos. The researcher establishes the nature and level of the child's involvement (Nieuwenhuys, 2001) and is in a position to encourage, enable and empower through supportive management (Griesel, Swart-Kruger & Chawla, 2002). The adult can thus use their power to guide the child away from unproductive or damaging outcomes and ensure that the research experience is pleasurable for the participant, whilst also being informative for the researcher. There was also a personal imperative to establish positive and authoritative relationships with participants in order to offset undue reticence or over-ebullience.

In light of these constraints, initially a qualitative design appeared attractive. However, most qualitative formats require some degree of adult interpretative analysis, bringing the attendant risk of wrongly attributed meanings and inaccurate representations of the child. There was the additional concern that the researcher may misunderstand children's language usage and, without recourse to member checking, this would compromise internal validity (Punch, 2005). It was also recognised that the boundaries between fantasy and reality are not always clearly defined amongst young children (Lillard & Wooley, 2015) and subsequently their expressed opinions are not necessarily either accurate or complete. From a purely theoretical point of view, qualitative methodology remains largely linked to subjectivity, *a priori* reasoning and a more interpretative epistemology than appeared appropriate here. The roots of this research were regarded as being fundamentally empiricist, necessitating an *a posteriori* approach and a search for nomothetic causal explanations. It was therefore decided to employ a quantitative methodology.

Consideration of theoretical perspectives had clearly demonstrated that successful research with young children is predicated on a number of key points. Not only does the researcher need to adhere to all recognised protocols regarding ethical probity and scientific rigour, the construction and execution of the research require a particularly innovative and delicate approach. Given the intended scale of the research project, it was important that the task was enjoyable (Barker & Weller, 2003), portable (as it would be conducted in a variety of locations) and sensitive to a range of responses.

3.3.2. Research Design

The focus of this study, as originally conceived, was to investigate the development and embedding of schemata. Several months were therefore spent in consideration of how schema may best be measured in pre-literate children. This section outlines the approaches which were considered and explains why a dual task paradigm was eventually selected.

Given that schemata are essentially ideational and have conjunctional environmental and situational causes, empirical measurement was not expected to establish sufficiency and necessity for any one factor, far less determine causation. However, it was felt to be both possible and useful to design an interventionist study wherein contributory factors were isolated and quantified. To this end, several experimental techniques that initially appeared to offer a plausible means of testing for the existence of schemata or their latent traits were considered:

3.3.2.1. Dot-probe paradigm (MacLeod, Mathews and Tata, 1986).

The dot-probe paradigm provides a measure of attentional bias and is frequently used with participants suffering from anxiety disorders or mental health issues. A fixation cross appears centre screen, followed by blocks of picture pairs, usually from the International Affective Picture System (IAPS) and then finally, a dot-probe. The participant responds by hitting a pre-determined location on a keyboard when they see the dot. Timings are recorded and latency calculated (by means of an attentional fixation index) for stimuli with differing emotional valence.

Whilst the dot-probe test is used primarily to assess affective disorders, it was considered viable to replace the IAPS with schematically typical and atypical images. Much previous research with young children has utilised familiarisation / novelty-preference methods, based on the supposition that attentional bias shows dishabituation in the young, meaning that their attention is directed towards unfamiliar items (Cohen & Strauss, 1979). Therefore, if test results showed attentional bias skewed significantly towards atypical images, this would appear to suggest dishabituation and hence, the existence of schematic categorisation.

However, the notion of novelty-preference amongst infants is countered by research findings which suggest a familiarity-preference (Slater, 1995) and those which suggest preferences vary between object categories (Park, Shimojo & Shimojo, 2010) or in accordance with age and

familiarisation time (Caron, Caron, Minichiello, Weiss & Friedman, 1977; Houston-Price & Nakai, 2003; Nelson, 1995; Roder, Bushnell & Sasseville, 2000). It would therefore be unclear whether fixation indicated the presence or absence of schemata. Furthermore, this paradigm would only be able to demonstrate base level categorisation or perceptual schemata, neither of which is necessarily sufficient to activate automaticity.

The dot-probe paradigm has also shown poor test-retest reliability with results often proving inconsistent or ambiguous (Price, Kuckertz, Siegle, Ladouceur, Silk, Ryan, Dahl & Amir, 2015; Schmukle, 2005). Difficulties become more pronounced if stimuli are presented for longer than 500ms; young children, however, are known to require a minimal presentation time of 500ms (Staugaard, 2009). Whilst doubts about reliability could be assuaged by a positive test-retest correlation coefficient, this would require a reasonable interval between tests, which may lead to participant maturation confounding the results. As the test is also prone to disengagement effects (Koster, 2003) and habituation (Staugaard, 2009), it appeared to be inappropriate for this study.

3.3.2.2. The War of the Ghosts (Bartlett)

The first investigations of schemata involved Bartlett's (1932) presentation of a story containing information outside participant's cultural expectations and norms. By monitoring their recollections, he demonstrated the existence of schema and stereotypes.

It was considered whether children could thus be presented with a story containing schematic atypicalities and their later recollections scored for omissions, transformations, shifts in emphasis or rationalisation. However, it was felt given the age of participants, both linguistic ability and cognitive immaturities may prove confounding.

3.3.2.3. Young's Schema Questionnaire / The Schema Questionnaire for Children.

Both Young's Schema Questionnaire (YSQ) (Young & Brown, 1990, 1994) and the Schema Questionnaire for Children (SQC) (Stallard & Rayner, 2005) were devised specifically to test the strength and persistence of schema and both are demonstrably valid.

However, both are used predominantly with children and young people over eleven-years-old in order to test for maladaptive schema and subsequently inform mental health interventions. Whilst modifications may have enabled measurement of adaptive schema in young people, this study's intended cohort was predominantly pre-literate, effectively rendering the "questionnaire" a structured interview, with the attendant threats to reliability and validity. Interviews are prone to both experimenter and participant bias, (Lee, 1993; Ngongo, Frick, Hightower, Mathingau, Burke & Breiman, 2015), demand characteristics (Bjorklund, Cassel, Bjorklund, Brown, Park, Ernst & Owen, 2000), transference (Scheurich, 1995) and misunderstanding. Whilst highly structured interviews are better able to control for reliability, they may miss the nuances and complexities of individual responses (Cohen, Manion & Morrison, 2007) and militate against sensitive response to those with limited vocabularies or alternative life experiences. Both questionnaire and interview formats were therefore rejected as means of gathering quantitative data.

3.3.2.4. Lexical Decision/Language Tasks

Sinclaire and Kunda (1999) used word-fragment completion tasks as an implicit measure of stereotypes. In the context of this research, it was considered possible to modify an oral task to meet the needs of young participants although it was feared that vocabulary limitations and variations may prove confounding. As the tasks are designed primarily to measure latent traits it was also feared that it would provide insufficient insight into children's cognitive processing. This fear was compounded by Fazio and Olson's (2002, p. 315) meta-analysis which concludes that the test battery "has little to do with what is automatically activated in response to given stimulus".

3.3.2.5. Implicit Association Tests (Greenwald & Banaji 1995).

Fazio and Olson's MODE Model (2003) suggests that when motivation and/or opportunity are low, behaviour is largely a function of automaticity, meaning rapid-response tasks lead individuals to reveal their implicit attitudes. Implicit Association Tests (IATs) utilise this tendency by presenting participants with computer-based stimuli. Typically, participants are required to categorise concepts such as valenced words (Greenwald, McGhee & Schwartz, 1998) or racial stereotypes (McConnell & Leibold, 2002) with dichotomised attributes.

Performance is demonstrably faster when terms are highly associated and slower when they are poorly associated or oppositional. The test has been used to study a range of topics (Greenwald, Poehlman, Uhlmann & Banaji, 2009), and has been shown to have high convergent and discriminant validity with both adults and teenagers (Yang, Shi, Luo, Shi & Cai, 2014). Whilst this is maintained with participants as young as eight-years-old (Cirovic, Josic & Zezelj, 2011), the test's cognitive demands have generally precluded use with younger participants (Castelli, Zogmaister & Tomelleri, 2009; Dunham, Baron & Banaji, 2006). Work to develop a Preschool Implicit Association Test (Cvencek, Greenwald & Meltzoff, 2011) has shown predictive and discriminant validity for children aged four-and-a-half-years but remains largely untested below this age range.

3.3.2.6. The Go / No-Go Association Task (GNAT) (Nosek & Banaji, 2001).

The GNAT test provides a simplified variant on the IAT, measuring automatic social cognition in a prescribed area without referencing associated or oppositional objects. It remains, nonetheless, a largely attitudinal measure, concerned with revealing implicit preferences. Furthermore, there has been some debate concerning test-retest reliability (Tierney, 2008). It was therefore considered to be inappropriate for use in this context.

Some thought was given to a variant of the IAT/GNAT approach wherein schema-typical and atypical photographs were used for categorisation, thus enabling a measure of implicit stereotypes. However, as keyboard use requires a level of manual dexterity, the fluctuations in fine motor control that are prevalent amongst two- to four-year-olds were considered to be potentially confounding. It was therefore decided to utilise key theoretical elements of this approach (i.e. increased performance speed for associated items) in a more child-friendly format.

3.3.2.7. Expectancy Consistent Events.

Fiske and Taylor's (1984) Cognitive Miser Model experiments demonstrated improved performance amongst participants who invoked stereotypes. Participants have similarly shown a tendency to remember schema-consistent traits more easily than those that are schema-

inconsistent (Badham & Maylor, 2015; Devine & Ostrom, 1988; Hastie & Park, 1986; Sekaquaptewa, 2002; von Hippel, 1997). As people take less time and have better recall of information that is schema-consistent it may reasonably be expected that children with a developed role or event schema would provide more rapid responses than those without one.

A strategy was therefore considered wherein children were presented with stories or pictures that contained (for instance) gender-typical and gender-atypical behaviours and were then tested for recall. However, it was felt that such a task would once again be a measure of latent traits and cognitive bias and would also be susceptible to confounding language, with the risk of compromising both reliability and validity.

3.3.2.8. Other possibilities.

Facial electromyography, amygdala activation (measured using fMRI), eye blink startle response and cardiovascular reactivity were all recognised to be viable means of measuring stereotypes and therefore had the potential to suggest schema acquisition.

Each of these testing mechanisms would do away with the need for a verbal report and thus would not be impacted by linguistic limitations amongst participants. However, they require specialist lab-based equipment and expertise on the part of the operative. They also have the potential to distress young participants. They were all therefore rejected.

It was thus rapidly apparent that no acceptable, reliable and practically viable means of ascertaining the existence of schema in young children was presently in existence. The need to devise one therefore became an early priority.

3.3.3. Automatic Processing in Dual Task Studies.

In their study of responses to stereo-types, Macrae, Milne and Bodenhausen (1994) presented participants with a dual task paradigm. One task involved studying a prose passage, whilst the other required participants to form an impression based on information presented via subliminal primes, superliminal primes or a dot-probe paradigm. Results were consistent across conditions and demonstrated a significant tendency to employ schemata and heuristics in the judgement task, thus reducing conscious processing. Having freed up resources, participants were then able to speedily complete the cognitively demanding memory task.

It was thus reasoned that if simultaneously presented with a schema-consistent judgement task and a cognitively demanding memory task, children with a developed schema would utilise it, freeing cognitive resources for the task requiring conscious processing. Subsequently, the conscious task would be performed faster; meaning speed and accuracy could be taken as an indicator of functional schemata.

It was decided to develop a dual-task paradigm, involving simultaneous presentation of a Judgement Task and a Memory task, to test young children's schemata. The research experience of others (Rakison & Butterworth, 1998; McGarrigle & Donaldson, 1974) had suggested participants were most responsive if the research was presented as a game (Gopnik & Astington, 1988) which made "human sense" (Donaldson, 1978; Kellett & Ding, 2004). Work therefore began on the production of a game to be played with picture cards while participants listened to a story.

3.4. Summary

The research within this thesis sought to investigate factors influencing the development and embedding of categorisation and schemata during the preschool period. This chapter has outlined the practical, methodological and ideological dilemmas which were addressed by the researcher prior to establishing the design framework. In order to develop a robust and reliable testing mechanism, due consideration was given to both the theoretical substructure and practical ramifications of each element. Ethical probity dictated that, given the potential vulnerability of participants, due heed must initially be paid to counteracting power imbalances and to providing an environment conducive to optimal participant performance. In combination, these informed the decision that the research should be conducted in Nursery and Pre-school environments by a single researcher, and should follow a lengthy period of familiarisation work. It was also deemed necessary to produce an engaging and enjoyable test that enabled fine-grain differentiation between participants of all abilities. Furthermore, the design needed to take account of the strengths and limitations of this age-range, including cognitive and neurological constraints and environmentally determined factors. It was felt that none of the established testing mechanisms fulfilled all of these criteria, it was therefore decided to develop, pilot and refine a bespoke toolkit that would be able to differentiate between forms and levels of categorisational ability for use in this research.

Chapter 4 documents the stages and particulars of this process, from the development of materials through to the data that emerged from initial use of the toolkit. It details measures taken to ensure the reliability and validity of the test instrument, including the trialling of different materials and modes of presentation. It includes consideration of whether preschool children are primarily reliant on perceptual or thematic criteria and the extent to which typicality / atypicality shapes their responses. Ultimately, it explains and justifies the development of a categorisation test battery designed to enable stratified response and analysis – from simple shape and colour matching to the construction of complex conceptual webs.

Chapter 4

Study One: The Development of Categorisation in Pre-School Children

4.1 Chapter Overview

This chapter, presents a chronological account of the initial stages of the research; beginning with the theoretical perspectives and practical considerations that underpinned methodological decisions before moving through each of the studies in turn. Each study ends with an interim discussion to explain how the results informed the next area of investigation. These discussion points are summarised and refined at the end of the chapter.

4.1.1. Study 1(a)

This study investigated four different aspects of pre-school children's categorisational abilities – categorising according to shape; according to colour; when presented with drawings of items, and when presented with the same items in the form of toys.

Addressing PhD Objectives 2-5 and Hypotheses 1-3

2. To explore the role of sex / gender on the development of categorisation in pre-school children.

It is hypothesised that girls will perform better in categorisation tasks than boys.

3. To assess whether socio-economic status impacts the development of categorisation in pre-school children.

It is hypothesised that children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups.

4. To explore the impact of dimensionality on pre-school children's ability to categorise.

It is hypothesised that all participants will perform better on categorisation tasks when presented with objects than when presented with images.

5. To extend psychological understanding of how differing forms of categorisation emerge and develop.

4.1.2. Study 1(b)

This study investigated the potential importance of realism by presenting participants with photographs as well as drawings.

Addressing PhD Objectives 2, 4 and 5

2. To explore the role of sex / gender on the development of categorisation in pre-school children.

It is hypothesised that girls will perform better in categorisation tasks than boys.

4. To explore the impact of dimensionality on pre-school children's ability to categorise.

It is hypothesised that all participants will perform better on categorisation tasks when presented with objects than when presented with images.

5. To extend psychological understanding of how differing forms of categorisation emerge and develop.

A small scale addendum investigated recall as a potentially confounding variable but failed to find any link between memorability and item categorisation.

4.1.3. Study 1(c) and Study 1(d)

These studies utilised two different formats of the match-to-sample technique that has been widely used by other researchers into childhood categorisation.

Addressing PhD Objectives 1, 4 and 5

1. To develop a means of testing pre-school children for schema-based automaticity.

4. To explore the impact of dimensionality on pre-school children's ability to categorise.

It is hypothesised that all participants will perform better on categorisation tasks when presented with objects than when presented with images.

5. To extend psychological understanding of how differing forms of categorisation emerge and develop.

4.2 Introduction and Background to Study

It was originally intended that this research should focus on the emergence of social schema. As the literature suggested a paucity of non-invasive tests for automaticity in pre-literate children (see Chapter 3), the first stage of the research was dedicated to the development and piloting of a theoretically and practically valid test. As previously outlined (see Chapter 3), it was anticipated that this would comprise a dual-task paradigm with stories and picture cards. However, when the picture cards were being assessed for familiarity, some participants spontaneously categorised them whilst others were unable to do so even with prompting. This was felt to warrant further investigation and ultimately led to the research emphasis shifting from schemata to categorisation.

The first phase of categorisation testing raised some unexpected but potentially important issues which clearly required exploration. Prior to recruiting more Nursery Units and testing a large sample (see Chapter 5), a series of smaller studies were conducted to check the tests' validity and reliability and remove possible confounding factors. Each test also intrinsically served to extend understanding of how categorisation emerges and develops.

4.3. Schema Theory: An Overview (see Chapter 1)

Schemata are conceptualised cognitive structures which represent all individually established information about a subject. Not only do schemata provide storage capacity, they determine the rubric against which new information is assessed. Individuals develop a wide-range of disparate schemata. Although role-schema sometimes pertain to achieved roles (e.g. "teacher"), the most salient forms of social categorisation are provided by visually accessible ascribed roles, particularly race, age and gender (Barbera, 2003; Zosuls, Ruble, Tamis-LeMonda, Shrout & Bornstein, 2009). Given the clear visual dichotomy, gender differentiation is generally one of the earliest forms of categorisation (Braisby, 2005). There is a significant body of research to suggest that young children consistently recognise physical gender cues (Barbera, 2003; Liben & Signorella, 1993; Miller, Trautner, Ruble & Balter 2006; Tenenbaum, Hill, Joseph & Roche, 2010). Six- to nine-month-old infants are able to distinguish males and females on the basis of hairstyle (Intons-Peterson, 1988). One-year-olds can tell the difference between photographs of men and women (Leinbach & Faogot, 1993). Two- to three-year-olds are able to sort photos into 'boys' and 'girls' piles and identify boys' and girls' toys (Campbell, Shirley

& Caygill, 2002), and three-year-olds consistently designate particular colours, clothing and hairstyles as belonging to boys or girls (Picariello, Greenberg & Pillemer,1990).

Furthermore, numerous studies have shown clear indications of gender-conformism in children's play and in their toy selection (Bandura, 1992; Eisenberg, Wolchick, Hernandez & Pasternack, 1985; Etaugh & Liss, 1992; Fagot, 1974; Feinman, Roberts, Hsieh, Sawyer and Swanson, 1992; Martin, 2011; Nelson, 2011). This inclination is supported by parental tendencies to endorse gender-conformist play behaviours (Beresin & Sutton-Smith, 2010; Caldera, Huston & O'Brien, 1989; Eisenberg, Wolchick, Hernandez & Pasternack, 1985; Fagot, Leinbach& O'Boyle, 1991), particularly those which endorse hegemonic masculine ideas (Kane, 2006; Lynch, 2015). Thus, whilst the timing and intensity is mediated by a range of environmental factors (Fromberg & Bergen, 2006); parental attitudes and gender-conformism in play appear to influence the child's move towards gender constancy and the internalisation of stereotypic behaviours (Eisenberg, 1985). Furthermore, gender awareness leads children as young as two to reject gender-atypical play and opposite sex playmates (Faogot, Leinbach & Hagan, 1986; Leinbach & Faogot, 1986).

By the time they reach three, the majority of children therefore have a range of relatively stable schemata, with gender schema apparently one of the most common and robust. Although this was once an active area of research, it has seen relatively little psychological investigation in recent years and appeared ripe for revisiting. The intended initial task for the first study comprised sorting picture cards into "things for boys", "things for girls" and "things for boys *and* girls". Given its demonstrable primacy, it was decided to focus on images related to play. Drawings of common foods and household objects were to be included as filler items to distract participants from the obvious link between the play items. In order to ensure empirical legitimacy, all materials underwent a process of rigorous testing and modification. This process is detailed below.

4.4. Development of Materials

Addressing PhD Objective 1:

To develop a means of testing pre-school children for schema-based automaticity.

4.4.1. Stage 1.

An illustrator was recruited to produce bespoke illustrations for the picture cards. An opportunity sample of twelve participants (6m, 6f) aged 17-38 months were observed handling cards of differing sizes and thicknesses in order to assess their manageability. As a result, it was decided to mount images on 480 GSM card cut into 10cm x 10cm squares. The images were located in the upper portion of the card to allow a lower border of no less than 1cm so that the image was not obscured when the child held the card. Card holders were trialled but were found to impede rather than to aid handling.

4.4.2. Stage 2.

In order to augment test reliability a programme of familiarisation was undertaken with five schools and Pre-Schools across the East Midlands who had agreed to allow the recruitment of participants. This involved the researcher visiting the school on a bi-weekly basis to read a story and join in at playtimes prior to the participants being exposed to any materials. Following a wave of Ofsted inspections in March and April 2013, three of these schools felt they needed to postpone further involvement in the research programme in order to respond to Ofsted's findings.

Subsequent to this loss, Study One was conducted solely in the two remaining locations. Cohort One (C1) was a Nursery School in an area classified as amongst the 15% most deprived wards in the country (2800 / 32482, Indices of Deprivation, 2012), Cohort 2 (C2) was a Pre-School located in an area classified as amongst the 15% least deprived wards in the country (30657 / 32482, Indices of Deprivation, 2012). (See section 4.6.3. for further details).

The artist produced seventy-three separate images of toys, foodstuffs and everyday household items which the literature suggested were liable to be familiar and schema-congruent (Bandura, 1992; Eisenberg, Wolchick, Hernandez & Pasternack, 1985; Etaugh & Liss, 1992; Fagot, 1974; Feinman, Roberts, Hsieh, Sawyer and Swanson, 1992; Martin, 2011; Nelson, 2011) (see also section 1.5 and section 4.3). Each of these was subject to an "image recognition trial" by an opportunity sample of at least sixteen participants aged 30-48 months, drawn from C1, C2 and from children known to the researcher. Some trials were conducted with individual children, some with small groups (maximum n = 5). In every trial, participants were shown a batch of cards, each bearing an individual image, and invited to name them or to explain their use. Thus,

either “lawn mower” or (for instance) “Grandad cuts our grass” were taken as evidencing recognition.

Children’s understanding and responses to the cards were observed and recorded. Some cards were embellished or re-drawn as a result. It was discovered, for instance, that the addition of hands using or operating an item greatly increased children’s ability to discern its function. The ten images that were not instantly recognisable to the majority of participants (e.g. a baby doll and a microwave) were withdrawn from use. The remaining images were ranked in order of participant recognition. Twenty-five images were recognised by all participants. (See Appendix 1)

During an image recognition trial with a group of five children in Cohort 1 (m x 2, f x 3) one of the girls began to arrange the cards on the table, grouping together foods, vehicles etc. When invited to join in, the other girls added further cards and further categories but the boys struggled to contribute, despite their best efforts. It was felt that this warranted further investigation as it was feared that an inability to categorise would prove a confounding variable in the test for automaticity. As the boys in question were observed sorting shapes and toys later the same day, it was decided to investigate children’s ability to categorise a range of 2D images and 3D objects.

The findings from the initial study (see section 4.6.5.) were so compelling that categorisation, rather than schemata, ultimately became the central focus of the research.

Therefore, Study One eventually comprised a number of studies in an attempt to more clearly define the central concepts and appropriate methodology for the research. Study One also

ultimately served to ensure that Studies Two and Three were reliable and valid and removed some potential confounds.

4.5 Study One: Factors Impinging on Pre-School Children's Ability to Categorise

4.5.1. Background and Rationale: Concepts and Categories.

Concepts and categories provide a cognitively efficient means of delineating information (Rosch, 1973, 1975 & 1978). Whilst "concepts" are generally regarded as being the psychological representation of attributes, "categorisation" refers to the process by which ideas; events or objects are recognised and classified (Braisby, 2005; Gillibrand, Lam & O'Donnell, 2011). Categorisation behaviour thus involves consideration of the relationship between items through identification, labelling and sorting, followed by judgements about category membership (Martin, Rubel and Szkrybalo, 2002) (see also Sections 1.4. – 1.7.)

Categorisation research with pre-literate children has used a range of techniques including sequential touching (Bornstein and Arterberry, 2010; Mandler, Bauer & McDonough, 1991; Nelson, 1973; Oakes, Plumert, Lansink & Merryman, 1996; Rakison & Butterworth, 1998; Sugarman, 1983), deferred imitation (Meltzoff, 1988), generalised imitation (Mandler & McDonough, 1998) and spontaneous categorisation (Gopnik and Meltzoff, 1987). As this study had been initiated by children spontaneously sorting picture cards into categories, it was reasoned that a sorting task using the same cards with different children had both intrinsic and face validity. The cards themselves had already been assessed for clarity and familiarity, thus reducing potential confounds. Furthermore, sorting tasks have been widely used with adults and teenagers (Abdi, Valentin, Chollet & Chrea, 2007; Berland, Gaillard, Guidetti & Barone, 2015; Grant & Berg, 2000; Ross and Murphy, 1999) and are considered to be both reliable and ecologically valid. These same procedures were easily modified for use with young children.

Mandler (2004) claimed that the use of picture cards provoked antipathy amongst participant, subsequently serving to mask comprehension and constrain performance. She therefore replaced images with facsimiles of familiar objects, believing that the opportunity to physically manipulate objects increased participant engagement and facilitated understanding of the object and its properties. Other researchers have agreed that the use of objects produces more valid and reliable results (Oakes & Plumert, 2002), whilst also warning that the process needs

to be carefully managed. Prior to 15 months, children are inclined to freeze if they are presented with too large a range of objects, and are more responsive to the slow and gradual presentation of individual items. Children above this age are generally happy to investigate a range of toys. It was therefore decided to compare participant responses to images and objects in order to see if there was any demonstrable difference in terms of pre-school children's ability to categorise the two.

4.5.2. Section Overview.

Sections 4.6 – 4.9 comprises four studies which are presented chronologically in order to demonstrate how the investigation progressively grew and developed. Study 1(a) investigated pre-school children's ability to categorise. Results demonstrated a difference according to participant's sex, socio-economic background and presentation modality. Study 1(b) further investigated the impact of modality and dimensionality on children's ability to categorise. It served to confirm the findings of Study 1(a). An addendum investigated recall as a potential confound but failed to find any link between item recall and item categorisation. Studies 1(c) and 1(d) utilised match-to-sample techniques as this has been the favoured testing mechanisms for researchers into pre-school categorisation (Blaye, Bernard-Peyron, Paour & Bonthoux, 2006). Results suggested that the 1(a) materials and methodology were more sensitive to performance range than established testing mechanisms.

4.6. Study 1(a) An investigation into pre-school children's ability to categorise.

Objectives.

Addressing PhD Objectives 2-5

2. To develop a means of testing pre-school children for differing forms of categorisation.

3. To explore the role of sex / gender on the development of categorisation in pre-school children.

It is hypothesised that girls will perform better in categorisation tasks than boys.

4. To assess whether socio-economic status impacts the development of categorisation in pre-school children.

It is hypothesised that children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups.

5. To explore the impact of dimensionality on pre-school children's ability to categorise.

It is hypothesised that all participants will perform better on categorisation tasks when presented with objects than when presented with images.

4.6.1. Design

Fifty-two participants aged between 30 and 50 months completed a battery of five tests aimed at exploring the development of categorisational abilities. Participants were drawn from two different cohorts, one a Nursery in a deprived area and the other a Pre-school in a middle-class area. Every test was conducted individually by the researcher at a table in a quiet area of the Nursery / Pre-school. Participants were not provided with any training prior to the task or given any instructions other than those detailed below (see section 4.6.4. *Procedure*).

Participants were required to name each of the items on the image cards. The remaining four tasks all involved free-categorisation tasks. One task called for the children to categorise toys, the others required cards to be classified according to the colour, shape or image printed on them. The researcher offered encouragement and praise but no specific feedback. It was hoped to discover what criterion children use when categorising and whether any variations were apparent between groups. In light of previous research, it was predicted that girls would perform better than boys and that children from the higher socio-economic group would perform better than those from the lower socio-economic group. Evidence of a developmental trajectory was also anticipated.

4.6.2. Materials.

2D Categorisation.

The 25 images that were recognised by all children in the second stage of the "Development of Materials" trials were used, together with two additional cards that had been recognised by the majority of children and that greatly enhanced categorisation possibilities. All images were mounted on 10cm x 10cm 480 GSM white card. (See Appendix 1)

3D Categorisation.

Twenty-seven play items, matched as closely as possible to the 2D images were used. In the interests of safety and ethical probity, all toys had undergone rigorous safety testing and were, as far as possible, Fair Trade from sustainable sources (e.g. Hape, Plan). (See Appendix 2). The toys were transported in an attractive, colourful box.

Shape Matching.

Eight 10cm x 10cm 480 GSM white cards; 4 with a red triangle mounted on to them at different angles and 4 with a red square. (Initially fifteen cards were used but it rapidly became apparent that participants either could or could not sort shapes and increasing card numbers served only to elongate the process). (See Appendix 3)

Colour Matching.

Fifteen 10cm x 10cm 480 GSM white cards; six with a 7cm x 7cm pink square; six with a 7cm x 7cm blue square and three with a 7cm x 7cm square divided equally between pink and blue. Following some initial concerns that this may be fostering sexually stereotypical responses, a further set of yellow and green cards were used. There were no differences between the results for the two sets. As with shape matching, it was decided that fifteen cards were unduly repetitious and the test was reduced to nine cards, three of each type. (See Appendix 4).

4.6.3. Participants.

An initial pilot study (N12, C1 n6, 3f, 3m; C2 n6, 3f, 3m) suggested differences may exist between cohorts and between sexes. Seventy further participants were therefore recruited, fifty-two of whom completed the full test battery.

Cohort 1: 27 participants (12 m, 15f) aged 38-49 months (*M*= 43.46 months)

Cohort 2: 25 participants (12 m, 13f) aged 30-50 months (*M*= 40.78 months)

The ethnic breakdown for both Cohort 1 and Cohort 2 is predominantly White British, with both areas having a White British population between 96.6-98.2% (Office for National Statistics, 2012).

The Cohort 1 Nursery is in an area classified as containing older and mature housing of mixed tenure. The typical property price is low. The most common social group is C2DE (NRS social grades) with unemployment standing at 88% of the national average. People living here are generally qualified to a low level and typical employment type is classified primarily as skilled manual or unskilled, but with a small number of white collar workers (Office for National Statistics, 2012).

The Nursery is attached to a Primary School, with day-to-day running being orchestrated by a Nursery teacher and three Teaching Assistants but with overall management and decision making lying with The Infant School Headteacher. All participants attend Nursery for fifteen hours per week. Testing took place in the kitchen area or book corner of the Nursery, each of which was relatively quiet and secluded.

The Cohort 2 Pre-School is in an area abutting a University campus, where properties are mainly detached or semi-detached and owned outright or mortgaged. The properties are generally large in size. The most common NRS social group is ABC1 and the people living here are generally qualified to a high level with the typical employment type being professional or white collar with some blue collar workers. The number of directors is 11% higher than the national average. (Office for National Statistics, 2012).

The Pre-School is a charitable organisation managed by a full-time Supervisor and a team of part-time play leaders. It is a member of the Pre-School Learning Alliance and is run co-operatively by staff and a committee of parents who share responsibility for management and decision making. The Pre-School meets in a Community Hall and testing took place at a table set up at the side of the hall.

4.6.4. Procedure.

Participants were invited individually to play some sorting games with the researcher. Participants were told that there were games with colours, shapes, pictures (2D) and "things in the box" (3D) and invited to choose which they would like to play. This served to randomise test order. A record was made of the order in which tests were completed.

Each participant was seated to the researcher's left, enabling her to record all responses on a notepad to her right. These were checked for legibility before the end of the session and any salient points added. This included interruptions, anything unusual in the child's demeanour or anything interesting or unusual they said. These were further clarified at the end of the day and retained as field notes. The scores from each test were then transcribed onto the proforma (see Appendix 5).

The procedures for each of the four conditions, shape, colour, 2D and 3D are outlined below.

Shape.

Participants were told they would need to "sort out which cards go together". The cards had either a red square or a red triangle on them, set at differing angles. The researcher held the pack of eight cards ready to show individually to the participant.

The researcher placed the first card, with a triangle on it, face up on the table between herself and the participant saying, "Look at the shape on this card", whilst she traced round the periphery of the triangle with her finger. The second card showed a square. The researcher said, "Look at the shape on this card," (as she traced the periphery of the square with her finger), "where shall we put it?" The majority of participants indicated a place next to the triangle, thus forming a new pile. If a child indicated that the square should be placed on top of the triangle, the researcher asked, "Do they go together?" and once again traced the edges of each shape.

Participants were then shown each of the cards individually and allowed to either place them where they wished or to point to where they wished the researcher to place them. On the rare occasions that the participant placed all of the cards in a single pile, after all eight cards had been produced; the child was asked if they were happy that they had sorted the cards that went together.

Regardless of outcome, every child was congratulated ("You sorted all of them!" "You thought really hard about that!") and asked if they would like to play another sorting game.

Colour.

Participants were told they would need to "sort out which cards go together". The original set of cards had a pink square, a blue square or a square which was half pink and half blue. Following initial concerns that this may evoke sexually stereotypical responses, a set of green and yellow cards was produced. The two sets were used interchangeably. The researcher held the pack of fifteen cards and showed them individually to the participant. The first five cards to be proffered were always in the following order

1. pink/yellow,
2. blue/green,
3. blue/green,
4. pink/yellow,
5. split card.

The researcher said

1. "I've got a pink/yellow card!" and placed it face up on the table between the participant and the researcher.
2. "I've got a blue/green card! Where should I put this one?" The vast majority of participants indicated a place next to the first card. The card was then placed face up on the table, thus forming a separate pile. If the child pointed to the first card, the researcher said, "Do they go together, the pink/yellow card and the blue/green card?" On the rare occasions that the participant replied in the affirmative, the cards were placed in a single pile and, after all fifteen cards had been produced, the child was asked if they were happy that they had sorted out the cards that went together.

Regardless of outcome, every child was warmly commended and then asked if they would like to play another game.

2D Image Cards.

The set of twenty-seven 2D picture cards were shown to participants as a pack and they were told that some of the cards were of "the same sort of thing" or of "things that go together". They were told that the game was to find the things that were the same or went together. The researcher turned over the first card and said "What's this?" and then, after affirming the

participant's response ("Yes, an apple"), placed the card face up on the table. The researcher then showed the child the second card and again asked "What's this?" After the child had named it the researcher asked, "The (first card) and the (second card), do they go together?" When the child responded in the negative, the researcher placed the card face up next to the first one. The fifth card always offered a clear perceptual match to one of the first four cards (for instance a football and a beach ball). If the child recognised the link, the researcher moved the relevant cards to the top of the table and placed them next to each other, ensuring that each image was still visible and that there was space to add further cards if the participant wished to extend the category. A clear thematic link followed rapidly after this (for instance a banana and an apple) and the researcher said "What a good idea! They don't look the same but they go together!" The cards were then placed together as before at the top of the table.

In some instances, the researcher showed the child each image; in others, participants preferred to hold the cards themselves. Beyond the first few enquiries from the researcher, most children rapidly began to name each image as it was turned over.

The researcher regularly asked, "Can you see any things that go together?" It might be things that are the same or things that you just think go together".

Once all of the cards had been placed on the table, the participant was asked whether they felt they had found all of the things which went together. No time limit was placed on the process; the researcher relied on cues from the participant that they felt they had completed the task. A note was made of the approximate time taken in order that the same length of time could be allocated to the toy sorting task.

Participants were then warmly congratulated for doing "good naming and sorting".

3D Objects.

Participants were shown the box with its lid on and told that some of the items inside were "the same sort of thing" or "things that go together". The lid was then removed and items placed individually on the table. The participant was invited to name each item and to look for other toys which were the same or which went with it. In some instances, participant enthusiasm hastened this process and toys were tipped unceremoniously on to the table. Participants were allowed to play with the items as they sorted them into groups.

A note was made of the approximate time taken in order that the same length of time could be allocated to the card sorting task.

Timing Protocols.

Although the time taken varied between participants, an attempt was always made to match the individual participant's timings for both the 2D and the 3D tests. Thus, if a participant spent five minutes sorting the picture cards, they were allowed approximately five minutes to complete the toy sorting task.

At the end of each test battery, participants were thanked and praised. The majority asked to play a further game. Each participant was invited to choose a sticker as a "reward"; this also served to alert parents and carers to the fact that their child had been involved in the research that day. A record was kept of whether children completed all five tests in one day or if participation was spread over several sessions. (In the majority of instances, participants completed all tests in a single sitting but it was sometimes considered necessary or propitious to pause – for instance when the school photographer arrived or the doors were opened for children to play outside. Testing was always halted if a participant appeared distracted or disengaged.)

Information from the Record Sheets was then transferred into the IBM Statistical Package for Social Sciences Version 22 (SPSS) and anonymised.

Many children asked to play the games again during later visits by the researcher, allowing test-retest reliability to be evaluated.

4.6.5. Results.

4.6.5.1. Analytic Strategy

This study involved five separate tests, with analysis incorporating sex and cohort effects. This section shall provide descriptive statistics and, where appropriate, inferential statistics and supplementary analysis for each of the tests in turn.

4.6.5.1.1. Data Screening

All data was manually entered into SPSS and checked repeatedly (over a period of several days) for accuracy of transcription. Data was not reduced, cleaned or transformed in any way.

Prior to inferential analysis, data for each individual component was screened to ensure that it met parametric assumptions.

Data was checked (initially by means of visual inspection of histograms, stem-and-leaf and box-plots and then through use of Kolmogorov-Smirnov or Shapiro-Wilks tests in SPSS) for normality of distribution, the presence of outliers and, in the case of independent measures designs, for homogeneity of variance. The skewness and kurtosis statistics reported within SPSS were then used to calculate z scores, which provided a mathematical estimate of the normality of the distribution. Given the small sample sizes in these studies, scores over 1.96 were regarded as being significantly skewed or kurtosed at p=.05. No outliers were apparent in any of the following studies.

4.6.5.1.2. Statistical Testing

Hypotheses 1. *Girls will perform better in categorisation tasks than boys* was investigated by means of a series of one-way and two-way ANOVAs

Hypothesis 2. *Children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups* was investigated by means of a series of one-way and two-way ANOVAs.

Hypothesis 3. *Participants will perform better on categorisation tasks when presented with objects than when presented with images* was investigated by means of a 2 (sex) x 2 (cohort) ANOVA.

4.6.5.2. Picture Identification.

Image recognition and naming was generally high with 86.5% of participants achieving over 93% accuracy (M = 25.7 images). In Cohort 1, 66.7% of the girls correctly identified all 27 images as compared to 41.7% of the boys. Whilst only one girl in this cohort recognised less than 26 of the 27 cards (M = 26.1), five boys correctly named less than 24 (M = 25, Mode 27). In Cohort 2, only one participant recognised less than 25 images (M = 26.2; Mode 27). A two-way ANOVA was conducted to investigate whether identification scores varied according to the participant's sex and/or cohort. The results demonstrated that girls identify more images than boys, (F (1, 53) = 3.72, p = .05, η^2 = .03). However, no significant difference was found between cohorts (F (1, 53) =1.74, p =.19, η^2 = .21), nor was there a significant interaction

between sex and cohort (F (1, 53) = 1.52), p = .22, η^2 = 0.0002). These results support Hypothesis 1 but do not support Hypothesis 2.

4.6.5.3. Categorising Shape.

Of the 54 participants, 47 were able to categorise the shape cards (87%). Of those participants who were unable to categorise shape, six were male, one was female; five were in Cohort 1 and two in Cohort 2.

A series of one-way ANOVAs indicated that the ability to categorise shapes did not differ according to age (F (1, 53) = 1.22, p = .30, η^2 = 0.26); those participants who were unable to categorise according to shape were not necessarily the youngest. No significant difference was found between the two cohorts (F (1, 53) = .06, p = .49, η^2 = 0.009). The ability to categorise shapes did, however, vary significantly according to sex, with girls performing better than boys (F (1, 53) = 1.21, p = .001, η^2 = 0.02).

With regard to shape categorisation, the results support Hypothesis 1 but do not support Hypothesis 2.

4.6.5.4. Categorising Colour.

Only 1 participant (Cohort 1, m) was unable to match the single coloured cards.

However, the split-colours card evoked a range of responses

- Fifteen participants created a new category pile for the split cards (Cohort 1, 3m, 7f; Cohort 2, 3m, 2f)
- Some participants appeared to change categorisation criteria and placed all solid colours in one pile and all split colours in another
- Some participants gave all split cards to their favourite single colour
- A few participants rearranged all cards into a pattern with matching colours touching.

(In subsequent studies, participants were made aware prior to the beginning of the test that there were three different types of cards and this served to reduce the confusion and the range of responses).

Analysis of variance indicated that the ability to categorise on the basis of colour did not differ according to age (F (1, 53) = 1.52, p = .14, d = 0.66). Due to the confusion created by test instructions, no further analysis was conducted on participant responses.

4.6.5.5. 2D Categorisation.

4.6.5.5.1. Data Screening.

Data was prepared and screened as detailed in section 4.6.5.1.1. With regard to the number of categories created from images, scores ranged from 0 to 13 (M = 3.35, SD = 3.01), z = 1.39 suggesting that the data was normally distributed and suitable for parametric testing. Data showed no significant skew or kurtosis and no outliers needed to be removed from the sample. Data was therefore analysed using a two-way ANOVA.

4.6.5.5.2. Descriptive Statistics.

Two boys in Cohort 1 and two boys in Cohort 2 were unable to create any categories (Cohort 1 male M = 1.8; Cohort 2 male M = 2.0). No girls in either cohort were unable to create categories (Cohort 1 Female M = 3.4; Cohort 2 female M = 5.5). In Cohort 1, 85% of participants identified between one and three different categories, no one identified four categories and only one participant identified more than five different categories. In Cohort 2, 64% of participants identified between one and three different categories, 6% identified four, five or six categories and 30% of participants identified seven or more different categories. In both cohorts, the highest score was nine categories (M = 2.7, SD = 2.4). In each case the highest scoring participant was a girl.

Figure 2: Mean number of categories identified from picture images by sex and cohort

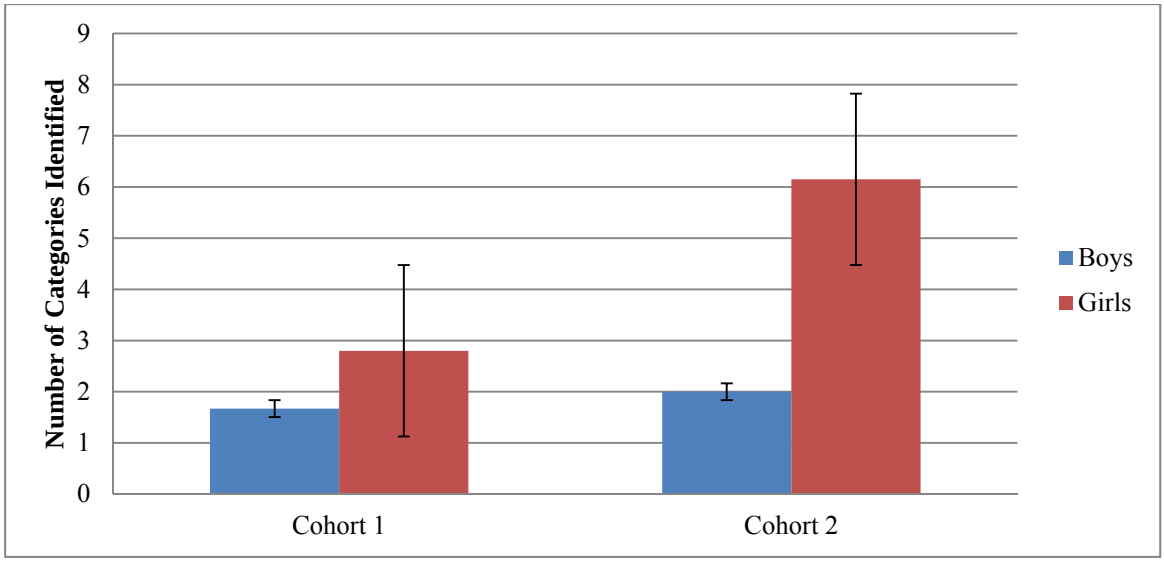


Figure 2 shows the mean number of categories participants identified from the picture images. The figure shows that, in each cohort, the girls performed better than the boys and that children in Cohort 2 performed better than those of the same sex in Cohort 1.

4.6.5.5.3. Inferential Statistics.

A 2 (sex) x 2 (cohort) ANOVA demonstrated a main effect of sex (F (1, 53) = 8.06, p = .01, η^2 = 0.06) with girls performing better than boys. This supports Hypothesis 1. Children from Cohort 2 created more categories than the children from Cohort 1 but this result was not significant (F (1, 53) = 3.83, p = .06, η^2= 0.06). Hypothesis 2 was therefore not supported. There was a significant interaction between sex and cohort (F (1, 53) = 7.51, p = .01, η^2= 0.13). Data was therefore subject to two one-way ANOVAs; these showed no significant difference between girls and boys in Cohort 1 (F (1, 27) = 0.07, p = .79, η^2= 0.001) but significant differences in Cohort 2 (F (1, 26) = 17.74, p = .000, η^2= 0.16).

Some preliminary analysis was also conducted as to the criteria participants utilised when categorising images. Table 2 shows that the most widely cited categories are “birds” and “balls”, primarily images (a) and (b) (see Table 3) which share clearly discernible physical features. Few males recognised categories beyond these.

Table 4: Most frequently cited 2D categories by sex and cohort

Category	Cohort 1 Male	Cohort 1 Female	Cohort1 Total	Cohort 2 Male	Cohort2 Female	Cohort2 Total	Sample Total
Birds	8	14	22	7	4	11	33
Balls	2	4	6	5	4	9	15
Foods	1	6	7	2	2	4	11
Found in Park	0	1	1	1	4	5	6
Vehicles	1	2	3	1	2	3	6
Colour	3	2	5	0	0	0	5
Toys	1	0	1	1	2	3	5

Figure 3: Most Frequent Matches

(a) (b) (c)

(a) (b) (c)

4.6.5.6. 3D Categorisation.

4.6.5.6.1. Data Screening.

Data was prepared and screened as detailed in section 4.6.5.1.1. Z-scores were calculated for raw scores. When considering the number of categories created from toys (*M* = 6.4, SD = 3.1), z = 1.48, suggesting that the data is normally distributed and suitable for parametric testing. Data was therefore analysed using a two-way ANOVA.

4.6.5.6.2. Descriptive Statistics.

All participants were able to identify at least two different categories (*M* = 6.4, SD = 3.1). The highest three scorers were all female, identifying 11, 13 and 15 different categories respectively (Female *M* = 7.7; Male *M* = 4.95, overall *M* = 6.32, SD = 3.12). In Cohort 1, scores varied from 2-15 (*M* = 6.6) whilst in Cohort 2 scores were clustered between 2 - 9 (*M* = 5.9).

Figure 4: Mean of categories identified from 3D objects by sex and cohort

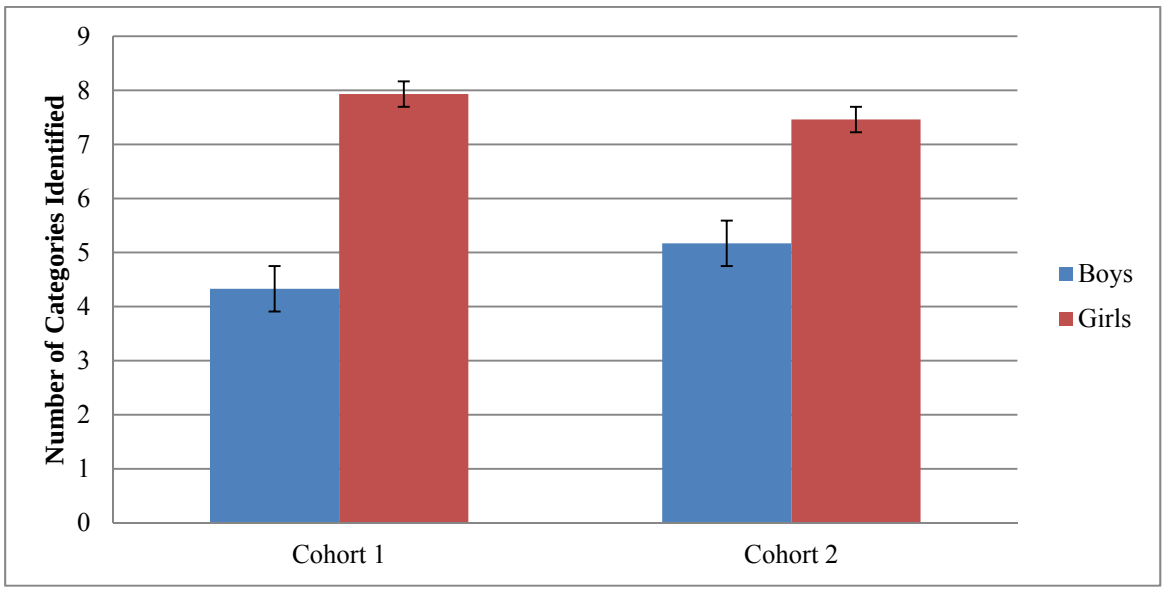


Figure 4 shows the number of categories participants recognised when using 3D objects. The figure shows that girls identified more categories than boys in both cohorts. However, whilst the boys in Cohort 2 identified more than the boys in Cohort 1, this was reversed for the girls.

4.6.5.6.3. Inferential Statistics.

Data was subject to a 2 (sex) x 2 (cohort) ANOVA. This indicated that girls identified significantly more categories from 3D objects than boys (F (1, 51) = 13.3, p = .001, η^2= 0.21). This supports Hypothesis 1. No significant difference was found between cohorts with regard to the number of categories formed using objects (F (1, 51) = .01, p = .94, η^2= 0.001). Hypothesis 2 was not supported. There was not a significant interaction between sex and cohort with regard to 3D categorisation (F (1, 51) = .37, p = .55, η^2= 0.007).

4.6.5.6.4. Exploratory Correlations.

Accuracy in card identification and accuracy in matching shapes showed a strong, positive correlation, (r =.5, n = 43, p = .001). The relationship between 2D category identification and accuracy in matching shapes was also found to be significant (r = .4, n = 41, p = .002).

The test – retest coefficient across all tests was calculated at r = .83

4.6.6. Interim Discussion.

The purpose of this study was to investigate pre-school children's ability to categorise. In light of previous research with young children, it was anticipated that the majority of participants would be able to categorise on the basis of colour and shape (Bornstein, 2006; Bornstein, Kessen & Weiskopf, 1976; Franklin & Davies, 2004). Observations during the trialling of materials (see section 4.4.2), and previous developmental research (Badham & Maylor, 2015; Chow & Conway, 2015; Gopnik & Meltzoff, 1997; Strand, 2014; Wallace & Russ, 2014), had fostered an expectation that girls would perform better than boys, particularly when presented with images. As boys had been observed categorising toys during free-play, less differences were expected between the sexes with regard to categorising objects. Previous research had found differences in achievement levels between socio-economic groups (Bulut, 2013; Gupta, 2000; McKinney, McClung, Hall, Cameron & Lowden, 2012; Mensah & Kiernan, 2009; Snook & O'Neill, 2010); it had therefore been questioned whether this would extend as far as categorisational ability amongst pre-school children (Gopnik & Meltzoff, 1987). Significant differences were found between the sexes, with girls doing better in each of the tests. Whilst the differences between cohorts were not found to be significant, the children from the middle-class cohort did consistently better than their peers from the more disadvantaged cohort.

Almost without exception, participants created more categories, and used more items within the categories, when working with toys than when working with images.

A rigorous review of all aspects of the test was conducted to ensure that any potentially confounding features were eradicated prior to Study 2. The researcher analysed data and field notes and held discussions with the supervisory team and with Nursery staff in order to fully reflect on participation, materials, outcomes and her own performance. There were a number of areas where it was felt improvements could be made. Both the errors and the remedial action are detailed below.

Each test shall now be considered in turn.

4.6.6.1. Image Recognition Test

Image recognition was high amongst most participants, which was taken to validate both the choice of subject matter and the clarity of the images. Participants frequently expressed delight and interest in the drawings. Given that participant engagement and enjoyment had been identified as an important consideration, it was decided to retain the cards used in this study and request further images to be drawn in the same style. In light of the demonstrable success of the "image recognition" trials in screening out unfamiliar or confusing images, it was also decided to replicate this procedure for all subsequent tests requiring new images.

The lowest image identification rates were amongst boys from the disadvantaged background. It was initially questioned whether, in some instances, this may be linked to vocabulary limitations (one boy named all food stuffs as "eat eats"; another repeatedly referred to a car as "Daddy"). Although this is in accordance with findings that girls generally acquire language more easily and more rapidly than boys and retain linguistic superiority throughout childhood (Eriksson, Marschik, Tulviste, Almgren, Pereira, Wehberg & Gallego, 2011; Schaadt, Hesse & Friederici, 2015; Schachter, Shore, Hodapp, Chalfin & Bundy, 1978), the scale of the observed limitations came as a surprise. Paucity of vocabulary was, however, clearly not the sole cause, as some competent conversationalists also struggled to name all of the images. Furthermore, the C1 boys were the poorest performing group in every test, including those which had no oral component. It therefore appeared unlikely that their difficulties with this task were so isolated and specific. Whilst Nativist theories contend that guidance from innate principles will allow language to develop despite poverty of stimulus (Chomsky, 1957; Gold,

1967; Pinker, 1979), other theoretical positions recognise environmental factors as playing a substantive role (Ambridge & Lieven, 2011). A severely restricted vocabulary may therefore be variously regarded as evidencing some cognitive delay or impairment; an absence of suitably presented and reinforced stimuli (Skinner, 1957); or cognitive concepts too inadequately developed to support grammatical mapping (Cromer, 1991; Dodd & Crosbie, 2004). In short, vocabulary limitations of this magnitude are generally indicative of other issues, be they internal or external to the child. As previously noted, factors which restrict language acquisition affect males most sharply and, for the boys in C1, this tendency is further exacerbated by their socio-economic disadvantage, which has been linked to lower linguistic attainment during the Foundation Stage (Mensah & Kiernan, 2010; Save the Children, 2014).

Whilst language is not a prerequisite of inductive inference (Baldwin, Markman & Melartin, 1993), an ability to provide category labels aids categorisation for both adults (Lupyan, Rakison & McClelland, 2007) and children (Althaus & Plunkett, 2015; Dewar & Xu, 2009). It was therefore postulated that an aggregation of internal and external factors had contributed to the boy's linguistic limitations. It is possible that this same cocktail of issues constrained performance in other test areas or served to exacerbate additional weaknesses and difficulties. It is also feasible that these factors were the antecedents of a domino-effect wherein they limited language, which in turn constrained performance in other fields. These possibilities are considered in greater detail in the final discussion (see Chapter 7).

4.6.6.2. Colour and Shape Tests

As has already been noted, the sudden emergence of a split-coloured card served to confuse many children during the colour categorisation task and resulted in a wide range of ostensibly "wrong" responses, with children failing to correctly match colours beyond that point. As it became apparent that the confusion was wide-spread amongst participants, the researcher amended her introductory strategy to either explain or show participants there were three different sorts of cards. When children were told shown that there were some pink (yellow), some blue (green) and some mixed cards prior to beginning the task, performance rates improved. It was therefore felt that the researcher's initial failure to prepare participants for the split card had acted as a confounding variable and produced a number of false negative results. This was rectified in subsequent studies.

The majority of participants demonstrated an ability to categorise on the basis of colour and shape from as young as thirty months. Age did not therefore appear as a significant factor in these tests, as even the youngest participants had generally already mastered this form of sorting. This finding would appear to support previous research which asserts that colour and shape categorisation emerge in infancy (Bornstein, 2006; Franklin & Davies, 2004; Mareschal & Quinn, 2001). Conversations with Nursery Staff further suggested that, where older children were unable to categorise according to shape or colour, it was often indicative of a broader delay or impairment (Chakrabarti & Fombonne, 2005; Edwards, Perlman & Reed, 2012). In the majority of cases, these children were subsequently deemed to require additional help and support within the Nursery.

4.6.6.3. Amendments to Participation Criteria

With regard to the 2D and the 3D tests, analysis again suggested that age was not a significant factor, although this seemed counter-intuitive during a period of such well documented cognitive growth and change. The only exclusion criterion for this study had been cognitive impairment of a degree which precluded attendance at a mainstream nursery. As a result, several children with undiagnosed delays participated in the study and all participants attempted the full battery of tests. The older participants who had been unable to categorise on the basis of shape, were also largely unable to categorise the 2D images or the 3D objects. It appeared that the absence of an exclusion criterion had served to mask the typical developmental trajectory and potentially led to a Type 1 error. Additionally, the sample spanned a relatively narrow age range with few children below thirty-six months or above forty-six months and with several large clusters. It was therefore deemed appropriate to expand the age range for subsequent studies in order to see whether age became a factor. As the primary focus was on typical development, these findings served to inform participation and structuring decisions for the remainder of the studies. In all subsequent test batteries, colour and shape were presented as the first two components. If participants were unable to complete either task, the process was gently terminated or, if participants were enjoying the “games” and wished to continue, they were allowed to do so but staff guidance was sought regarding inclusions of their data. In all instances the children were praised for their efforts and achievements.

4.6.6.4. Image and Toy Categorisation.

Initial analysis of the most commonly occurring 2D categories can be taken to evidence support for both the "exemplar" explanation of categorisation (Medin and Schaffer, 1978; Nosofsky, 1991; Kruschke, 1992) and the assertion that basic level categorisation precedes the use of subordinate or superordinate categories (Rosch, 1978; Rosch, Mervis, Gray, Johnson & Boyes-Braem, 1976). Most participants selected regularly encountered items such as balls and birds. It was also notable that children in suburban Cohort 2 frequently grouped items that may be found in the park, whilst the Cohort 1 children, who live in a built up area, failed to do so. The most popular superordinate category, and the category which attracted the most items for inclusion was "food", which each participant has regular exposure to. Participants did, therefore, give the appearance of drawing on both episodic and semantic information (Baddeley, Eysenck & Anderson, 2015) in order to formulate their categories. Furthermore, those items which had been amenable to deep-level processing through self-referencing (Symons & Thompson, 1997) and to binal storage (Paivio, 1971) appeared to have been more accessible to recall. However, as all images had been specifically selected for their familiarity and typicality, it was questioned whether this had served to direct potential responses. Conclusions regarding the role of episodic memory and the use of exemplars in this test are therefore necessarily tentative.

The majority of participants selected basic level categories, primarily birds and balls. However, whilst this could be regarded as evidence that basic level categorisation is the first of the hierarchical levels to emerge (Rosch, 1978; Rosch, Mervis, Gray, Johnson & Boyes-Braem, 1976) it could equally be regarded as a simple matching of visually similar items (Mandler & McDonough, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997). For instance, the common crow and the rare crested lark were the most common match, followed by the football and the beach ball. It is highly unlikely that any participant based their criteria on their personal experience or physiological understanding of crested larks. It would seem more feasible that the phenetic similarities between these category members had fostered recognition of equivalence (Quinn & Eimas, 1996); especially as they shared key distinguishing features (Quinn, 2004) and conceptual coherence (Blanchet, Dunham & Dunham, 2001; Gelman & Davison, 2013). Additionally, the superordinate category members on offer (the dog could, for instance, have been added in order to create a superordinate "animal" category) were physiologically dissimilar and so a clear understanding of their biology was required in order to create the grouping. Hence, basic level categories that can be formed on the evidence of

physical similarities are very clearly "right", whereas subordinate and superordinate categories often necessitate a degree of specialist knowledge which the child may not yet possess or may not have sufficient confidence to propose to an adult (Bergman, 2011; Risko, Laidlaw, Freeth, Foulsham & Kingstone, 2012). The frequent clustering of food items did, however, provide clear evidence that three-year-olds are able to form superordinate categories, which brings into questions the assertions of Fang, Fang and Xi (1991) and Liu, Song and Seger (2012) that superordinate categorisation does not emerge until the sixth year. Familiarity and certitude appeared to be key factors here.

With this test format and this selection of images, physical similarity amongst basic level categories appeared to be the most secure, accessible format for categorisation. This would fit with previous research findings that categories emerge in accordance with the extent of cognitive effort (Collins and Quillian, 1969) and the amount of specialist information they require (Anderson, 1991; Colunga & Smith, 2005); as subordinate categories are generally specific and precise, these are the last to embed but the emergence of basic and superordinate categorisation is probably at least partially shaped by their accessibility and salience (Mandler & McDonough, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997).

The structure of this test had required participants to name every image prior to sorting and, as Gelman and Davidson note (2013), similarities between labels provide an additional measure of comparability. Furthermore, articulation accesses the phonological loop and the item is subsequently subject to dual processing (Baddeley, Lewis & Vallar, 1984). As a result, recognised items underwent semantic encoding, greater elaborative rehearsal and deeper level processing (Craik & Tulving, 1975; Unsworth, 2015), which should have rendered them more accessible to recall (Saeki & Saito, 2004; Saeki, Baddeley, Hitch & Saito, 2013). This was more pertinent to some items than to others. The aural similarities between the beach *ball* and the foot*ball* provided additional lexical and auditory cues to augment their perceptual similarities. Similarly, the majority of participants named both the crow and the crested lark simply as "bird". In each instance, language may feasibly have played a role in the categorisation criteria (Callanan, 1985; Gopnik & Meltzoff, 1997; Markman, 1989).

The bulk of the low-scoring participants were boys from Cohort 1. In the majority of instances, they recognised only two categories, the two perceptually similar birds (see Figure 3) and the two perceptually similar balls (see Figure 3). A range of potential explanations for this limited response were propounded. It is possible that a paucity of instructive experiences (Erzurumlu,

Guido & Molnar, 2006) and / or neural immaturity had led these boys to utilising the sort of rudimentary categorisation skills that are heavily reliant on discernible environmental stimuli and more usually associated with infancy (Gelman & Davidson, 2013; Mandler & McDonough, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997). Alternatively, as witnessed in the image naming task, many of these boys suffered from an impoverished vocabulary but had sufficient linguistic proficiency to name the birds and the balls. This had enabled dual processing (Baddeley, Lewis & Vallar, 1984), semantic encoding and deeper level processing (Craik & Tulving, 1975; Unsworth, 2015) for these, but only these items. This would therefore suggest that language is the major protagonist in constraining encoding, categorisation and recall. Conversely, in line with categorisation theory, it is also possible that these children's lexical deficits had prevented conceptualisation from moving through the expected levels of refinement and abstraction (Anderson, 1991; Callanan, 1985; Colunga & Smith, 2005; Gopnik & Meltzoff, 1997; Markman, 1989), rendering them cognitively immature.

The results of this study had thus served to raise an abundance of questions regarding the role of visual and aural cues, the emergence of hierarchical levels and the importance of typicality. Each of these factors were therefore addressed in Study 1(c) and then in Study 2.

As has been previously noted (see Chapter 1), there is wide spread agreement amongst theoreticians that categorisation begins with perceptual similarities (Badger & Shapiro, 2015; Deng & Sloutsky, 2015; French, Mareschal, Mermillod & Quinn, 2004; Mareschal, French & Quinn, 2000; Quinn, Eimas & Rosenkrantz, 1993) and develops to incorporate progressively greater abstraction (Carey, 1999; Inagaki & Hatano, 2002), with the shift towards conceptual categorisation occurring when children are aged around six- to seven-years-old (Badger & Shapiro, 2012; Fang, Fang & Xi, 2012). Whilst many have suggested that young children lack the world knowledge to classify on anything other than perceptual qualities (Keil, 1989; Keil & Batterman, 1984, Murphy, 2001) there was evidence of many three- to four-year-old participants (primarily girls), forming thematic links between items, suggesting they were activating conceptual webs. Furthermore, their categories were not biologically grounded and required considerable cognitive effort, both of which are generally associated with older children (Badger & Shapiro, 2012; Gelman & Waxman, 2007). Whilst there has been some previous evidence of preschool participants utilising thematic criteria, it has generally been in response to instruction or researcher manipulation (Deak, 2000; Nguyen & Murphy, 2003).

Given that this finding ran somewhat against the grain of previous research, the ability of pre-school children to formulate thematic categories was felt to warrant further investigation.

One of the most striking aspects of the analysis was that girls performed better than boys in every instance and often by a considerable margin. This mirrors many previous research findings pertaining to developmental milestones (Badham & Maylor, 2015; Chow & Conway, 2015; Gopnik & Meltzoff, 1997; Halpern, 2012; Junaid & Fellows, 2006; Smith, Cowie & Blades, 2003) and educational attainment (Department for Education, 2015; Gupta, 2000; Machin & McNally, 2005). It has already been noted that this first sample contained several (at the time) undiagnosed disorders and atypicalities. Cohort 1 shares a site with a specialist Autistic Unit. As the incidence of pervasive developmental disorders is higher amongst the siblings of children with autism (Lauritsen, Pedersen & Mortensen, 2005) and higher amongst boys (Chakrabarti & Fombonne, 2005), it was questioned whether some of the difficulties being encountered by boys in Cohort 1 may be attributable to Autism Spectrum Disorder (Edwards, Perlman & Reed, 2012). However, whilst two of the participants did have siblings in the Unit, one participant was male and the other female and although neither had excelled at the tasks, nor had they struggled unduly. This explanation was therefore discounted.

It was noted that, as well as generally recognising more conceptual links, girls also proffered more imaginative abstract categories (one girl suggested that the washing machine, car and ball formed a "go round and round" category and that the ball and dog belonged together in a category of "bouncy things"). It was considered that this may be linked to the reading of picture books at home (Logan & Medford, 2011), to higher instances of imaginative play (Serbin, Moller, Powlishta & Gulko, 1991) or to superior linguistic skills (Goldin-Meadow, Levine, Hedges, Huttenlocher, Raudenbush, & Small, 2014; Gopnik & Meltzoff, 1987; Gopnik & Meltzoff, 1997; Schachter & Coll, 1978). These differences between the sexes were to prove a feature of subsequent studies and so are discussed in greater detail following Study 2.

The other particularly striking feature was the finding that virtually every child performed better when the task involved toys than when it involved images and this trend was most apparent amongst boys. This serves to validate Mandler's (2004) assertion that the provision of objects enables participants to explore their properties and qualities whilst images engender participant apathy. As many theories regarding the development of categorisation during the pre-school period are predicated on the use of image based match-to-sample tasks (Blaye, Bernard-Peyron & Bonthoux, 2000; Diesendruck, Hammer & Catz, 2003; Fang, Fang & Xi,

1991; Gelman & Markman, 1986; Liu, Song & Seger, 2012; Scheuner, Bonthoux & Cannard, 2004; Yao & Sloutsky, 2010), it also brings into question their conclusions regarding the age at which key abilities emerge. It appears highly possible that the use of images in tests had masked participant's conceptual understanding.

By and large, superior performance was also associated with socio-economic status, with the girls in Cohort 2 achieving the highest scores and boys from Cohort 1 achieving the lowest scores. These results mirror research findings regarding the link between deprivation and low academic achievement (Gupta, 2000; Snook & O'Neill, 2010) and are also in keeping with national trends at GCSE, where middle class girls achieve most highly and working class boys achieve the poorest results (Department of Education, 2013). The superior performance of the girls from the more disadvantaged background in the 3D categorisation test, however, remains an anomaly. Whilst conclusions from such a small scale investigation must necessarily be tentative, this clear gender divide amongst pre-school aged children helps to contextualise boy's poor academic and examination performance later in the school system. It is suggested there are likely to be contiguous factors contributing to this achievement gap (NatCen, 2013). These shall be discussed in greater detail later.

These results clearly required further investigation in order to ascertain whether they were context specific or replicated in other settings with similar cohorts. It was therefore decided to extend the study and recruit further participants from diverse backgrounds. (See Study 2)

In order to check for potential confounds within Study 1(a), a further small scale study was undertaken.

4.7. Study 1(b) The Impact of Modality and Dimensionality on Pre-School Children's Ability to Categorise

Addressing PhD Objectives 3 - 6.

3. To explore the impact of sex and socio-economic status on the development of categorisation in pre-school children.

4. To explore the impact of dimensionality on pre-school children's ability to categorise.

5. To extend psychological understanding of how differing forms of categorisation emerge and develop.

In order to address these objectives, the following hypotheses were pursued:

1. Girls will perform better in categorisation tasks than boys.

2. Children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups.

3. All participants will perform better on categorisation tasks when presented with objects than when presented with images.

4.7.1. Design

Whilst several studies have suggested that three-year-old children are able to distinguish between images and reality (Estes, Wellman, & Woolley, 1989; Wellman & Estes, 1990) or between toys / pictures and reality (Woolley & Wellman, 1990), other studies have suggested they struggle to differentiate between reality and fantasy (Samuels and Taylor, 1994; Taylor & Howell, 1973). It was therefore questioned whether the whimsical nature of the illustrations used in Study 1(a) had rendered them more difficult to categorise than objects. An investigation was therefore conducted in which 47 participants, once again drawn from Cohorts 1 and 2, were required to separately categorise drawings, photographs and toys. Each participant was tested individually by the researcher at a table in a quiet area of the Nursery. Given that Study 1(a) had shown scores were increased when children were presented with toys (M = 6.35, SD = 3.12) instead of images (M = 3.35, SD = 3.01), the following hypotheses were generated:

It is predicted that more categories will be produced from toys than from images.

It is predicted that categorisation will differ according to the mode in which images are presented.

It is predicted that girls will identify more categories than boys in each modality.

It is predicted that older children will identify more categories than younger children in each modality.

4.7.2. Participants.

Materials were initially trialled with an opportunity sample of six participants who were known to the researcher (3 m, 3 f, M = 39 months). Following minor adjustments (for instance, altering the angle of a photograph to increase its similarity to the drawing), the test was then run with

47 participants (23m, 24f); 32 were from Cohort 1 (14m, 18f, *M* = 43 months) and 15 from Cohort 2 (9m, 6f) none of whom had participated in Study 1(a).

4.7.3. Materials.

The 25 artist's images (referred to as "drawings" for the remainder of this Study in order to differentiate them from the photographs) which were recognised by all children in the second stage of the "Development of Materials" trials were used, together with 25 photographic equivalents. In some instances, the artist had worked from a photograph and so was able to provide that image for use (see Appendix 6).

Figure 5: Example of photograph and artist's image

All images were mounted on 10cm x 10cm 480 GSM white card.

The 25 image-matched toys which had been utilised in Study 1(a) were also reused.

Notebook for field notes.

Pro-forma for recording categorisation numbers (See Appendix 5)

4.7.4. Procedure.

The order in which the three modalities were presented was varied and recorded.

4.7.4.1. Drawings.

The set of twenty-five drawings were shown to participants as a pack and they were told that some of the pictures were "the same sort of thing" or "things that go together". They were told

that the game was to find these. The researcher turned over the first card, named it ("Oh look, I've got an apple!") and placed it face up on the table. The researcher then showed the child the second card, named it and asked, "The (first card) and the (second card), do they go together?" When the child responded in the negative, the researcher placed the card face up next to the first one. The fifth card always offered a clear perceptual match to one of the first four cards (for instance a football and a beach ball). If the child recognised the link, the researcher moved the relevant cards to the top of the table and placed them next to each other, ensuring that each image was still visible and that there was space to add further cards if the participant wished to extend the category. A clear thematic link followed rapidly after this (for instance a banana and an apple) and the researcher said "What a good idea! They don't look the same but they go together!" The cards were then placed together as before at the top of the table. The choice of words and researcher demeanour were considered to be important in supporting participants through the process and encouraged them to employ different strategies.

In some instances, the researcher showed the child each image; in others, participants preferred to hold the cards themselves.

The researcher regularly asked, "Can you see any things that go together?" It might be things that are the same or things that you just think go together".

Once all of the cards had been placed on the table, the participant was asked whether they felt they had found all of the things which went together. No time limit was placed on the process; the researcher relied on cues from the participant that they felt they had completed the task.

4.7.4.2. Photographs.

The process outlined for Drawings was replicated in its entirety for the presentation of the photographs.

4.7.4.3. 3D Objects.

Participants were shown the box with its lid on and told that some of the items inside were "the same sort of thing" or "things that go together". The lid was then removed and items placed individually on the table. The participant was invited to look for objects which were the same

or which went together. In some instances, participant enthusiasm hastened this process and toys were tipped on to the table. Participants were allowed to play with the items as they sorted them into groups.

4.7.4.4. Timing Protocols.

Although the time taken varied between participants, as with Study 1(a), an attempt was made to match individual participant's timings for all tests. Thus, if a participant spent five minutes on categorising drawings, they were allowed approximately five minutes each to categorise photographs and toys.

At the end of each test battery, participants were thanked and praised. Each participant was invited to choose a sticker as a "reward", this also served to alert parents and carers to the fact that their child had been involved in the research that day.

The researcher recorded each category the child formed and the cards which they suggested should be placed in that category. At the end of the session, scores were tallied and results transcribed onto the record sheet. Information from the Record Sheets was then transferred onto SPSS and anonymised.

Many children asked to play the games again during later visits by the researcher, allowing test-retest reliability to be evaluated.

4.7.5. Results.

4.7.5.1. Analytic Strategy

This study involved five separate tests, with analysis incorporating sex and cohort effects. This section shall provide descriptive statistics and, where appropriate, inferential statistics and supplementary analysis for each of the tests in turn.

4.7.5.1.1. Data Screening

All data was manually entered into SPSS and checked repeatedly (over a period of several days) for accuracy of transcription. Data was not reduced, cleaned or transformed in any way. Prior to inferential analysis, data for each individual component was screened to ensure that it met parametric assumptions.

Data was checked (initially by means of visual inspection of histograms, stem-and-leaf and box-plots and then through use of Kolmogorov-Smirnov or Shapiro-Wilks tests in SPSS) for normality of distribution, the presence of outliers and, in the case of independent measures designs, for homogeneity of variance. The skewness and kurtosis statistics reported within SPSS were then used to calculate z scores, which provided a mathematical estimate of the normality of the distribution. Given the small sample sizes in these studies, scores over 1.96 were regarded as being significantly skewed or kurtosed at p=.05. No outliers were apparent in any of the following studies.

4.7.5.1.2. Statistical Testing

Z-scores were calculated from raw scores for each modality. From drawings, (*M* = 4.26, SD = 2.95), z = .41; from photographs (*M* = 4.70, SD = 2.99) z = .257 and from toys (*M* = 7.53, SD = 3.18) z = -.65, suggesting that the data was normally distributed. The results thus met parametric assumptions and were subject to a series of one-way ANOVAs to discover if there were any discernible differences between modalities or between the performance of girls and boys

Hypotheses 1. *Girls will perform better in categorisation tasks than boys* was investigated by means of a series of one-way and two-way ANOVAs

Hypothesis 3. *Participants will perform better on categorisation tasks when presented with objects than when presented with images* was investigated by means of a series of one-way ANOVAs and a Pearson's Correlation.

A 2 (sex) x 3 (modality) ANOVA was conducted to investigate whether there were any significant differences between the performances of the sexes in each modality.

4.7.5.2. Descriptive Statistics.

Two children (1m, 1f) were unable to form any categories from the drawings (highest score = 11); two (1m, 1f) were unable to form any categories from the photographs (highest score = 10). All participants were able to form categories using the toys (highest score = 16).

Table 5: Mean scores for number of categories created in each condition by sex.

	Girls	Girls	Boys	Boys	Total	Total
	M	SD	*M*	SD	*M*	SD
Categories created using drawings	5.08	3.13	3.39	2.54	4.26	2.95
Categories created using photographs	5.29	2.96	4.09	2.97	4.70	2.99
Categories created using objects	8.56	2.34	6.48	3.63	7.53	3.18

Both boys and girls created most categories from the toys and least from the drawings. This finding supports Hypothesis 3.

When creating categories, participants varied in terms of the number of items they placed in categories. Some children matched pairs, whilst others grouped large numbers of items together into a category. Analysis of the number of *items* (i.e. cards or toys) used was therefore undertaken to see whether individual participants used more items in the photograph condition, in the drawings condition, or whether they used the same number of items in each.

Table 6: Modality Preference by sex

	Boys	Girls	Total
Used more photographs	10 (45%)	12 (48%)	22 (46.8%)
Used more drawings	6 (27.3%)	11 (44%)	17 (36.2%)
Same number of photographs and drawings	6 (27.3%)	2 (8%)	8 (17%)

Whilst girls were fairly evenly divided as to whether they used more photographs or drawings, boys tended to use a greater number of photographs than drawings when creating categories.

There were a number of recurrent categorisation choices.

Table 7: Number of participants creating category from photographs by sex.

Item	Boys	Girls	Total
Vehicles	21	24	45
King / Queen	17	23	40
Fruit / Vegetables	11	23	34
Bakery items	10	24	34
Balls	11	16	27
House / Play house	9	9	18
Animals	6	11	17
Washing	1	4	5

The majority of girls in the sample were able to categorise a range of different objects, however, the results for boys drop away sharply after the two most popular categories.

4.7.5.3. Inferential Statistics.

Data was analysed using a series of one-way ANOVAs. Age was not found to be significant in the photograph condition (F (1, 46) = .93, p = .55, η^2= 0.03), in the drawing condition (F (1, 46) = .85, p = .63, η^2= 0.03) or in the 3D objects condition (F (I, 46) = .79, p = .68, η^2= 0.03). Given the speed of cognitive development, this finding that children's performance does not significantly improve with age appears counter-intuitive. However, the large effect sizes suggest that this may be attributable to other factors, potentially the relatively small sample size.

A 2 (sex) x 3 (modality) ANOVA was conducted. When categorising the drawings, girls identified significantly more categories than boys (F (1, 46) = 7.32, p = .01, η^2= 0.19). In the 3D object condition, girls once again identified significantly more categories than boys (F (1, 46) = 8.01, p = .007, η^2= 0.15). However, whilst girl still identified more categories than boys

in the photograph condition, the differences between them lessened to below the level of significance (F (1, 46) = 3.03, p = .09, η^2= 0.06). These findings therefore support Hypothesis 1 with regard to the categorisation of drawings and objects but not photographs.

The next stage of the analysis considered the number of items used by participants in the creation of categories. This area of analysis was included in order to differentiate between participants who were primarily reliant upon (generally perceptual) matching, as had been apparent in study 1(a) and those who were forming broader categories. In the photograph condition, there was no significant difference between the number of cards used by girls and the number used by boys (F (1, 46) = 2.7, p = .11, η^2= 0.06). However, the difference in the drawing condition was found to be significant (F (1, 46) = 6.86), p = .01, η^2= 0.13) with girls using more cards than the boys did. These findings therefore support Hypothesis 1 with regard to the categorisation of drawings but not photographs.

No significant difference was found between the two cohorts in any modality, although it is recognised that the Cohort 2 sample was too small to allow valid analysis.

A Pearson's Correlation was conducted to investigate the strength of the relationship between each of the variables. The test showed a significant correlation between the numbers of categories identified from drawings and from photographs, r (47) = .84, p <.001. A similar correlation was found between the number of categories identified from photographs and the number identified from toys r (47) = .45, p = .002 and between the number of categories identified from drawings and from toys r (47), = .49, p <.001.

4.7.6. Interim Discussion.

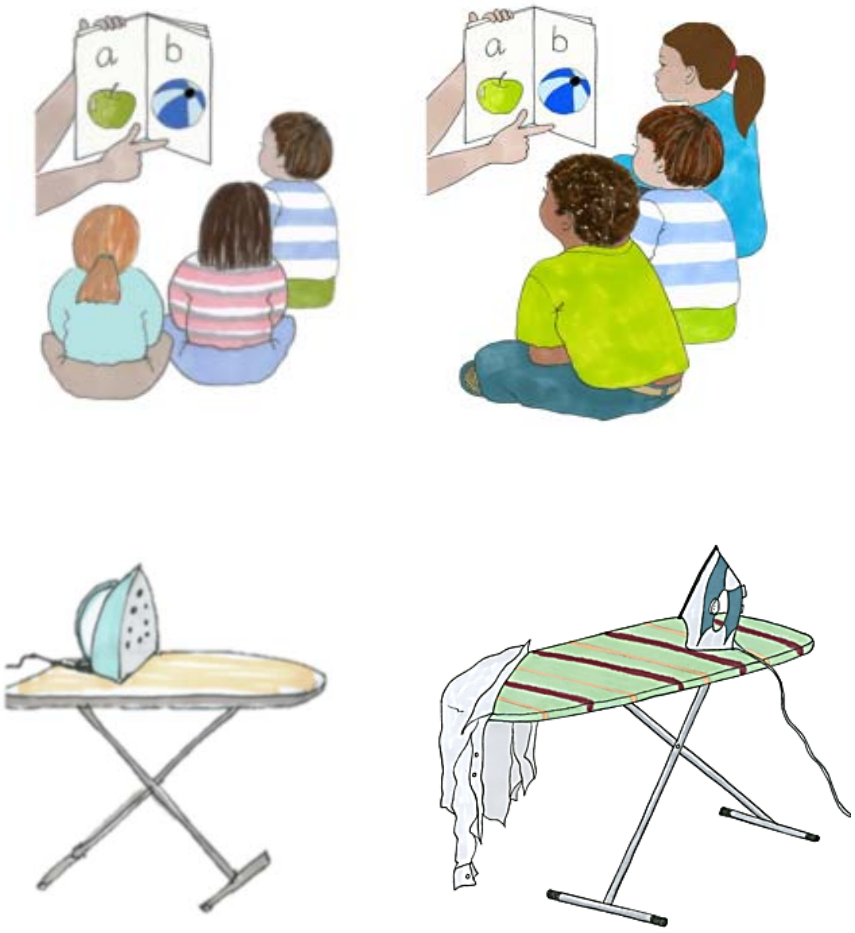
The purpose of this study was to investigate whether the realism of photographs had an impact on pre-school children's ability to categorise images. In light of the results of Study 1(a), it had been anticipated that participants would continue to create more categories from objects than from images and that girls would continue to perform better than boys in each modality. Evidence of an age-related developmental trajectory was also expected. Significant differences were found between the sexes, although these lessened in the photograph condition. Once again, children performed better when categorising objects than when categorising images. Correlational studies showed a relationship between the number of categories participants

created in each condition. Thus, children were inclined to either do well across all conditions or struggle across all conditions.

Unfortunately, major roadworks had begun in the area surrounding the Cohort 2 Hall. These substantially limited access and, as a result, membership and attendance went through a period of disruption and decline. The subsequent recruitment and testing difficulties led to an unbalanced sample which precluded reliable analysis of between-cohort factors. The data which was collected endorsed previous findings that sex is a significant factor in pre-schools children's ability to categorise. The girls used more items and identified more categories in each modality than boys. However, in the photograph condition the gap between the sexes narrowed in terms of the number of categories created, as it did with regard to the number of cards used in order to create the categories. This suggests that boys have a marginal preference for photographs whereas girls have a slight preference for drawings. As the differences had dropped below the level of significance, they were not considered to be of sufficient magnitude to warrant changing the materials for subsequent studies.

It was initially questioned whether performance may be linked to exposure to picture books (Logan & Medford, 2011), or to a difficulty in engaging with figurative representations; but during analysis it became apparent that the majority of boys had matched vehicles, the king and queen and the balls, all of which have strong perceptual similarities (Mandler & McDonough, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997). Of those boys who proffered an explanation, several pointed out the wheels on vehicles or the king and queen's crowns and purple robes, suggesting their categorisation criteria was largely perceptual (Badger & Shapiro, 2012). This replicated their classification behaviours in Study 1 (a). The only common thematic category was the fruit and vegetables which were offered to children in both settings at snack time. Relatively few boys created categories beyond this. It was therefore postulated that the photographs served to accentuate perceptual features, easing the process of categorisation. The artist subsequently sharpened colour contrasts and edgings to give the drawings greater realism. Examples of two early illustrations and their replacement are provided in Figure 6 on the next page.

Figure 6: Examples of Initial and Developed Artist's Images



4.7.7. Addendum.

Working memory (Baddeley & Hitch, 1974; Chow & Conway, 2015; Sanchez-Torres, Elosua, Lorente-Omenaca, Moreno-Izco & Cuesta, 2015) conserves transient information whilst also co-ordinating cognitive responses to a task (See Chapter 1- Baddeley, 2007, 2012; Cowan, 2005). Such is its fragility however, that transitory information is frequently lost or attempts to retain it precipitate errors in task completion. This tendency is exacerbated when individuals face competing attentional demands, such as in experimental dual-task studies (Logie & Cowan, 2015). It was therefore questioned whether children's performance in the categorisation tasks was merely a reflection of the object / images' memorability. Fourteen children (4m, 10f) from Cohort 1 who had participated in Study 1(b) individually played

"Kim's Game" (Kipling, 1901) with the researcher. No link was found between recall frequency and an items appearance in categorisation tasks. This was taken as affirmation that participants were not using the most frequently matched items simply because they were the easiest to remember. The difference between sexes in terms of the number of items recalled was not found to be significant ($F(1, 14) = .23$, $p = .64$, $\eta^2 = .02$) although the limited number of participating males is acknowledged.

4.8 Study 1 (c) Investigating Alternative Test Mechanisms : Match to Sample.

Addressing PhD Objectives 2, 3, 4 and 6

2. To develop a means of testing pre-school children's ability to categorise.

3. To explore the role of sex / gender on the development of categorisation in pre-school children.

4. To assess whether socio-economic status impacts the development of categorisation in pre-school children.

6. To extend psychological understanding of how differing forms of categorisation emerge and develop.

In order to address these objectives, the following hypotheses were pursued:

1. Girls will perform better in categorisation tasks than boys.

2. Children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups.

3. All participants will perform better on categorisation tasks when presented with objects than when presented with images.

4.8.1. Background and Rationale: Concepts and Testing Mechanisms.

Researchers and cognitive theoreticians continue to debate the mechanisms underlying the organisation and use of categories (see Chapter 1.4.4.) The notion of a series of hierarchical networks (Collins & Quillian, 1969) has been largely rejected as being unduly simplistic

(Conrad, 1972). Likewise, neurological evidence (Seger & Miller, 2010; Shallice, Fletcher, Frith, Grasby, Frackowski & Dolan, 1994; Soto, Waldschmidt, Helie & Ashby, 2013) has served to discredit the previously influential *spreading activation model* (Collins & Loftus, 1975; McNamara, 1992; Meyer & Schvaneveldt, 1976; Sanchez-Casas, Ferre, Garcia-Albea & Guasch, 2006). Present theories centre on a *hub and spoke model*, wherein modality-specific spokes process information as it flows through to a modality-independent hub, where it is integrated. Similarly, the Classic view of concepts (Bruner, 1956; Hull, 1920) was fatally undermined by examples of fuzzy concepts (McCloskey & Glucksberg, 1978; Rey, 1983), the undeniable inapplicability of transitive inference (Hampton, 1982) and issues around definitions (Pinker, 1997). Recent research has continued to explore the *typicality* or *prototype* view of concepts (Rosch, 1973; Rosch & Mervis, 1975); the *exemplar* approach (Kruschke, 1992; Medin & Schaffer, 1978; Nosofsky, 1991) and a range of hybrid models (Erickson & Krusche, 1998; Herzog & von Helversen, 2013; Jakel, Scholkopf & Wichmann, 2009; Love, Medin & Gureckis, 2004; Nosofsky, Little & James, 2012). Discussions centre around the relative importance of perceptual features (Barsalou, 2003, 2008; Borghi, 2005; Lakoff, 2005) and the triggering of existing connections in semantic memory (Goldstone & Rogosky, 2003).

Data from Study 1(a) and 1(b) suggested that many boys appeared to categorise largely on the basis of perceptual features, whilst several girls also considered schematic links. This finding that three-year-olds spontaneously created thematic categories was at odds with previous research which suggested that pre-five, children lack the life experience to classify according to anything other than perceptual qualities (Blaye, 2000; Fang, Fang & Xi, 1991; Keil. 1989; Keil & Batterman, 1984). This task therefore sought to further investigate whether participants were using taxonomic or thematic categorisation.

Study 1(a) had also raised questions regarding the typicality effect (Gruenenfelder, 1984; Kittur, Holyoak & Hummel, 2006; Rosch, 1973; Rosch & Mervis, 1975) and prototype centrality (Homa, Sterling & Trepel, 1981; Liu, Song & Seger, 2012; Posner & Keele, 1968, 1970; Reed, 1972). It was therefore decided to include both prototypical and atypical examples of categories in order to investigate the importance of typicality for young children.

Most previous researchers investigating children's categorisation have utilised a technique termed "Match to Sample", wherein participants are presented with an item and asked to find others which may be categorised alongside it (Blaye, Bernard-Peyron, & Bonthoux, 2000;

Blaye, Paour & Bonthoux, 2006). As this has been effectively used with both adults and children, it was decided to trial this approach.

Hypotheses.

(i) *It is predicted that boys will group images primarily according to their natural features and taxonomy.*

(ii) *It is predicted that girls will group images according to their natural features and taxonomy, but will also utilise a "conceptual web" approach and add schematically congruent images.*

(iii) *It is predicted that children in Cohort 2 will show greater evidence of thematic categorisation than children in Cohort 1.*

(iv) *It is predicted that children will categorise typical items together more frequently than atypical items.*

4.8.2. Design

Thirty-one participants from Cohorts 1 and 2 completed two match-to-sample tests. In the first test participants were initially presented with a sample image card, then five other cards, each of which may feasibly form a category with the sample card. Participants were asked to select which card or cards went with the sample. Two cards were perceptually linked, two were thematically linked and the final card was an atypical example from the same category as the sample. In the second test, the procedure was replicated using toys instead of cards.

4.8.3. Participants.

Materials were trialled with an opportunity sample of three children (2f, 1m) and then presented to thirty-one participants. Seventeen participants (8m, 9f) were from Cohort 1 and fourteen (4m, 10f) from Cohort 2. At this point Cohort 2 had very few boys on roll, rendering this a skewed sample.

4.8.4. Materials.

The four images/toys which had been most frequently utilised by participants during Studies 1(a) and 1(b) were selected as the "Sample" items. These were the football, the crow, the bus

and the carrot. The two most common thematic links for each sample were also used, together with perceptual matches which had been regularly proffered by previous participants.

As with Studies 1(a) and 1(b), materials included both an artist's drawing of an item and the matched toy.

Each "sample" item had five potential matches – one prototypical clear perceptual match; one basic level categorical match with lesser perceptual similarities; one atypical basic level categorical match; one common thematic link and one less frequently cited thematic link.

Table 8: Match-to-Sample items

Sample	Match 1	Match 2	Atypical	Associated 1	Associated 2
Football	Beach ball	Tennis ball	Rugby ball	Trainers	Kit
Crow	Lark	Toucan	Penguin	Nest	Tree
Bus	Car	Lorry	Bicycle	Bus Queue	Road
Carrots	Bananas	Eggs	Cake	Supermarket Checkout	Cooker

Figure 7: The Bus and its potential matches:

A proforma was used to record the order of selection. (See Appendix 7)

4.8.5. Procedure.

4.8.5.1. 2D Images.

Participants were told that they would firstly be shown a picture and then given five more cards with drawings on. The game was to find things which are the same, or go with the first picture.

The sample picture was placed face up on the table and named by the researcher. The five potential match cards were then rapidly placed in a line underneath the sample card. The researcher then said "Can you see anything that goes with this (points to sample card) picture? Anything which is the same or goes with this picture?"

Participant responses were recorded by circling the appropriate item on the proforma. This procedure was then repeated with the next sample item until all four samples had been individually presented to the participant.

4.8.5.2. 3D Objects.

Participants were told that they would be given a toy and then five more toys from the box. The game was to find things which were the same, or went with the first toy.

The sample toy was placed on the table and named by the researcher. The five potential matches were then rapidly placed underneath the sample. The researcher then said "Can you see anything that goes with this (points to sample) toy? Anything which is the same or goes with this toy?"

Participant responses were recorded by circling the appropriate item on the proforma. The procedure was repeated with each of the four sample items in turn.

The order in which tests and items were presented was varied.

4.8.6. Results.

4.8.6.1. Analytic Strategy

This study involved one test, with analysis incorporating sex and cohort effects. This section shall provide descriptive statistics, inferential statistics and supplementary analysis for each aspect of the test in turn.

4.8.6.1.1. Data Screening

All data was manually entered into SPSS and checked repeatedly (over a period of several days) for accuracy of transcription. Data was not reduced, cleaned or transformed in any way. Prior to inferential analysis, data for each individual component was screened to ensure that it met the statistical requirements for conducting a parametric test. Data was checked (initially by means of visual inspection of histograms, stem-and-leaf and box-plots and then through use of Kolmogorov-Smirnov or Shapiro-Wilks tests in SPSS) for normality of distribution, the presence of outliers and homogeneity of variance. The skewness and kurtosis statistics reported within SPSS were then used to calculate z scores, which provided a mathematical estimate of the normality of the distribution. Given the small sample sizes in these studies, scores over 1.96 were regarded as being significantly skewed or kurtosed at p=.05. No outliers were deleted or manipulated.

4.8.6.1.2. Statistical Testing

The Z scores calculated from raw scores for each of the areas being investigated were as follows. For sex (M = 1.61, SD = .5) z = -1.16; for cohort (M = 1.45, SD = .5) z = .48; with regard to the number of categories created using images (M = 8.26, SD = 3.88) z = .06; and with regard to the number of categories created using toys (M = 10.06, SD = 4.63) z = -.54. Data therefore met parametric assumptions and was analysed using a series of ANOVAs.

Responses were also tabulated and order of selection analysed.

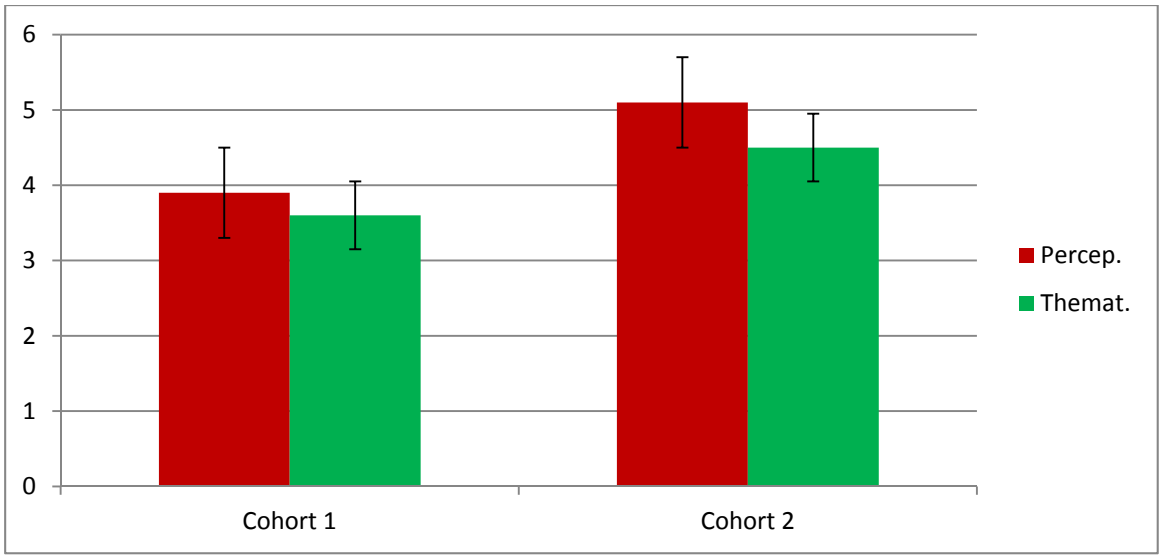
4.8.6.2. Descriptive Statistics

In 6.8% of cases, participants stated that none of the items could be matched to the sample. These "no match" responses were divided equally between cards and toys. All "no match" responses came from participants in Cohort 1. This accounted for 11% of the variance.

The number of items which each participant stated to be a match across the test battery was calculated for each modality. When categorising images, Cohort 1, $M = 7.35$, Cohort 2, $M = 9.36$. When categorising objects, Cohort 1, $M = 8.18$ toys, Cohort 2, $M = 12.35$.

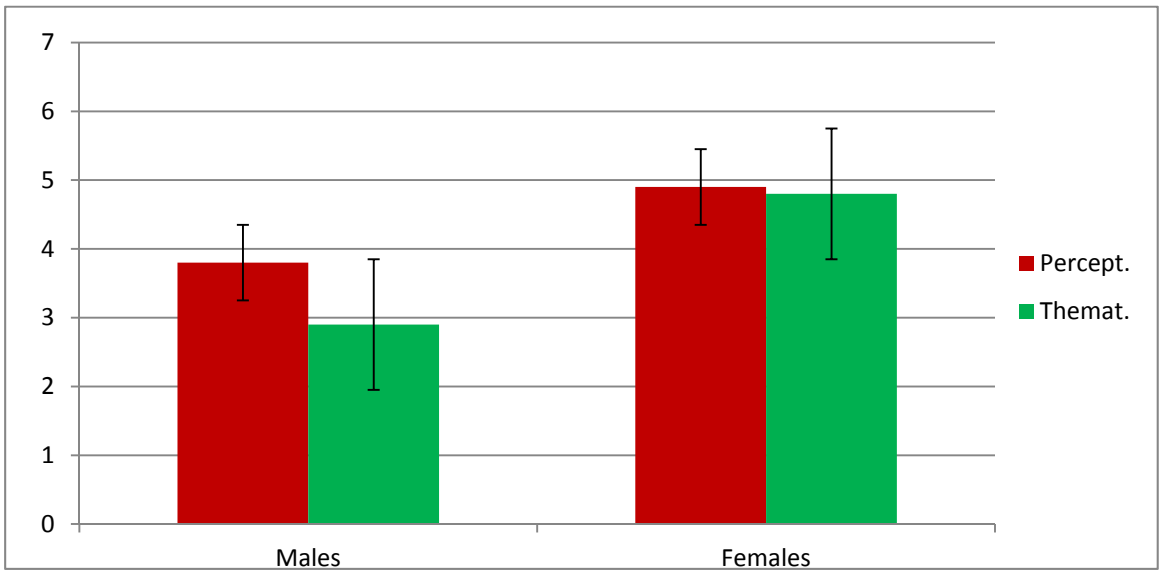
As participants were allowed to match as many items as they wished to the sample, responses ultimately showed a fairly equal number of perceptual ($M = 5$) and thematic ($M = 4.2$) categorisations but in 70.5% of cases, participants matched the item which had strong perceptual similarities to the sample first and added thematic categories later.

Figure 8: Mean Number of Perceptual and Thematic Categories Created by Cohort.



Participants in Cohort 2 formed more perceptual categories and more thematic categories than participants in Cohort 1. Participants in both cohorts created more perceptual than thematic categories.

Figure 9: Mean Number of Perceptual and Thematic Categories Created by Sex



Females were able to form more perceptual and more thematic categories than boys in the match-to-sample task. Female participants showed a smaller discrepancy between perceptual and thematic categorisation scores. Male participants were more heavily reliant on perceptual categorisation.

Atypicality did not prevent participants from matching it to the sample item. Amongst the six most common first choices, female participants had three atypical items and males had two.

4.8.6.3. Inferential Statistics

Data was analysed using a 2 (sex) x 2 (cohort) x 2(category type) three-way ANOVA.

No significant difference was found between boys and girls regarding the number of matches they created from images (F (1, 29) = 3.57, p = .069, η^2= 0.11) or from objects (F (1, 29) = 2.61, p = .12, η^2= 0.08). The effect size suggests, however, that a significant difference may have been found in the images had the sample been larger and more balanced. No significant difference was found between cohorts regarding the number of matches they created from images (F (1, 29) = 2.12, p = .16, η^2= 0.07). There was no significant interaction between sex and cohort (η^2= .26). There was, however, a significant difference in the number of matches created using toys (F (1, 29) = 7.64, p = .01, η^2= 0.21), with participants in C2 using more toys than participants in C1.

4.8.7. Interim Discussion.

The purpose of this study was to investigate some of the factors influencing pre-school children's categorisation judgements. Previous researchers have asserted that children within this age range are heavily, or even exclusively, reliant upon perceptual categorisation (Blaye, 2000; Fang, Fang & Xi, 1991; Keil. 1989; Keil & Batterman, 1984). In Study 1(a) lower-scoring participants had shown an inclination to match items which shared clear perceptual similarities. This was particularly marked amongst boys and members of Cohort 1. It was therefore predicted that boys would group images primarily according to their natural features and taxonomy. (Barsalou, 2003, 2008; Borghi, 2005; Lakoff, 2005). However, Study 1(a) had also found evidence of thematic categorisation amongst participants, especially in Cohort 2 and amongst girls. Confirmation that some three-year-olds were able to utilise a thematic, conceptual web approach (Goldstone & Rogosky, 2003; Mandler, 2004) was therefore anticipated, especially amongst these groups. The results from Studies 1(a) and 1(b) were ambiguous regarding the importance of typicality (Rosch, 1973; Rosch & Mervis, 1975) in categorisation judgements. However, it was considered likely that typical items would be selected more frequently than atypical items.

The results of this study demonstrated that three-year-old's first choice in match-to-sample tasks is usually a clear perceptual match which is also typical of the category. The visual cues provided by these items boost perceptual salience (Sloutsky, 2003), are rapidly verifiable and thus represent a secure option in "test" situations such as this. As perceptually similar items require less cognitive energy, they increase processing speed (Taylor & Fiske, 1978; Unsworth, 2015). The selection of typical items further aids this process as their matching attributes can be quickly checked and their category membership rapidly affirmed (Rosch, 1975). This study therefore confirms the findings of previous research that the categorisation techniques favoured by adults are typically already in use when the individual is three-years-old (Mandler & McDonough, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997). It is, however, acknowledged that the provision of an image or object allowed the child participants to compare the properties of items, meaning that they were not entirely reliant on stored representations. This will have served to reduce cognitive load and increase processing speed; it will also have aided children with no lived experience of these items. As such, it could be argued that the process may have been testing participant's categorisation skill rather than their cognitive store.

In light of the visual (and in the case of toys, tactile) cues on offer, it came as an enormous surprise that 6.8% of participants were unable to find any matches for any of the sample images or toys. It is notable that every participant in Studies 1(a) and 1(b) had been able to create categories using objects, suggesting that this match-to-sample testing mechanism actually serves to constrain children. It is thus possible that the conclusions reached on the basis of it have been unduly pessimistic regarding children's actual abilities (Blaye, Bernard-Peyron & Bonthoux, 2000; Diesendruck, Hammer & Catz, 2003; Fang, Fang & Xi, 1991; Gelman & Markman, 1986; Liu, Song & Seger, 2012; Scheuner, Bonthoux & Cannard, 2004; Yao & Sloutsky, 2010). The test battery devised and used in Study 1(a) allowed participants with a tenuous grasp of categorisation to succeed and is thus a more sensitive mechanism for testing nascent abilities. It had also allowed children who had developed more sophisticated categorisational criteria to demonstrate their understanding. It is thus proposed that the testing mechanism developed as part of this thesis, is more sensitive to nuances at every level and hence provides a more accurate reflection of children's capabilities than match-to-sample tests.

Whilst children, like adults, generally select typical and perceptually similar items first (French, Mareschal, Mermillod & Quinn, 2004; Mareschal, French & Quinn, 2000; Quinn, Eimas & Rosenkrantz, 1993; Rosch, 1975), they also recognised atypical members as belonging to the same category as sample items. In several instances atypical matches (particularly the penguin) were actually selected ahead of their typical counterparts. In these instances, whilst the atypical member shared certain key defining attributes such as wheels or wings (Smith, Otherson, Rips & Keane, 1988), these features also carried a degree of perceptual salience. It is therefore possible that by presenting images and toys, typicality weightings were shifted from conceptually high-weighted matches (such as the ability to fly), towards the less cognitively demanding, visual matching. As few participants proffered explanations for their choices, the importance of typicality remains unclear.

As this test allowed participants to select all relevant matches, most participants made multiple choices. As a result, the number of thematic categories created by these three-year-old participants was only marginally short of the number of perceptual categories. As anticipated, girls created more thematic categories than boys, but they also created more perceptual categories. There would appear to be clear evidence of the ability of pre-school children to move beyond physical properties and employ conceptual webs when forming categories. The themes on offer must, however, be within the child's frame of reference; it was notable, for

instance, that more children from Cohort 1 than from Cohort 2 selected the bus queue as a match for the bus.

Although the differences between girls and boys dropped below the level of significance, the effect size suggests that this may be attributable to the sample size, in particular, the number of male participants in Cohort 2. Girls continued to create more categories and use more items in both the image and the toy conditions (see figure 9). Similarly, Cohort 2 performed better than Cohort 1 in terms of recognising the variety of potential matches in both conditions, although the small sample size prevented this from reaching significance. However, analysis of the number of matches created using toys highlighted a clear demarcation between cohorts, raising the question of whether the Nursery itself was playing a role. The children in Cohort 2 had constant free access to a large range of toys, whereas the children in Cohort 1 spent a substantial proportion of each session engaged in organised activities. It was thus postulated that the availability of toys and the freedom to explore them had enhanced categorisational abilities amongst Cohort 2. This fledgling notion was later to grow into Study 3.

4.9 Study 1 (d) Reduced Options Match-to-Sample.

Addressing PhD Objectives 2, 3, 4 and 6

2. To develop a means of testing pre-school children's ability to categorise.

3. To explore the role of sex / gender on the development of categorisation in pre-school children.

6. To extend psychological understanding of how differing forms of categorisation emerge and develop.

In order to address these objectives, the following hypothesis was pursued:

1. Girls will perform better in categorisation tasks than boys.

The surprising discovery that relatively young children were using thematic categorisation was felt to warrant further investigation. This small scale study reduced the number of potential options in the hope of further dichotomising participant responses. Participants were offered a choice between a perceptual/taxonomic match, a thematic match and a filler item and were required to select only their "best match" or the category which they considered most pertinent.

4.9.1. Participants.

As previously noted, the population of Cohort 2 was predominantly female at this time and, as access was severely restricted by major road works, attendance had begun to drop. It was therefore recognised that it was unrealistic to attempt further research there. Recruitment and familiarisation work had begun at other units but was incomplete at the time this study was conducted.

Participants for this small scale study (N = 15, m5, f10) were all drawn from Cohort 1 (age *M* = 49.3 months). None of these children had participated in Study 1(c)

4.9.2. Materials.

Five "sample" cards were used as for Study 1(c). For each sample card there were three potential match cards, one was perceptually and taxonomically linked to the sample card; one was thematically linked to the sample card and the third was unrelated.

Table 9: Reduced Options Match-to-Sample Cards

Sample Card	Perceptual Match	Thematic Match	Irrelevant Card
Book	Book	Nursery	Boots
Crow	Toucan	Nest	Lorry
Prince	Princess	Castle	Bin
Washing Machine	Cooker	Washing Line	Apple
Bus	Car	Bus Queue	Eggs

Figure 10: The Prince and potential matches

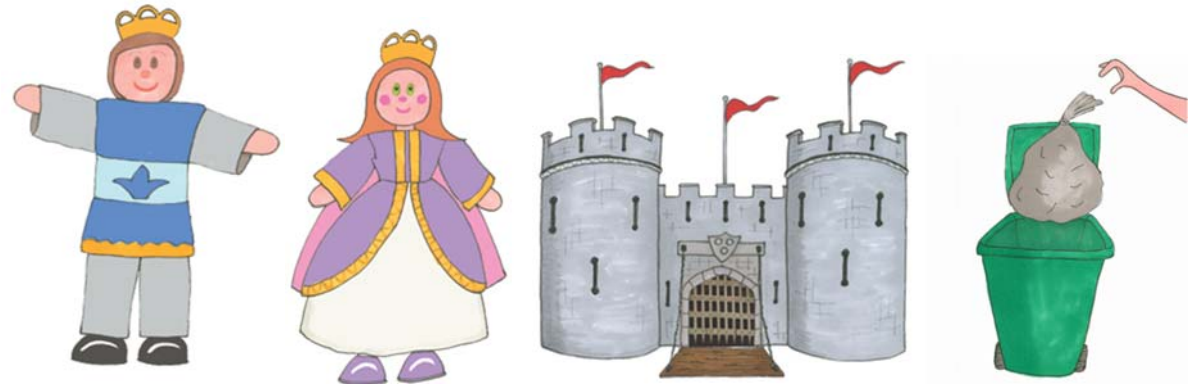


Figure 11: The washing machine and its potential matches

4.9.3. Procedure.

Participants were told that they would be shown a picture and then given three more cards with drawings on. The game was to select which drawing went best with the first picture.

The sample picture was placed face up on the table by the researcher who said "Look what I've got!" The three potential match cards were then rapidly placed in a line underneath the sample card. The researcher asked "Which picture goes with this one (points to sample card)? This procedure was repeated with all five sample cards with each participant.

Participant responses were recorded by circling the appropriate item on the proforma.

4.9.4. Results.

4.9.4.1. Analytical Strategy

This study comprised a single test with analysis incorporating sex effects. This section shall provide descriptive statistics, inferential statistics and supplementary analysis for each aspect of the test in turn.

4.9.4.1.1. Data Screening

All data was manually entered into SPSS and checked repeatedly (over a period of several days) for accuracy of transcription. Data was not reduced, cleaned or transformed in any way. Prior to inferential analysis, data for each individual component was screened to ensure that it met the statistical requirements for conducting a parametric test. Data was checked (initially by means of visual inspection of histograms, stem-and-leaf and box-plots and then through use of Kolmogorov-Smirnov or Shapiro-Wilks tests in SPSS) for normality of distribution and the presence of outliers. The skewness and kurtosis statistics reported within SPSS were then used to calculate z scores, which provided a mathematical estimate of the normality of the distribution. Given the small sample sizes in these studies, scores over 1.96 were regarded as being significantly skewed or kurtosed at p=.05. No outliers needed to be deleted or manipulated in any of the following studies.

4.9.4.1.2. Statistical Technique

Z scores were as follows: for age (M = 49.3, SD = 4.47) z = .15; with regard to the number of instances in which participants categorised using taxonomic/perceptual criteria (M = 3, SD = 1.19) z = 0; the number of instances in which participants used thematic criteria (M = 4, SD = 1.87) z = .5. Data therefore met parametric assumptions and was analysed using a series of one-way and two-way ANOVAs in order to pursue Hypotheses 1.

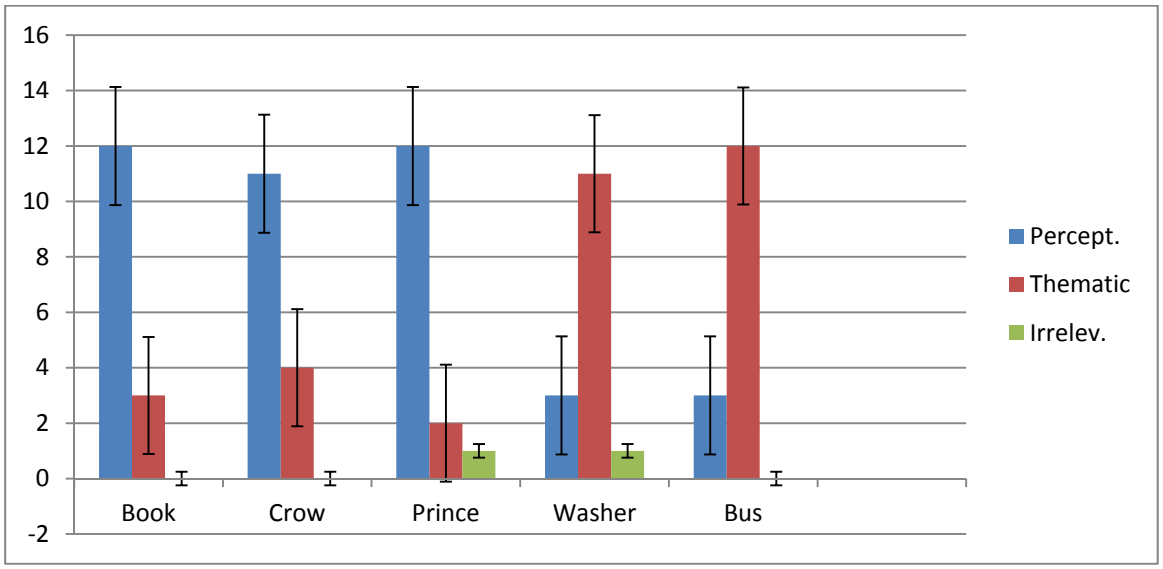
Girls will perform better in categorisation tasks than boys

4.9.4.2. Descriptive Statistics.

In each of the five tests, all participants were able to select a match. Only two participants selected an irrelevant match (filler item); they were both boys and they both selected only one irrelevant match and four relevant matches. One boy and one girl selected only perceptual matches, no participants selected only thematic matches, thirteen participants utilised a mixture of perceptual and thematic criteria. Taxonomic or perceptual criteria was thus the most common choice (*M* – m = 2.8, f = 3.1), then thematic criteria (*M* – m = 1.8, f = 1.9).

Thematic criteria were, however, the most common response in two of the categories, with most participants matching the washing line (rather than the perceptual match which was the cooker) to the washing machine and favouring the queue at a bus stop over the car.

Table 10: Responses to Sample Cards by Type



4.9.4.3. Inferential Statistics

The use of taxonomic / perceptual categorisation data was subject to two one-way ANOVAs. The first considered the possible impact of participant sex. Whilst females selected more perceptual matches than males, this did not reach a level of significance (F (1, 14) = .19, p = .66, η^2= 0.01). The second analysed participant age but once again, this was not found to significantly impact choices (F (1, 14) = .8, p =.63, η^2= 0.52).

Thematic categorisation data was similarly subject to one-way ANOVAs. Once again, the sex of the participant was not found to be significant (F (1, 14) = .02, p = .88, η^2= 0.002); nor was age significant (F (1, 14) = .89, p = .57, η^2= 0.54).

The large effect size suggests that age may have not reached significance potentially because of the small sample size.

4.10. Interim Discussion

This small scale study sought to further investigate the ability and propensity of pre-school children to use thematic categorisation. Using a match-to-sample task, participants were requested to select their favoured "match" from a perceptually similar, thematically linked or unrelated image. The majority of children rapidly discounted the irrelevant card in every instance. When faced with the remaining dichotomous variables, participants generally favoured perceptual categorisation. Thus, the two visually similar books were matched by most participants; the princess doll was selected to go with the prince; and the toucan, despite having some markedly dissimilar features, was the majority choice to go with the crow. These findings are in line with the results from previous studies in this chapter and from other researchers (Blaye, 2000; Fang, Fang & Xi, 1991; Keil. 1989; Keil & Batterman, 1984; Rosch, 1975).

However, it was not the case that perceptual similarity automatically engendered perceptual matching. Despite strong visual similarities between the washing machine and the oven, their shared "white goods" functionality and their physical proximity in most households, only three participants selected them as a match. The majority of children instead selected the washing line, which provided no perceptual cues. In the search for plausible explanations, several possibilities presented themselves. Although participants were not required to name items in this test, it is known that sub-vocalisation can activate the phonological loop (Gathercole & Baddeley, 1993; Saeki & Saito, 2004; Saeki, Baddeley, Hitch & Saito, 2013); it was therefore considered possible that choices were driven by sub-vocal naming of the *washing* machine and *washing* line. Several children, however, had talked about the "twirly-whirly" / "spinney-twiddler" that they had at home. Whilst the potential names for rotary driers proliferated, none (in this sample) featured the word "washing". There was also the possibility that these results were contextually dependent; the test was conducted in the midst of a long dry spell in the summer, so it was more likely that children had been playing outside and had seen washing on

a line. This explanation would, however, necessitate a robust conceptual web linking unseen items inside a machine to clothes hanging outside on a line. Furthermore, the association would need to be strong enough to overwhelm the perceptual similarities between the two white machines.

The preference for conceptual categorisation was repeated with the final card set when children showed a greater inclination to match the bus to the bus queue rather than to the car. The bus stop image was one of the most popular of all those produced. Every participant in the sample studied it with interest and commented on it, with most discussions revolving around the infant's wants and needs. Whilst the representation was of a younger child, it was therefore considered viable that responses were being driven by interest and empathy, rather than strictly by categorisation. The social demographic of this cohort and the accessibility of public transport also meant that these children were more likely to travel by bus than by car; it is possible therefore, had this test been run with a more affluent cohort, participants would have selected the car.

There are therefore a number of potential contributory factors but it remains clear that this group of three-year-olds could rapidly create conceptual categories even when perceptual alternatives were available. Thus, whilst marked visual similarities will usually prevail; thematic choices are both viable and preferable where there an item has personal salience and available stored representations.

4.11. Concluding Discussion.

Categorisation enables items, actions and experiences to be compartmentalised on the basis of their defining features and characteristics (Oakes & Rakison, 2003; Rosch, 1973, 1975 & 1978). Repeated exposure to analogous examples serves to progressively expand and fortify both the requisite cognitive architecture and the information contained within it (Anderson & Lindsay, 1998; Fiske & Taylor, 1991; van Kesteren, Fernandez, Norris & Hermans, 2010). Categories, however, not only contain received information, they create juxtapositions and consequently facilitate confident conjecture (Barsalou, 2012; Bruner, Goodnow & Austin, 1956; Quinn, 2002). Ultimately, they become cognitively integrated structures with strong associative links that can be consciously or non-consciously activated. Automaticity requires minimal cognitive expenditure (Martin, Rubel and Szkrybalo, 2002), but, if the need arises,

can be laterally inhibited or embellished through conscious processing (Baddeley & Hitch, 1974; Posner & DiGirolamo, 2000). The ability to categorise is thus paramount to an individual's ability to understand and function in the world (Gopnik & Wellman, 1994; Gopnik & Meltzoff, 1997). As the basic unit of semantic memory (Johnson, Hashtroudi & Lindsay, 1993), it is also fundamental to learning and to academic success.

Whilst testing the familiarity of images, the inability of two boys to join in a spontaneous sorting game changed the intended trajectory of this research. This chapter has documented the succession of studies which were subsequently devised to investigate the development of categorisational abilities in pre-school children. Each study made its own specific contribution and, as a collective, they served to inform the structure of later studies. Listening to participants and staff, careful analysis of results and assiduous examination of field notes, led to substantial fine-tuning and consequently improved the validity and reliability of the two large studies that follow. In particular, greater strictures were imposed around data exclusion criteria, the oral information given to participants was clarified and a fixed presentation order was introduced. Some aspects of the process proved to be agreeably functional from the outset. The image checking by individuals and by ad hoc groups of children (and the responsiveness of the artist to their feedback) ensured clarity and familiarity. The decision to conduct research in the Nursery / Pre-school increased ecological validity, relaxed participants and ultimately reduced logistical headaches. The greatest positive, however, was the selection of materials with both the images and toys proving enormously popular with participants.

Individually, the tests have produced some unexpected results. On the basis of previous literature (Bornstein, 2006; Bornstein, Kessen & Weiskopf, 1976; Cohen & Caputo, 1978; Franklin & Davies, 2004), it was anticipated that all participants (especially those over three-years-old) would be proficient in the sorting of colours and shapes. The fact that this proved problematic for some children was initially attributed to researcher error and study 1(b) was approached with the confident expectation that amending the oral instructions would alleviate any difficulties. This was clearly not the case. A proportion of participants, primarily boys from Cohort 1, remained unable to categorise according to colour or shape even when presented with dichotomous variables. This finding runs counter to expectations based on previous research (Bornstein, Kessen & Weiskopf, 1976; Cohen & Caputo, 1978; Franklin & Davies, 2004). In a few rare instances, this inability was linked to a pervasive developmental disorder or undiagnosed impairment; in other instances, the child presented no symptomology or additional deficits which would indicate a broader issue. The absence of this fundamental

ability in (presumed and apparently) neuro-typical three- to four-year-olds is of considerable concern, not only because it militates against successful learning in school but because, for them, the world retains its "blooming, buzzing confusion" (James, 1890/2001).

Although the gender-divide in language acquisition (Eriksson, Marschik, Tulviste, Almgren, Pereira, Wehberg & Gallego, 2011; Schaadt, Hesse & Friederici, 2015), developmental milestones (Junaid & Fellows, 2006; Smith, Cowie & Blades, 2003) and educational achievement (Department for Education, 2015; Machin & McNally, 2005) has been well documented; the degree of difference found between the sexes came as a surprise. Several possible reasons were postulated, including vocabulary limitations and lexical impairments, access to picture books (Logan & Medford, 2011), and participation in imaginative play (Holmes, Romeo, Ciraola & Grushko, 2015; Johnson, Christie & Yawkey, 1999). Throughout the studies, boys appeared more hide-bound to perceptual categorisation, showing greater reliance on visual similarity than girls did. In line with adult categorisation strategies, children's first recourse is generally to feature matching (French, Mareschal, Mermillod & Quinn, 2004; Mandler & McDonough, 1993; Mareschal, French & Quinn, 2000; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997) and to basic level categories (Rosch, 1978; Rosch, Mervis, Gray, Johnson & Boyes-Braem, 1976). It was clear, however, that thematic categorisation was also widely used, particularly amongst girls. It was proposed that thematic categories were employed if they were salient and familiar (Mandler, 2004).

It was felt that the testing mechanism had proved functional and, in Study 1(a) had exposed what was potentially a substantial gender and socio-economic divide. This was felt to warrant further investigation, however, dwindling attendance at Cohort 2 had precluded further work there. Further similar cohorts were therefore recruited in order to investigate whether the findings from this first study were contextually dependent. The potentially confounding factors which came to light during the course of this first study were all remedied prior to commencement of Study 2.

4.12. Summary

This chapter has provided a chronological account of how a new mechanism for the testing of categorisational abilities in pre-school children was devised and developed and the measures that were taken to ensure reliability and validity. The resultant test battery was popular with all

participants but appeared to be of particular use with participants at the upper and lower boundaries of categorisational competency. Results suggested that the emergence and development of categorisational ability was mediated by gender and socio-economic status; it was thus decided to utilise the test battery with a larger sample, drawn from additional cohorts. This larger study is detailed in the following chapter.

Chapter 5

Study 2: The Impact of Sex and Socio-Economic Status on the Development of Categorisation in Pre-School Children

5.1. Chapter Overview

This chapter is dedicated to Study 2, a refined and extended version of Study 1(a). It begins with a recap of the major findings from Study 1 and an explanation of how these shaped this second study. An explanation of methodology and procedure is followed by the results of the study and a discussion of their theoretical implications.

Addressing PhD Objectives 2-6

2. To develop a means of testing pre-school children's ability to categorise.
3. To explore the role of sex / gender on the development of categorisation in pre-school children.
4. To assess whether socio-economic status impacts the development of categorisation in pre-school children.
5. To explore the impact of dimensionality on pre-school children's ability to categorise.
6. To extend psychological understanding of how differing forms of categorisation emerge and develop.

Hypotheses

1. *Girls will perform better in categorisation tasks than boys.*
2. *Children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups.*
3. *All participants will perform better on categorisation tasks when presented with objects than when presented with images.*

5.2. Introduction and Background to Study 2.

Prior to Study 1(a), it had been anticipated that the majority of participants would be able to categorise on the basis of shape and colour (Bornstein, Kessen & Weiskopf, 1976; Franklin & Davies, 2004). Observations during the trialling of materials (see section 4.4.2), had also

fostered an expectation that girls would categorise images more easily than boys, although less differences were expected between the sexes with regard to categorising objects. Significant differences *were* found between the sexes, with girls doing better in each of the tests but it was also discovered that a substantial number of children were unable to complete the colour and shape matching tasks. As previous research had found differences in achievement levels between socio-economic groups (Bulut, 2013; Snook & O'Neill, 2010); it had been questioned whether this would extend as far as categorisational ability amongst pre-school children. Whilst the differences between cohorts were not found to be significant, the children from the middle-class cohort did consistently better than their peers from the more disadvantaged cohort. The other important finding was that, almost without exception, participants created more categories, and used more items within the categories, when working with toys than when working with images.

The extent of the difference between scores for images and objects, raised questions as to whether this may be related to realism, with the fanciful nature of the drawings serving to constrain understanding. Children were therefore tested to see if photographs would yield results that were higher than those achieved for drawings and thus closer to scores obtained in the "toy" condition. Correlational studies, however, showed a relationship between the number of categories participants created in each condition, demonstrating that children were inclined to either do well across all conditions or struggle across all conditions. Similarly, an investigation to assess whether some items or images were simply more memorable, failed to establish a link.

Studies 1(c) and 1(d) utilised a different experimental technique in order to further gauge the reliability and validity of the testing mechanism devised for this Study. Despite the "match-to-sample" technique having been widely used by previous researchers in the field, it was found to be less sensitive to the fine grain of potential responses. Indeed, it was felt to actually inhibit performance and supress scores, particularly amongst the least able and most able participants. The results of the tests did, however, suggest that pre-school participants, like adults (Rosch, 1975) categorised primarily on the basis of perceptual similarity, with an inclination towards selection of prototypical members of basic level categories.

Study 1 had thus found sex and modality to be significant factors in pre-school children's ability to categorise. The range of components had also served to reduce confounding variables in test procedures, and rule out several alternative explanations for the variations in

performance found in 1(a). Throughout Study 1, there appeared to be a difference between cohorts which, given that the sample was socially-dichotomised, were tentatively linked to socio-economic status. However, the sample was relatively small and drawn from only two settings, leaving it at risk of Type II errors. In order to ensure that the results were valid and generalizable, not context specific, it was necessary to increase participant numbers and extend the range of cohorts.

Furthermore, Study 1 had lacked the age variations necessary to demonstrate maturational progression and so required extension at both ends of the sample's age range. Attempts to establish a developmental trajectory had been further confounded by the number of participants with unacknowledged developmental atypicalities. Whilst the researcher wished to remain inclusive in her approach to participants, the need for increased scientific rigour regarding the removal of outliers from the data was acknowledged. Hence, children with Autistic Spectrum Disorders, elective mutism and global delays joined in (and enjoyed) the study. However, whilst their responses are commented upon in the Results section, their data was not included in the analysis. The same holds true for several participants who had just arrived in Britain and had little functional English. Children exhibiting language delay were included in the analysis if there was no additional symptomology and if their individual z scores did not highlight them as outliers.

Confounding variables which had been noted during the course of Study 1 were removed or corrected. For instance, the researcher's failure to prepare participants for the split-coloured card in the colour test had confused many and muddied the data. It had also become apparent that some participants felt overwhelmed when presented with too many image cards simultaneously, whilst others liked to spread all of the cards out for inspection before beginning to categorise. The researcher had learnt to be responsive to individual preferences and, as a result, participants appeared more focussed and at ease. Running Study 1 had thus flagged up areas that were clearly in need of change; indicated areas which would benefit from greater flexibility and provided empirical evidence as to what impact any such changes would have on test validity.

Study 1 had demonstrated that the majority of participants were able to categorise on the basis of shape and colour and that those who were going to struggle were generally apparent very early in the process. Furthermore, the results showed, children who encountered difficulties with shape sorting were inclined to struggle with all three of the card tasks (colour, shape and

images). For Study 2, it was therefore decided to adopt a more fixed order of presentation; participants were always given the shape task first, followed by colour, then the image and object tasks were alternated. The number of cards was also reduced from the original fifteen, to eight for shape and nine for colour, as participants generally either grasped the task immediately or not at all. The use of extra cards had therefore served only to elongate the process. As the majority of children succeeded easily with the shape and colour tasks, running these first allowed the researcher to offer praise ("Look at how quickly you did that!". "You are so good at these sorting games!") Participants then approached the more complex image and object sorting tasks with confidence and enthusiasm. It also had the additional and unexpected benefit of speeding up what had been a very lengthy testing process.

During Study 1 it had become clear that participants who were unable to categorise on the basis of colour and/or shape, were invariably slow and tentative in their approach to the image task. It was feared that the sheer volume of cards was overwhelming for children who found the task exacting. Where participants struggled to categorise both colour and shape, they were therefore offered a truncated form of the image and object tasks, with only the most common matches and some popular fillers. Children who were unable to categorise any images were engaged in conversation about the pictures; those who were unable to categorise the toys were invited to join in playing with them. Through analysis of the initial data and taking heed of participant responses, the process of testing thus increased in scientific rigour but also became slicker and more participant focussed.

Study 2 therefore aimed to check the veracity of Study 1(a)'s conclusions by presenting a more valid and reliable test to a larger population from a broader demographic of children.

A full account of Method and Results is presented below, together with a discussion of conclusions and recommendations for future research.

5.3. Design

One hundred and ninety participants aged between 30 and 60 months completed a battery of four tests aimed at exploring the development of categorisational abilities. Participants were drawn from five cohorts; Cohorts 1 and 2 were as for Study 1. The five cohorts comprised a Nursery unit attached to a Primary School that was situated in a disadvantaged area, a Community Nursery situated in an area of extreme disadvantage, the Reception class of an

Infant School and two pre-school playgroups, both of which were situated in middle-class areas. Every task was conducted individually by the researcher at a table in the quietest available area of the setting. Participants were not provided with any training prior to the task or given any instructions other than those detailed below (see 5.4.3. *Procedure*).

All four tasks involved free-categorisation (i.e. the criteria for categorisation was not specified by the researcher). One task called for children to categorise toys, the others required cards to be classified according to colour, shape or image printed on them. The researcher offered encouragement and praise but no specific feedback. It was hoped to discover more as to the criterion children used when categorising and to see if the sex, modality and socio-economic differences apparent in Study 1 were replicated with a larger and more diverse sample. It was also hoped that by increasing the age range, a developmental trajectory may become apparent.

In light of Study 1 and the findings of previous researchers, it was predicted that girls would perform better than boys and that children from higher socio-economic groups would perform better than those from the lower socio-economic groups. It was also anticipated that participants would continue to score more highly when categorising toys than when categorising images. Evidence of a developmental trajectory was also expected.

Hypotheses

It is predicted that more categories will be produced from toys than from images.

It is predicted that girls will identify more categories than boys in each modality.

It is predicted that participants from high socio-economic groups will achieve higher scores than those from lower socio-economic groups.

It is predicted that older children will identify more categories than younger children in each modality.

5.4. Method

5.4.1. Materials

Materials were largely as for Study 1(a), although the number of shape and colour cards was reduced. The information is presented again here in order to aid the reader.

5.4.1.1. Shape Matching.

Eight 10cm x 10cm 480 GSM white cards; four with a red triangle mounted on to them at different angles and four with a red square. (See Appendix 3)

5.4.1.2. Colour Matching.

Nine 10cm x 10cm 480 GSM white cards; three with a 7cm x 7cm pink square; three with a 7cm x 7cm blue square and three with a 7cm x 7cm square divided equally between pink and blue. These were used interchangeably with a set of nine yellow and green cards. (See Appendix 4)

5.4.1.3. 2D Categorisation.

The 25 images which were recognised by all children in the second stage of the "Development of Materials" (see Chapter 4) trials were used, together with two additional cards which had been recognised by the majority of children and which greatly enhanced categorisation possibilities. These were the same images which had been used in Study 1(a). All images were mounted on 10cm x 10cm 480 GSM white card. (See Appendix1)

5.4.1.4. 3D Categorisation.

The 27 play items, matched as closely as possible to the 2D images were used. In the interests of safety and ethical probity, all toys had undergone rigorous safety testing and were, as far as possible, Fair Trade from sustainable sources (e.g. Hape, Plan). These were the same toys which had been used in Study 1(a) (See Appendix 2). The toys were transported in an attractive, colourful box.

5.4.2. Participants

Initially, over 250 participants were recruited from five different Early Years settings in the East Midlands. These participants ranged in age from 30 to 60 months. As the two original settings were classified as predominantly White British, (i.e. with a White British population between 96.6-98.2%; Office for National Statistics, 2012), recruitment focussed on settings with the same ethnic profile to ensure no further (potentially confounding) variables were introduced. The parents / carers of all participants were issued with a written explanation of the research and provided informed consent prior to testing taking place. Children with a known

learning impairment or pervasive developmental disorder (n = 16) were welcomed to play the games but, as this study sought to investigate typical developmental trajectories, their data was not included in the analysis. One hundred and ninety participants completed the full battery of tests and had their responses analysed.

Table 11: Breakdown of participants by cohort, sex and mean age.

	Males	Females	Total	% of Sample	Age Range in months	Mean Age	NID Rank*
Cohort 1	32	43	75	39.5	37 - 49	43.4 (SD 3.42)	2,800
Cohort 2	26	18	44	23.2	30 - 50	39.5 (SD 4.82)	30,657
Cohort 3	25	23	48	25.3	36 - 49	42.1 (SD 3.9)	1,043
Cohort 4	7	8	15	7.9	30 - 50	42.4 (SD 6.3)	29,964
Cohort 5	6	2	8	4.2	54 - 60	56.4 (SD 2.7)	29,964
Sample	96	94	190	100	30 - 60	42.64(SD5.24)	

*NID = National Indices of Deprivation (2014). Area ranking according to multiple indices of deprivation with 1 being the most deprived and 32,482 being the least deprived.

Cohort 1 and Cohort 2 were the same settings used for Study 1.

The Cohort 1 Nursery is in an area classified as containing older and mature housing of mixed tenure. The typical property price is low. The most common social group is C2DE with unemployment standing at 88% of the national average. The area is ranked at 2,800/32,482 in the National Indices of Deprivation (2014). People living here are generally qualified to a low level and typical employment type is classified primarily as blue collar or unskilled, but with a small number of white collar workers (Office for National Statistics, 2012).

The Nursery is attached to a Primary School, with day-to-day running being orchestrated by a Nursery teacher and three Teaching Assistants but with overall management and decision making lying with The Infant School Head teacher. The Nursery can accommodate a maximum

of fifty-two children, split equally between the morning and afternoon sessions. All participants attend Nursery for fifteen hours per week.

At its last inspection, in April 2015, Ofsted classified it as "Good".

Testing took place in the kitchen area or book corner of the Nursery.

The Cohort 2 Pre-School is in an area abutting a University campus, where properties are mainly detached or semi-detached and owned outright or mortgaged. The properties are generally large in size. The most common social group is ABC1 and the people living here are generally qualified to a high level with the typical employment type being professional or white collar with some blue collar workers. The number of directors is 11% higher than the national average. (Office for National Statistics, 2012). The area is ranked at 30,657/32,482 in the National Indices of Deprivation (2014).

The Pre-School is a charitable organisation managed by a full-time Supervisor and a team of part-time play leaders. It is a member of the Pre-School Learning Alliance and is run co-operatively with staff and a committee of parents who share responsibility for management and decision making. All participants attend Nursery for fifteen hours per week.

The Pre-School meets in a Community Hall and testing took place at a table set up in the centre of the hall.

At its last inspection, in March 2015, Ofsted classified it as "Good".

The Cohort 3 Community Nursery is situated in an area classified as being amongst the 10% most deprived wards in the country. The estate on which the Nursery is situated is also amongst the top 10% nationally in terms of the number of families living in poverty. It has the highest proportion of vulnerable children and children on School Action or School Action Plus (Office for National Statistics, 2012). The area is ranked at 1,043/32,482 in the National Indices of Deprivation (2014). There is low satisfaction with the neighbourhood and higher than average calls to the Local Authority regarding fouling, fly tipping, graffiti and needles. A high proportion of people have no qualifications. The area has the highest rates of teen pregnancy and the lowest proportion of residents living a healthy lifestyle (with regard to smoking, eating

and exercise) in the Authority. There are higher levels of crime and injuries to children than elsewhere in the Authority (Local Authority Strategic Services and Transformation, 2013).

The Nursery has one hundred and four places (split equally between the morning and afternoon sessions) and also offers some wrap around childcare. Additionally, it is an enhanced resource facility for children with additional needs. It is run by a full-time Head teacher and Deputy Head teacher and a team of part-time teachers and Nursery Nurses.

The Nursery recently made thirty-two funded places available for two-year-olds through the Flying Start initiative. It was therefore possible to begin familiarisation work with this group of children in the summer, before they started Nursery.

The Nursery has large, purpose build accommodation. Testing took place in the Puzzles Corner as this was the quietest area of the Nursery. Whilst some of the children with additional needs played the sorting games, their data was not included in the analysis due to the known magnitude of their developmental delays.

At the last inspection, Ofsted classified it as "Good".

The Cohort 4 Pre-School serves an area of predominantly mature, semi-detached housing, most of which is owned outright or mortgaged. The most common social group is ABC1 and the people living here are generally qualified to a high level with the typical employment type being professional or white collar with some blue collar workers. It is ranked 29,964 of 32, 482 (Office for National Statistics, 2012).

The Pre-School is a charitable organisation managed by a full-time Supervisor and a team of part-time play leaders. It is a member of the Pre-School Learning Alliance and is run co-operatively by staff and a committee of parents who share responsibility for management and decision making.

The Pre-School meets in a Church Hall and testing took place at a table set up in the corner of the main hall or the corner of the small hall.

At the last inspection in October 2014, Ofsted classified it as "Good".

The Cohort 5 Infant School is situated approximately 100 meters from the Cohort 4 Pre-School and therefore shares its demographic characteristics. Participants were the youngest members of the Reception Class. Nationally, it is in the lowest quintile (0.0 -9.4%) for pupils eligible for free school meals. It is also in the lowest national quintile (0.0-4.1) for pupils supported by school action plus or with a statement of special educational needs (SEN) (Ofsted, 2014).

Testing took place at the Discovery Table, which was situated on the periphery of the main classroom.

At the last inspection (July, 2010), Ofsted classified it as "Outstanding".

5.4.3. Procedure

Procedures are largely as for Study 1(a) but with the minor amendments detailed in the Introduction. Procedures are reproduced in full here for the reader's convenience.

Participants were invited individually to play some sorting games with the researcher. Participants were told that there were games with shapes, colours, pictures (2D) and "things in the box" (3D). As Study 1 had established that most children were able to complete the shape and colour matching easily, they were always attempted first in order to build participant confidence. They also served to establish what was required in the two more complex categorisation tasks.

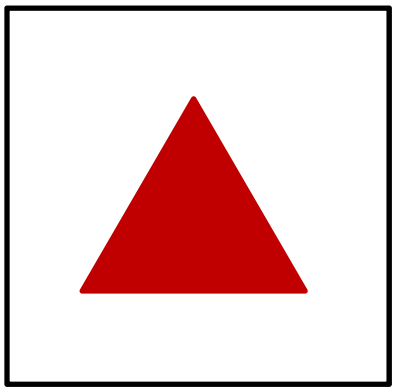
Each participant was seated to the researcher's left, enabling her to record all responses on a notepad to her right. These notes were checked for legibility before the end of the session and any salient points added. This included interruptions, anything unusual in the child's demeanour or anything interesting or unusual they said. These were further clarified at the end of the day and retained as field notes. The scores from each test were then transcribed onto the proforma (see Appendix 5).

Shape

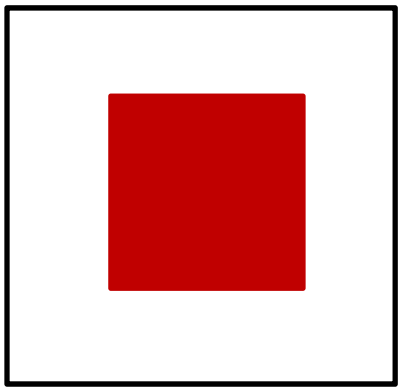
Participants were told they would need to "sort out which cards go together". The cards had either a red square or a red triangle on them, set at differing angles. The researcher held the pack of eight cards ready to show individually to the participant. The researcher placed the first

card, with a triangle on it, face up on the table between herself and the participant saying, “Look at the shape on this card”, whilst she traced round the periphery of the triangle with her finger.

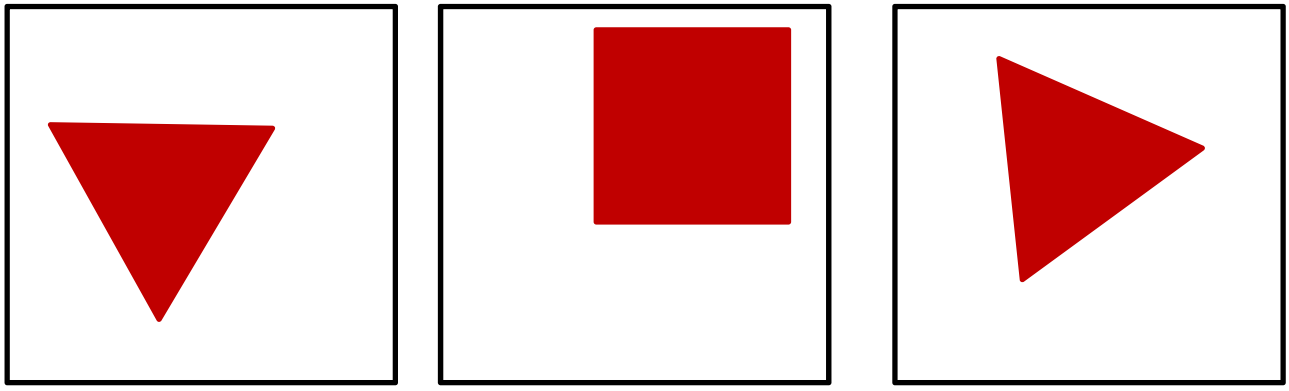
Figure12: Shape Cards



The second card showed a square. The researcher said, “Look at the shape on this card,” (as she traced the periphery of the square with her finger), “where shall we put it?”



The majority of participants indicated a place next to the triangle, thus forming a new pile. If a child indicated that the square should be placed on top of the triangle, the researcher asked, “Do they go together?” and once again traced the edges of each shape.

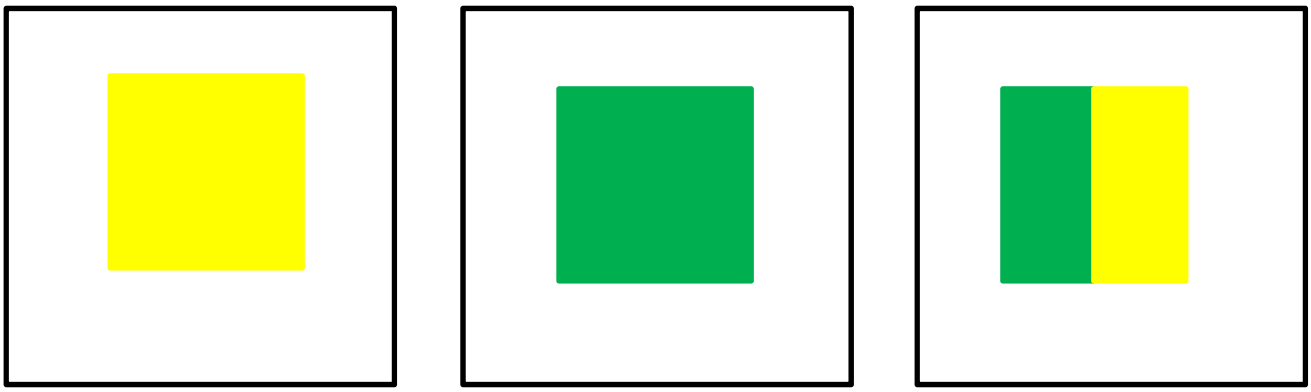


Participants were then shown each of the cards individually and allowed to either place them where they wished or to point to where they wished the researcher to place them. On the rare occasions that the participant placed all of the cards in a single pile, after all eight cards had been produced; the child was asked if they were happy that they had sorted the cards that went together. Regardless of outcome, every child was congratulated ("You sorted all of them!" "You thought really hard about that!") and asked if they would like to play another sorting game.

Colour

Participants were told they would need to "sort out which cards go together". There were two sets of cards; Set 1 had 3 pink squares, 3 blue squares and 3 squares which were half pink and half blue; Set 2 had 3 yellow squares, 3 green squares and 3 squares which were green and yellow. Participants were invited to choose which set they would like to use. The researcher held the pack of nine cards and showed them individually to the participant. The first five cards to be proffered were always in the following order

6. pink/yellow,
7. blue/green,
8. blue/green,
9. pink/yellow,
10. split card.



The researcher said

3. "I've got a pink/yellow card!" and placed it face up on the table between the participant and the researcher.

4. “I’ve got a blue/green card! Where should I put this one?” The vast majority of participants indicated a place next to the first card. The card was then placed face up on the table, thus forming a separate pile. If the child pointed to the first card, the researcher said, “Do they go together, the pink/yellow card and the blue/green card?” On the rare occasions that the participant replied in the affirmative, the cards were placed in a single pile and, after all fifteen cards had been produced, the child was asked if they were happy that they had sorted out the cards that went together.

Regardless of outcome, every child was warmly commended and then asked if they would like to play another game.

2D Image Cards

The set of twenty-seven 2D picture cards were shown to participants as a pack and they were told that some of the cards were of “the same sort of thing” or of “things that go together”. They were told that the game was to find the things that were the same or went together. The researcher turned over the first card and said “What’s this?” and then, after affirming the participant’s response (“Yes, an apple”), placed the card face up on the table. The researcher then showed the child the second card and again asked “What’s this?” After the child had named it the researcher asked, “The (first card) and the (second card), do they go together?” When the child responded in the negative, the researcher placed the card face up next to the first one. The fifth card always offered a clear perceptual match to one of the first four cards (for instance a football and a beach ball). If the child recognised the link, the researcher moved the relevant cards to the top of the table and placed them next to each other, ensuring that each image was still visible and that there was space to add further cards if the participant wished to extend the category. A clear thematic link followed rapidly after this (for instance a banana and an apple) and the researcher said “What a good idea! They don’t look the same but they go together!” The cards were then placed together as before at the top of the table. Participants were told they could add to the category if they wished to, or move cards to use again in alternative categories.

In some instances, the researcher showed the child each image; in others, participants preferred to hold the cards themselves. Beyond the first few enquiries from the researcher, most children rapidly began to name each image as it was turned over.

The researcher regularly asked, “Can you see any things that go together?” It might be things that are the same or things that you just think go together”. Every category the participant created and the items in each category were recorded in the notebook. If an item was used a second time in a new category, it was recorded again. The number of items used was totalled at the end of the session, any card which had been used twice (for instance if a washing machine was classified with the cooker and plate as “kitchen things”, then later with the washing line and iron as “clothes washing”, it would be counted as two items).

Once all of the cards had been placed on the table, the participant was asked whether they felt they had found all of the things which went together. No time limit was placed on the process; the researcher relied on cues from the participant that they felt they had completed the task.

Participants were then warmly congratulated for doing “good naming and sorting”.

3D Toys

Participants were shown the box with its lid on and told that some of the items inside were “the same sort of thing” or “things that go together”. The lid was then removed and items placed individually on the table. The participant was invited to name each item and to look for other toys which were the same or which went with it. In some instances, participant enthusiasm hastened this process and toys were tipped unceremoniously on to the table. Participants were allowed to play with the items as they sorted them into groups.

General Timing Protocols

Although the time taken varied between participants, an attempt was made to match individual participant’s timings for both the 2D and the 3D tests. No participant was allowed to exceed ten minutes for either the 2D or the 3D task. Where a participant became distracted, disengaged or left without completing the final task, their data for all tests was discarded.

At the end of each test battery, participants were thanked and praised. Each participant was invited to choose a sticker as a “reward”, this also served to alert parents and carers to the fact that their child had been involved in the research that day.

Many children asked to play the games again during later visits by the researcher, allowing test-retest reliability to be evaluated.

5.5. Results

5.5.1. Analytic Strategy

This study involved four separate tests, with analysis incorporating sex and cohort effects. This section shall therefore provide descriptive statistics and, where appropriate, inferential statistics and supplementary analysis for each of the tests in turn.

5.5.1.1. Data Screening

All data was manually entered into SPSS and checked repeatedly (over a period of several weeks) for accuracy of transcription. Data was not reduced, cleaned or transformed in any way. Prior to inferential analysis, data for each individual component was screened to ensure that it met the statistical requirements for conducting a parametric test. Data was checked (initially by means of visual inspection of histograms, stem-and-leaf and box-plots and then through use of Kolmogorov-Smirnov or Shapiro-Wilks tests in SPSS) for normality of distribution, the presence of outliers and, in the case of independent measures designs, for homogeneity of variance. The skewness and kurtosis statistics reported within SPSS were then used to calculate z scores, which provided a mathematical estimate of the normality of the distribution. Scores over 1.96 were regarded as being significantly skewed or kurtosed at p=.05. No outliers were deleted or manipulated in any of the following studies. However, as soon as data analysis began, it was apparent that the Cohort 2 sample was somewhat skewed; only 18 of the total 190 participants were under three-years-old, but 13 of these were from Cohort 2; furthermore, ten of these thirteen were boys. The results for the Cohort were therefore treated with caution. This is discussed further in the Discussion section.

5.5.1.2. Statistical Testing

Hypothesis 1 *Girls will perform better in categorisation tasks than boys* was tested using a series of Chi-Square Tests for Independence

Hypothesis 2 *Children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups* was tested using a series of Chi-Square Tests for Independence

Hypothesis 3 *Participants will perform better on categorisation tasks when presented with objects than when presented with images* was tested by means of an Independent Samples Mann-Whitney U Test,

5.5.2. Shape and Colour

One hundred and ninety participants completed the tests. The ability to categorise on the basis of shape and the ability to categorise on the basis of colour were both recorded according to a simple pass / fail criteria. The emergent data was subject to a Chi-Square Test for Independence in order to determine whether a significant association existed between participant sex and their ability to categorise according to colour / shape.

5.5.2.1. Descriptive Statistics

Eighty-four point two percent of participants were able to correctly categorise all of the cards on the basis of shape. As inability to categorise on the basis of shape or colour is anomalous at this age, the analysis focussed on those participants who were not achieving developmental norms in order to investigate potential explanations and consider possible correlations with other test scores. Of the thirty participants who were unable to categorise on the basis of shape, twenty-three were male and seven were female. Fourteen were from Cohort 1; six were from Cohort 2; eight were from Cohort 3; two were from Cohort 4 and none were from Cohort 5.

Twenty-seven children (14.2% of the total sample) who were unable to categorise on the basis of shape, were also unable to categorise on the basis of colour. Eighty-one point eight percent of participants were able to correctly categorise all of the cards on the basis of colour. Of the thirty-six participants who were unable to categorise on the basis of colour, twenty-six were male and ten were female. Fifteen were from Cohort 1; seven from Cohort 2; eleven from Cohort 3; three from Cohort 4 and none from Cohort 5.

Data was analysed according to sex, cohort and mean age.

Table 12: Number of participants unable to categorise shape / colour by sex, cohort and mean age.

	Colour Male	Colour Female	Colour Total	Shape Male	Shape Female	Shape Total	Both Male	Both Female	Both Total	Both Mean Age
Cohort 1	10	5	15	11	3	14	9	3	12	43.4
Cohort 2	6	1	7	6	0	6	4	1	5	36.2
Cohort 3	5	6	11	4	4	8	4	3	12	37.6
Cohort 4	3	0	3	2	0	2	3	0	3	32
Cohort 5	0	0	0	0	0	0	0	0	0	N/A
Total	26	10	36	23	7	30	20	7	27	N/A

More boys (n =26, 23) than girls (n = 10, 7) were unable to categorise colour and / or shape. More children from the lower socio-economic groups (C1, n = 15, 14 and C3, n = 11, 8) than from the higher SES groups (C2, n = 7, 6 and C4, n = 3, 2), were unable to categorise on the basis of colour and /or shape. These results support Hypothesis 1 and Hypothesis 2.

The mean age for participants from Cohorts C1 and C3 who were unable to categorise on the basis of colour and/or shape was also higher than the mean age of those from C2 and C4 who encountered similar difficulties. Seven of those who were unable to classify according to either colour or shape were under thirty-six months old; they were all male. All of the Cohort 2 and Cohort 4 males who were unable to classify either shape or colour were under thirty-six months old. All participants from Cohorts 1 and 3 who were unable to classify either shape or colour were over thirty-six months of age.

The mean age for girls who were unable to classify either shape or colour was 39.5 months, for boys it was 39.2 months.

Eleven of these children were also unable to create any categories using the picture cards; two participants were unable to form any categories using toys.

5.5.2.2. Inferential Statistics.

A series of Chi-Square Tests were conducted in order to assess whether there was a significant association between the variables. These showed significantly more boys than girls were unable to categorise on the basis of shape, (X^2 (1, 190) = 94.5, p = .001, r = .71). A significant difference was also found amongst cohorts (X^2 (4, 190) = 94.51, p <.001, r = .64); with Cohorts 4 and 5 performing significantly better than Cohorts 1 and 3.

Significantly more boys than girls failed to categorise cards on the basis of colour (X^2 (1, 190) = 73.28, p <.001, r = 0.07). With regard to colour categorisation, a significant difference was found between cohorts (X^2 (4, 190) = 77.21, p <.001, r = 0.62) with Cohorts 4 and 5 performing significantly better than Cohorts 1 and 3.

These results support Hypothesis 1 and Hypothesis 2.

5.5.3. Categorisation Using Images and Toys

5.5.3.1. Data screening.

Z scores were calculated from raw data for the age of participants (M = 42.64, SD = 5.24) z = 1.95; the number of categories participants created using images (M = 3.23, SD = 3.17) z = 7.25 and the number of categories participants created using toys (M = 6.4, SD = 3.25) z = 2.7. These results violated parametric assumptions and were therefore analysed using a Kruskal-Wallis Test.

5.5.3.2. Statistical Testing

Hypothesis 1 Girls will perform better in categorisation tasks than boys was tested using an Independent Samples Mann-Whitney U Test.

Hypothesis 2 Children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups was tested using a Kruskal-Wallis Test.

Hypothesis 3 Participants will perform better on categorisation tasks when presented with objects than when presented with images was tested by means of a Kruskal-Wallis Test, and a Wilcoxon Test.

5.5.3.3. Descriptive Statistics.

Table 13: Categories created and items used by modality

	Range	Mean	SD
Categories created using images	0 - 14	3.23	3.18
Cards used to create categories	0 - 43	7.61	8.16
Categories created using toys	0 - 18	6.40	3.25
Toys used to create categories	0 - 42	17.16	8.85

Note: If an item was re-categorised by a participant, this was counted as an extra item. Thus a bus classified with a car as "things with wheels" and with a doll and a beach ball as "going to the sea-side" would be counted as two items. Any scores over 27 necessarily indicate some re-classification.

More categories were created using toys than were created using cards and more toys were generally used in the creation of categories.

5.5.3.4. Inferential Statistics.

5.5.3.4.1. Socio-economic background

Using a Kruskal-Wallis Test, cohort was shown to be significant for both the number of categories created using images (p <.001) and the number of categories created using toys (p <.001), with children from higher socio-economic groups creating more categories than those from lower socio-economic groups. When subject to a pair-wise comparison, these differences were found to be pronounced between some cohorts whilst other groups did not differ significantly from one another. Thus, significant differences were apparent between Cohort 1 and Cohort 4 H (4) = -52.61, p = .001; Cohort 1 and Cohort 5, H (4) = -86.9, p < .001; Cohort 3 and Cohort 4, H (4) = -68.63, p < .001 and Cohort 3 and Cohort 5, H (4) = -102.92, p <.001;

but Cohort 1 and Cohort 3 did not differ significantly H (4) = 16.02, p = 1.00. Thus, whilst a significant difference was found *between* high and low socio-economic groups, no significant difference was found between the cohorts *within* these groups. These results support Hypothesis 2.

Similarly, when the number of image cards used to create categories was analysed by means of a Kruskal-Wallis Test, a significant difference was found between cohorts (p <.001) but more detailed analysis showed this to be specific to some sub-samples. When subject to a pair-wise comparison, Cohort 1 and Cohort 4 differed significantly H (4) = -51.35, p = .009; as did Cohort 1 and Cohort 5 H (4) = -87.69, p <.001; Cohort 3 and Cohort 4 H (4) = -43.1, p = .001; and Cohort 3 and Cohort 5, H (4) = -100.91, p <.001. However, no significant difference was found between Cohort 1 and Cohort 3, which are both classified as low socio-economic groups. These results support Hypothesis 2.

These results were again replicated when the use of toys in categorisation was analysed. In each instance, Cohort 2 did not generally register as being significantly different from either the high or the low socio-economic cohorts in either the number of categories created (Cohort 2 / Cohort 1 H (4) = 14.28, p = 1.00; Cohort 2 / Cohort 4, H (4) = -42.81, p = .082) or the number of toys used in the creation of categories (Cohort 2 / Cohort 1 H (4) = 12.13, p = 1.00). There was, however, a significant difference between the number of toys used in the creation of categories between Cohort 2 and Cohort 4, H (4) = -58.94, p = .003).

Once again, no significant difference was found between the two low SES groups in terms of either number of categories created using toys (Cohort 3 / Cohort 1, H (4) = 16.72, p = .97) or number of toys used in the creation of categories (Cohort 1 / Cohort 3 H (4) = 10.15, p = 1.00). Nor was there a difference between the high SES groups in terms of either number of categories created using toys (Cohort 4 / Cohort 5, H (4) = -41.95, p = .77) or number of toys used in the creation of categories (Cohort 4 / Cohort 5, H (4) = -24.72, p = 1.00).

There was, however, a significant difference between each of the groups representing different ends of the socio-economic spectrum. When considering the number of categories created using toys, Cohort 1 differed from Cohort 4 (H (4) = -28.53, p = .036) and Cohort 5 (H (4) = -70.48, p = .005); similarly, Cohort 3 differs from both Cohort 4 (H (4) = -45.25, p = .05) and Cohort 5, (H (4) = -87.19; p <.001). These results support Hypothesis 2.

5.5.3.4.2. *Sex*

When subject to an Independent Samples Mann-Whitney U Test, the difference between sexes failed to reach significance either with regard to the number of categories created using images (U = 5,233.50, p = .054, r = 0.53) or the number of cards used to create these categories (U = 5,237.5, p = .054, r = 0.54). However, the number of categories created using toys showed a significant difference (U = 5,515.00, p = .003, r = 0.19), with girls creating more categories than boys. The number of toys used to create categories was also found to be significant (U = 5, 628.5, p = .001, r = 0.19), with girls using more than boys. These results thus supported Hypothesis 1 with regard to the number of toys used to create categories and the number of categories created using toys, but not with regard to the number of cards used to create categories or the number of categories created using cards.

5.5.3.4.3. *Modality*

When subject to a Wilcoxon Test, modality was shown to be significant for the number of items used to create categories (p <.001) and the number of categories created using items (p <.001). Children used more toys than images when creating categories and created more categories when using toys than when using images. These results support Hypothesis 3.

5.5.4. Second Stage of Analysis

Descriptive statistics, particularly with regard to Cohort 2, suggested a developmental trajectory. Participants were therefore sub-divided into age bands; the lesser number in the upper band is reflective of the sample spread.

- Under 40 months (n = 67)
- 41 – 48 months (n = 93)
- Over 48 months (n = 30)

A series of Chi-Square Tests were conducted in order to assess whether there was a significant association between age, shape and colour categorisation. Those under 40 months were least likely to be able to categorise on the basis of shape (X^2 (2, 190) = 8.19, p = .02, r = .21).The same pattern was also observed for colour categorisation, wherein those under 40 months were the least likely to be able to categorise according to colour (X^2 (2, 190) = 8.81, p <.01, r = .22).

The remainder of the data was subject to a Kruskal-Wallis Test. Age was found to be significant regarding the number of categories participants created using images (H (2) = 29.97, p <.001), the number of cards used to create categories using images (H (2) = 27.99, p <.001), the number of categories created using toys (H (2) = 31.57, = <.001) and the number of toys used to create categories (H (2) = 29.95, p <.001). In each instance, there is clear evidence of a developmental trajectory, with children reaching milestones sooner when categorising toys than when categorising images.

5.6. Discussion.

The purpose of this study was to investigate whether the findings of the small-scale Study 1(a) would be replicated with a more diverse cohort drawn from a wider age range. The discovery that some children in the first study were unable to categorise on the basis of shape or colour is anomalous to the broader population (Bornstein, 2006; Bornstein, Kessen & Weiskopf, 1976; Franklin & Davies, 2004). There was thus a need to scrutinise whether this inability was specific to one group or correlated to any other difficulties. The first study had also found a difference between sexes, with girls performing consistently better than boys in all conditions. Similarly, children from higher socio-economic groups attained higher results in each test than their peers from lower socio-economic groups. A further consistent difference was found between modalities, with significantly more participants able to create more categories using toys than when using images. It was predicted that these differences would be replicated in this study, which was largely the case. The potential reasons underlying the results for each test will now be discussed, together with some general issues arising from the research.

Blanket permission was sought from all parents / carers in each setting and all children whose parents had provided informed consent were welcomed as participants. As the main focus of this study was typical development, data gathered from participants with known developmental delays and atypicalities (n = 16) was collected but not analysed. Children with classic autism did not engage with the tasks, but generally took an interest in some of the toys. Two female participants, diagnosed with selective mutism, volunteered as participants. Although they were in separate settings, each girl volunteered by arriving at the testing table and sitting next to the researcher. The naming component of the image test was withdrawn and each participant completed the task with apparent enjoyment. One male participant with a severe and persistent Specific Language Impairment participated enthusiastically and scored highly in each of the

tests. This was of considerable interest to the Staff and proved remarkably reassuring for his parents. Each setting had children, often newly arrived in the country, who spoke little or no English. Without exception, these children were able to successfully complete the categorisation tasks. It was therefore apparent that the test was accessible to children across this age range with little or no language and that it was able to provide a measure of understanding and cognitive ability which is often otherwise difficult to gauge. It also further contributes to the debate concerning the importance of language in categorisational ability (Gleason, 2014; Golinkoff, Mervis & Hirsh-Pasek, 1994; Gopnik & Meltzoff, 1987; Gopnik & Meltzoff, 1992; Gopnik & Meltzoff, 1997; Graham & Kilbreath, 2007), apparently adding weight to dismissal of the Whorfian hypothesis and similar theories of linguistic relativity (Berlin & Kay, 1969; Mandler & McDonough, 1993; Pinker, 1994; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997). It must be recognised, however, that it is possible participants employed sub-vocalisation (Saeki & Saito, 2004; Saeki, Baddeley, Hitch & Saito, 2013), or drew on received information (Anderson, 1991; Callanan, 1985; Colunga & Smith, 2005; Gelman, Coley, Rosengren, Hartman & Pappas, 1998; Millikan, 1998) when completing the tasks. The development of their categorisational abilities may therefore have had a linguistic component which was influential but not apparent. These results merely demonstrate that a shared language is unnecessary when conducting this test battery.

As noted in Chapter 3, conducting research with young children and in pre-school settings is inevitably beset by practical and logistic difficulties (Bergman, 2011; Buscemi, Blumstein, Kong, Stolley, Schiffer, Odoms-Young, Bittner & Fitzgibbon, 2015; Jorm, Kelly & Morgan, 2007; Risko, Laidlaw, Freeth, Foulsham & Kingstone, 2012). Families are more inclined to move house when they have young children, especially if they have been living in a disadvantaged neighbourhood (van Ham, Manley, Bailey, Simpson & Maclennan, 2013). The prevalence of infectious diseases and the speed with which they spread frequently leads to periods of substantial absenteeism, particularly amongst families living in poverty (Barnardo's, 2015). School rolls are also bedevilled by fluctuations in the birth rate, political change and local circumstance (GOV.UK, 2015). It was therefore unsurprising that a number of children with whom familiarisation work had been conducted did not ultimately participate and that subsequently, something of the planned match between cohorts was lost. The preponderance of males under 36-months-old in Cohort 2 caused particular difficulties when attempting between-cohort comparisons. Furthermore, the researcher's positioning in the central hall and the range of alternative activities on offer, rendered participants far more susceptible to

distraction than any other cohort. It is believed that these factors had an adverse effect on results, reducing them from the levels seen in the previous study. For these reasons, the results from Cohort 2 are to be treated with caution.

Previous research in the field (Mandler, 2003; Quinn, 2004; Rosch, 1978; Sloutsky, 2003) had suggested that the ability to categorise according to colour and defined shape emerges in early infancy (Bornstein, 2006; Bornstein, Kessen & Weiskopf, 1976; Franklin & Davies, 2004), together with some other broad perceptual and conceptual categories (Cohen & Caputo, 1978; Mandler & McDonough, 1993; Quinn, Eimas and Rosenkrantz, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997). It was therefore surprising to discover that approximately 15% of the sample was unable to categorise on the basis of shape or colour. Undoubtedly, the inclusion of the split-coloured card continued to confuse a proportion of the participants, but even with this variable removed, the figure remained higher than would have been anticipated. When subject to analysis, it was clear that the majority of those who struggled with colour and shape were males. Even though some allowance was needed for the fact that the male participants from Cohorts 2 and 4 who encountered difficulties were predominantly under three-years-of-age, this did not fully address the issue, as girls of this age in these cohorts successfully completed the tasks. Furthermore, the boys from Cohorts 1 and 3 who struggled were all over three-years-of-age. This provided the first clear indication that the superior female performance recorded in Study 1was replicated across a range of cohorts. Whilst the anticipated developmental trajectory held true for the middle-class girls, there was evidence that boys hit developmental milestones later, with retardation further exacerbated amongst economically disadvantaged communities (Brooks-Gunn, Duncan & Maritato, 1997; Williams-Shanks, 2007; Williams-Shanks, Kim, Loke & Destin, 2010).

Analysis of the image and toy categorisation tasks provided further evidence of a difference predicated on sex and socio-economic status. Girls, from the youngest to the oldest, performed better than boys across the board. And whilst there were sharp divisions between the performance of children from high and from low socio-economic groups, there was relative cohesion within each demographic band, with children from disadvantaged backgrounds achieving lower scores. This appeared to indicate that some of the key factors influencing performance were connected to social grouping rather than being specific to the setting.

The order in which differing categorisational abilities became apparent was the same for virtually all children, and broadly replicated the findings of other researchers in the field

(Mandler & McDonough, 1993; Mareschal & Quinn, 2001). Colour and shape categorisation emerged first, followed by an ability to categorise toys (Mandler, 2004; Oakes & Plumert, 2002) then images. However, as previously noted, there appeared to be a developmental lag of several months between girls and boys which is in line with previous research findings relating to cognitive development (Badham & Maylor, 2015; Chow & Conway, 2015; Gopnik & Meltzoff, 1997; Halpern, 2012; Junaid & Fellows, 2006; Martin & Szkrybalo, 2002; Patman & Kehily, 2004; Smith, Cowie & Blades, 2003 Strand, 2014; Wallace & Russ, 2014). Given the impact of socio-economic status and sex, it was unsurprising that an interaction should be found between the two, rending middle-class girls foremost and leaving working-class boys with magnified and contiguous disadvantages. This polarisation based on social class is reflective of divisions in academic attainment which are apparent throughout the education system (Bulut, 2013; Gupta, 2000; McKinney, McClung, Hall, Cameron & Lowden, 2012; Mensah & Kiernan, 2009; Snook & O'Neill, 2010). It is well documented that children living in poverty face, not only financial constraints, but a range of other factors which serve to impede their cognitive growth and emotional wellbeing (Kintrea, St. Clair & Houston, 2011; Yoshikawa, Aber & Beardslee, 2012). Parental education rates tend to be lower whilst the incidence of lone parenting or young parenting is higher (Barnardo's, 2015). These factors are often associated with job (and subsequently, financial) insecurity (Hill & Ybarra, 2014). As a result, children experience greater instability (van Ham, Manley, Bailey, Simpson & Maclennan, 2013), poorer health and a higher incidence of inadequate living conditions (Barnardo's, 2015). Children raised in poverty therefore begin school already behind more affluent peers (Duncan & Magnuson, 2013).

Given the cumulative nature of knowledge acquisition and the links between categorisation and semantic memory, it is possible that the disparities revealed by this study are one of the antecedents of subsequent academic divergence (Favarotto, Coni, Magni, & Vivas, 2014; Irish & Piguet, 2013). It would appear plausible that academic achievement would be further supressed if this failure to hit early cognitive milestones was coupled with the aggregated impact of continued disadvantage. The impact of poverty and disadvantage will be considered in greater detail in Chapter 7.

Almost without exception, male and female pre-school participants from all cohorts performed better when asked to categorise toys, than when dealing with images. This finding is in line with previous research (Kalenine & Bonthoux, 2008; Mandler, 2003, 2004; Mandler & McDonough 1993, 1996), thus strengthening the assertion that objects provide a more sensitive

measure of categorisational ability than pictures when working with the very young. As a consequence of this, it is feasible that many previous assertions regarding pre-school children's inabilities were actually a reflection of an inappropriate testing mechanism rather than a reliable measure of cognitive development. It is notable, however, that once a child's understanding of categorisation is secure (generally around the time of their fifth birthday) (Gelman & Markman, 1986; Gelman & Koenig, 2003), the gulf between the two modalities lessens. The Infant School participants and some of the high-scoring younger children showed little disparity in their scores. It is therefore recommended that whilst categorisation tests using images are appropriate for use with school-aged children, pre-schoolers should use toys whenever possible.

This study had sought to investigate the importance of sex and socio-economic status in the development of categorisation through use of a new, bespoke testing mechanism. The toolkit was demonstrably valid and reliable, allowing fine-grained differentiation between participants. It proved accessible to pre-schoolers of all abilities, including those with little or no functional English. As such, it provided a quick and illuminating insight into preschool children's categorisational abilities. The data, having been drawn from a demographically diverse group, adds further credence to previous assertions regarding a developmental trajectory and provides new insights into the importance of sex and socio-economic status in the development of categorisation.

5.7. Summary and Links to Study Three.

This study had sought to investigate whether the sex and socio-economic differences found in Study 4 would be replicated with a larger sample and across a range of cohorts. Once again girls were found to score more highly than boys, and children from higher socio-economic groups scored more highly than those from disadvantaged locations. Furthermore, there was found to be an interaction between the two, with middle class girls scoring most highly and working class boys encountering most difficulty. It was postulated that this may be a contributory factor in later academic disparity. Once again, significant differences were found in participant performance dependent upon presentation modality, with the use of objects allowing many to demonstrate a clear grasp of thematic categorisation at an age previous researchers had considered to be untenable. This served to affirm the validity and reliably of

the toolkit in providing fine-grained differentiation between participants of all abilities, including those with little functional English.

All four of the pre-school settings had been unimaginably warm and welcoming to the researcher. Ofsted had classified them all as "Good", but they each had an individual approach. The sharpest divide was between Cohort 1, (which observed National Curriculum strictures by providing formal teaching of literacy and numeracy) and Cohorts 2, 3 and 4 which were all play focussed. Although there were clear similarities between Cohorts 1 and 3, there were also a number of differences. Participants from Cohort 3 were substantially more disadvantaged according to every diagnostic criterion and they were also younger than the participants from Cohort 1, each of which should have placed them at a disadvantage. However, they performed marginally better. Cohort 3 advocated learning through child-led play and embraced elements of the Reggio Emilia philosophy, specifically the need for children to move, explore and enjoy some control over their own learning. Whilst both the Cohort 1 and Cohort 3 Nurseries provided a joyful experience for children, the daily curricular and pedagogic diets were markedly different.

Given that play has been widely acknowledged as a means of developing language (Bates, Benigni, Bretherton, Camaioni & Volterra, 1977; McCune-Nicolich, 1981; Orr & Geva, 2015), cognition (Alfieri, Brooks, Aldrich & Tenenbaum, 2011; Cheng and Johnson, 2010; Fischer, 1992; Kim, 1999; Krafft & Berk, 1998; Wallace & Russ, 2015) and skill acquisition (Roskos & Neuman, 1998; Stone & Christie, 1996) it was postulated that the apparently analogous differences in performance may be attributable to the provision of greater play opportunities in Cohort 3. It was therefore decided that the third study would consider the impact of differing approaches to Nursery provision on the development of categorisational ability.

Chapter 6

Study Three: The Impact of Play on the Development of Categorisation in Pre-School Children

6.1. Chapter Overview

Study 2 had confirmed that during the pre-school period, girls perform better than boys in all measures of categorisational ability and that those of high socio-economic status out-perform those of low socio-economic status. These results, garnered from pre-school children were thus reflective of the pattern of attainment seen throughout education (Department of Education, 2011). However, the most disadvantaged group performed consistently better that the other low socio-economic group, despite also having younger participants. Study 3 therefore aimed to investigate the reasons for this disparity in the hope of isolating measures that could help weaken the association between social and educational stratification. Being part of an Infant School, Cohort 1 was the only setting within Study 2 to fully embrace structured group teaching with explicit and targeted literacy and numeracy sessions. Cohorts 2, 3 and 4 focussed on play, with the seven areas of learning (Standards and Testing Agency, 2014) being addressed via the activities on offer, adult responses and some instruction during staff-led sessions such as registration. Cohort 3 in particular, had a strong philosophical belief in the importance of child-led play as a means of encouraging children's active involvement in knowledge construction.

It was therefore decided to compare the impact of these differing strategies by returning to the two nurseries situated in disadvantaged areas (C1 and C3) in order to test children on admission, then again at the end of their first term. The entire new intake in each cohort therefore completed the Study 2 test battery in September and a matched test battery in December. It was anticipated that maturation would lead to gains for all children over the three-month period but the results from Study 2 indicated that these gains were liable to be greater amongst children who played than amongst children who followed a formal curriculum.

Addressing PhD Objectives 4, 6, 7.

4. To assess whether socio-economic status impacts the development of categorisation in pre-school children.

6. To extend psychological understanding of how differing forms of categorisation emerge and develop.

7. To explore the impact of play on the development of categorisation.

Hypotheses

1. Girls will perform better in categorisation tasks than boys.

2. Children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups.

3. All participants will perform better on categorisation tasks when presented with objects than when presented with images.

4. Children who experience a play-based intervention at nursery will, over twelve weeks, make greater gains in all measures of categorisational ability than those who experience a more formal curriculum and pedagogy.

6.2. Introduction and Background to Study 3

Within this study, *Cohort 1* refers to the primary school nursery unit that had previously provided participants for Study 1 and Study 2; *Cohort 3* refers to the community nursery that also participated in Study 2. The chapter begins by providing additional detail about each setting in order to further contextualise the study. As the study was conducted in two discrete sections, a full report, including results, is then provided for the September portion of the study. It is subsequently explained how the September results informed production of a matched test for use in December. During the period between tests, the researcher continued to visit each setting and conducted a series of structured observations in an attempt to quantify the differences in approach she had discerned during the previous two years of visiting the settings. A brief resume of these observations is offered chronologically within the chapter, with some of the full accounts in the appendices. These pupil pursuits and "activity snapshots" serve to illustrate the difference of approach within the two settings. Following this, the December study is outlined and a breakdown provided of the change statistics for each group. The chapter ends with a discussion of the findings and their implications.

6.3. Demographic Information

6.3.1. The Cohort 1 Nursery is in an area ranked 2,800/32,482 in the National Indices of Deprivation (2014).

The Nursery is attached to a Primary School, with the day-to-day running being orchestrated by a Nursery teacher and three Teaching Assistants but with overall management and decision making lying with the Infant School Headteacher. The Nursery thus observes all aspects of the Statutory Framework for the Early Years Foundation Stage (2014) and aims to ensure a smooth progression from Nursery to Reception Infants for each child. Fifty children were admitted in September, split equally between the morning and afternoon sessions. All participants in this study attended Nursery for fifteen hours per week.

The Nursery occupies one large area, sub-divided into sections; it also has a partially enclosed kitchen, toilets, and a "Focus Room" which is used for registration and story-time. It has access to its own yard area which is used for outdoor play and container-gardening activities. Pupils occasionally use the grassed area attached to the Infant School.

Figure 13: The Yard outside Cohort 1 Infant and Junior School

Image removed

At its last inspection, in April 2015 (four months after this study was completed), Ofsted classified the school as "Good".

Ofsted noted:

- Children enter the school with skills that are below what is typical for their age, particularly in the area of language and communication. Their physical development is stronger.

- In the 2014 national checks in Year 1, pupils' understanding of letters and the sounds linked to them was well below the national average.

- Pupils' speaking skills are very mixed. Some of the most-able pupils have a good vocabulary and are able to express their ideas well, but a considerable number of pupils struggle to explain themselves in much detail.

- Staff and governors all recognise that White British boys do not attain as highly as other groups of pupils. Changes have been made to the curriculum and resources to make learning more interesting for boys. While this has met with some success, it remains a key priority for the school. Boys still do not attain as highly as girls, with the biggest gap in writing.

- In 2014, disadvantaged pupils entitled to support from the pupil premium were just over two terms behind their classmates in reading, over a term behind in writing and one term behind in mathematics. They were also a year or more behind other pupils nationally. From their different starting points, disadvantaged pupils make good progress and achieve well. This is because the quality of support they receive is good and activities are well matched to their different abilities.

- The small number of pupils who speak English as an additional language make good progress too. Many speak English as well as their home language and by Year 2 often outperform other groups of pupils.

- Children have very mixed early learning experiences and understanding of the world beyond their local area. Some, especially boys, lack confidence and do not use a wide range of words to express their ideas. Skills in other areas of learning are also generally below what is typical. The Nursery provides opportunities to learn a wide range of skills so that children grow in confidence.

- Provision for children in the early years is good, especially in the Nursery.

Testing took place in the kitchen area or book corner of the Nursery.

6.3.2. The Cohort 3 Community Nursery is situated in an area ranked at 1,043/32,482 in the National Indices of Deprivation (2014). The Nursery has large, purpose build accommodation, with yard and gardens to all sides. It is under the control of the Local Authority but is not linked to a Primary School. It is run by a Headteacher and a team of teachers and Nursery Nurses. The Nursery had 104 children on roll in September 2014 (split equally between the morning and afternoon sessions). Testing took place in the Puzzles Corner. The school advocates child-initiated learning through child-led play. Staffing ratios are high, enabling staff to respond to emerging ideas and thus incorporate the seven areas of learning into daily activities. The outdoor area is permanently staffed and available for children to use

throughout the day (the Nursery provides waterproofs, wellingtons, sun hats etc. to ensure that children are suitably clothed). Children and parents also regularly visit a Forest School.

The Nursery was part of a pilot scheme, providing 15 hours of free childcare per week for 32 two-year-olds from families with a household income below £16,190 and in receipt of Working Tax Credit or Child Tax Credit. The children attended a Pre-School Unit attached to the main Nursery, but with its own play room, kitchen and outdoor area. The Pre-School had four full-time staff.

Figure 14: A Garden Area outside Cohort 3 Pre-School.

Image removed

At the last inspection, in July 2012, Ofsted classified the Nursery as "Good". Ofsted noted:

- Children are very happy, confident and settled in this friendly pre-school.
- Partnerships with parents are effective.

No comments were made regarding children's achievements.

6.4. Study 3(a): Time Point 1 (September 2014)

6.4.1. Materials

All materials were as for Study 2.

6.4.1.1. Shape Matching.

Eight 10cm x 10cm 480 GSM white cards; 4 with a red triangle mounted on to them at different angles and 4 with a red square. (See Appendix 3)

6.4.1.2. Colour Matching.

Twelve 10cm x 10cm 480 GSM white cards; four with a 7cm x 7cm pink square; four with a 7cm x 7cm blue square and four with a 7cm x 7cm square divided equally between pink and blue. (See Appendix 4)

6.4.1.3. 2D Categorisation.

The 27 images which had been developed during Study 1 and utilised during Study 2 were used once again with this group of naïve participants. As previously, all images were mounted on 10cm x 10cm 480 GSM white card. (See Appendix 1)

6.4.1.4. 3D Categorisation.

The 27 play items, matched as closely as possible to the 2D images and used during Study 2 were used once again. (See Appendix 2). The toys were presented in an attractive, colourful box.

Record Sheet (see Appendix 5)

Notebook for initial records and observations.

6.4.2. Participants

A total of 102 participants (44m, 58f), aged 36-48 months were recruited. The sexual asymmetry in the sample was entirely attributable to an imbalance in the intakes of both settings. None of the participants in this study had previously been exposed to these materials. The parents/carers of each participant had given their informed consent. Children with a known learning impairment or pervasive developmental disorder (n = 6) were welcomed to engage in each of the tasks but, as this study sought to investigate typical developmental trajectories, their data was not included in the analysis.

Table 13: Participants with data eligible for analysis by sex, cohort and mean age.

	Males	Females	Total	% of Sample	Age Range in Months	Mean Age
Cohort 1	20	28	48	50	37-48	43.13 (SD 3.41)
Cohort 3	22	26	48	50	36-48	41.96 (SD 3.82)
Total	42	54	96	100	36-48	42.55 (SD 3.63)

Eighty-six of these children completed the entire battery of tests in both September and December. Four males and four females from C1 and one male and one female from C3 did not complete the full battery of eight tests because of illness, relocation or because it was not felt to be in the child's best interests. Hereafter, participant numbers are provided for each individual test as appropriate.

6.4.3. Procedure

6.4.3.1. Familiarisation work was conducted with each cohort in the summer term prior to testing.

Cohort 1: the researcher attended all new-intake induction days in order to meet both parents and children.

Cohort 3: the researcher spent ten days in the Pre-School Unit for two-year-olds and made some visits to the adjoining Nursery with the children who were due to transfer into it.

This arrangement allowed the researcher to spend approximately the same amount of time with each new participant.

6.4.3.2. Testing

During the first four weeks of the Autumn Term, the researcher alternated between the two units, testing as many naïve participants as possible, including the entire new intake. A record was kept of the date on which every child was tested.

In line with Study 2, testing began with the easiest task (shape) in order that the child could be instantly praised and would be confident and motivated to approach subsequent tests. The colour test was presented second and then the order of presentation for the toy and image categorisation tests alternated.

All procedural details were as for Study 2 (see 5.4.3.)

All participant responses were recorded in a notebook and transcribed onto a proforma at the end of the session. Information from the Record Sheets was subsequently transferred onto SPSS and anonymised.

Many children asked to play the games again during later visits by the researcher, allowing test-retest reliability to be evaluated.

6.4.3.3. Additional Activities

During October and November, the researcher conducted a series of "activity snap-shots", in which a record was made of the activity every child on the premises was engaged in

Activity Snapshots Example: Cohort 1

Thursday 16th October 1.55 pm

Playdough 3m

Pencil table 2m 2f

Sand 4f

Toilets 1m 2f

Dolls houses 1m 3f

Puzzles 1m

Home Corner 2m 1f

Lego 1f

Noticeable that most play was individual, sometimes parallel.

2.30 pm

Book corner 1m 2f

Lego 1m 1f

Dolls houses 1m 2f

Pencil table 1f

Dough 3m

Puzzles 2m Sand 4f

Toilet 1f

Four pupil pursuits were also conducted in each location, six of which are included in the Appendices (See Appendix 8). In these, an individual child was followed for the duration of the session and all of their activities and interactions recorded. The pupil pursuit and snap-shot data has been included here in order to demonstrate some of the differences between the two units.

Figure 15: Note Taking on the Yard during Cohort 3 Activity "Building a House for Baby". See Pupil Pursuit for "Saffron" in Appendix 9

Image removed

Parental questionnaires were distributed and a series of parental interviews were held in each location during July and September. These focussed on shared parent-child activities; for instance, reading books and playing together. However, demand characteristics were high and the data gleaned from the questionnaires and interviews was not subsequently used.

6.4.4. Results for Time Point 1 (September 2014)

6.4.4.1. Analytic Strategy

This study involved four separate tests, with analysis incorporating sex and cohort effects. This section shall therefore provide descriptive statistics and, where appropriate, inferential statistics and supplementary analysis for each of the tests in turn.

6.4.4.1.1. Data Screening

All data was manually entered into SPSS and checked repeatedly (over a period of several days) for accuracy of transcription. Data was not reduced, cleaned or transformed in any way. Prior to inferential analysis, data for each individual component was screened to ensure that it met parametric assumptions.

Data was checked (initially by means of visual inspection of histograms, stem-and-leaf and box-plots and then through use of Kolmogorov-Smirnov or Shapiro-Wilks tests in SPSS) for normality of distribution, the presence of outliers and, in the case of independent measures designs, for homogeneity of variance. The skewness and kurtosis statistics reported within SPSS were then used to calculate z scores, which provided a mathematical estimate of the normality of the distribution. Given the small sample sizes in these studies, scores over 1.96 were regarded as being significantly skewed or kurtosed at p=.05. No outliers were apparent in any of the following studies.

6.4.4.1.2. Statistical Testing

Hypothesis 1. *Girls will perform better in categorisation tasks than boys* was investigated by means of a Chi-Square test

6.4.4.2. Descriptive Statistics: Shape

Ninety-five participants completed this test (C1, 20m, 28f; C3, 22m, 25f).

Eighty-two participants (85.4%) correctly categorised the cards on the basis of shape. The 14.6% who were unable to do so were as follows:

Table 14: Number of Participants Unable to Categorise on the Basis of Shape.

Cohort	Boys	Girls	Total
Cohort 1	3	1	4
Cohort 3	6	3	9
Total	9	4	13

More boys than girls and more members of Cohort 3 than of Cohort 1 were unable to categorise on the basis of shape.

6.4.4.3. Inferential Statistics: Shape

As data was categorical, it was analysed using a Chi-Square Test in order to determine whether there was a significant relationship between factors. Although more boys than girls were unable to categorise on the basis of shape, this did not reach a level of significance (X^2 (1, 95) = 516, p = .101, r = 0.04). More participants from Cohort 3 than from Cohort 1 struggled to complete the task but the difference between cohorts was not found to be significant (X^2 (1, 95) = .01, p = .17, r <.001.) These results fail to support Hypothesis 1 or Hypothesis 2.

6.4.4.4. Descriptive Statistics: Colour

Ninety-five participants completed this test (C1, 20m, 28f; C3, 22m, 25f).

Seventy-nine participants (83.2%) correctly categorised the coloured cards. Sixteen participants (16.8%) were unable to categorise on the basis of colour; they were as follows:

Table 15: Number of Participants Unable to Categorise on the Basis of Colour.

Cohort	Boys	Girls	Total
Cohort 1	4	2	6

Cohort 3	3	7	10
Total	7	9	16

More girls than boys and more members of Cohort 3 than of Cohort 1 were unable to categorise on the basis of colour.

6.4.4.5. Inferential Statistics: Colour

Data was analysed using a Chi-Square Test. No significant difference was found between boys and girls (X^2 (1, 95) = .52, p = .83, r = 0.05) or between cohorts (X^2 (1, 95) = .011, p = .32, r =.05) in terms of their ability to categorise on the basis of colour. These results fail to support Hypothesis 1 or Hypothesis 2

6.4.4.6. Data Screening: 2D Images

Skewness and kurtosis suggested a need to calculate z scores for each data set. When considering the number of categories created from images, participant scores ranged from 0 to 13 (M = 2.16, SD = 2.48) z = 6.23. With regard to the number of cards used to create categories, scores ranged from 0 to 25 (M = 4.91, SD = 5.64) z = 5.36.

The data therefore failed to meet parametric assumptions and were subject to a Mann-Whitney U Test in order to compare differences between groups.

6.4.4.7. Inferential Statistics: 2D Images

No significant difference was found between boys and girls in the number of categories created using images U = 404.00, p = .79, r = .64 or the number of cards used to create categories U = 407.50, p = .84, r = .55. Nor was any significant difference found between cohorts in the number of categories created using images U = 200.50, p = .24, r = .56 or the number of cards used to create categories U = 207.50, p = .30, r = .28. These results fail to support Hypothesis 1 or Hypothesis 2.

6.4.4.8. Data Screening: 3D Toys

Participant scores for the number of categories created using toys ranged from 0 to 10 (M = 5.88, SD = 2.43) z = -1.07. Participant scores for the number of toys used to create the categories, scores ranged from 0 to 28 (M = 15.68, SD = 6.63) z = -1.01. The data therefore met parametric assumptions and was subject to a one-way ANOVA in order to determine whether there were any significant differences between groups.

6.4.4.9. Inferential Statistics: 3D Toys

No significant difference was found between boys and girls (F (1, 90) = .14, p = .71, η^2 =.0001) or cohorts (F (1, 90) = .12, p = .73, η^2 = .004) for the number of categories formed using toys. Nor were any significant differences found between boys and girls (F (1, 90) = .066, p = .79, η^2 =.001) or between cohorts (F (1, 90) = .026, p = .87, η^2 =.002) for the number of toys used to create categories. These results fail to support Hypothesis 1 or Hypothesis 2.

6.4.4.10. Inferential Statistics: Age

Age was not found to be significant for the number of categories created from images (F (1, 90) = 1.63, p = .13, η^2 = 0.18); the number of cards used to create categories (F (1, 90) = 1.21, p = .32, η^2 =.0.15); the number of categories created from toys (F (1, 90) = 1.86, p = .081, η^2 =.06); or the number of toys used (F (1, 90) = 1.60, p = .14, η^2 =.34).

In summary, no significant differences were found on entry between participants in the two settings. This was in line with the findings of previous studies.

6.4.4.11. Category Analysis.

Participant responses were analysed to see

- How frequently each image/toy had been used
- What criteria was used for categorisation in each instance

- How participant's scores compared to the school-based assessments in each of the seven areas of learning.

6.4.4.11.1. Categorisation Frequency

Table 16: Frequency of Item use by Modality.

Item Name(s)	2D Image: Times Used	3D Toy: Times Used
King & Queen	47	81
Birds	44	57
Balls	43	111
Washing Machine/Cupboard	21	5
Carrot	19	54
Clothes	19	59
Banana	17	51
Eggs	16	55
Cooker	14	49
Apple	14	47
Bread	13	45
Washing Line	13	N/A
Car	12	39
Bus	12	48
Bear	10	47
Ironing Board/Iron	8	3
Truck	6	42
Cake	5	55
Boots	4	28
Train	4	42
Dog	3	48
Penguin	1	19
Tree/Teapot	1	24

As images and as toys, the three most regularly selected pairings each had strong perceptual similarities which afforded them visual salience. They therefore collectively accounted for 69.2% of the first choice matches in each modality.

Figure 16: Most frequently selected pairings

Items with categorical flexibility were also frequently used. Carrots, for instance, were categorised with fruits, with the oven and were the most common foodstuff to be fed to the animals or people. Similarly, clothing was sometimes categorised with washing items, sometimes with the football and boots and sometimes with the people.

The items which scored poorly were those which required superordinate classification; had only a thematic link to other items and/or were atypical.

Responses were analysed for potential gender bias; 36.9% of the male sample and 25.9% of the female sample created a vehicles category; 45.6% of the males and 29% of the females selected washing or cooking themes, 36.5% of males and 63.5% of females matched the king and queen; 11.9% of the boys and 14.8% of the girls categorised the football with the boot, or engaged the king and queen in a game of football.

6.4.4.11.2. Categorisation Criterion.

In Study 1(c), it was noted that 70.5% of participants began by selecting a perceptual category, and in Study 2, it was apparent that items with clearly discernible similar physical features were matched most frequently. However, categorisation criteria had not been fully recorded or analysed in previous studies, so it was considered to be of interest to do so here. Participant responses were analysed to see whether they had categorised on the basis of perceptual or thematic criteria. In some instances, the division was unclear as the items could arguably be classified according to either criterion and the participant had not explained their reasoning (e.g. the king and queen were linked thematically, but also had many perceptual similarities). In such instances, the categorisation strategy was classified as "questionable"; given the ambiguity of this classification, no analysis was conducted beyond descriptive statistics.

Table 17: Number of Categories formed and number of items used by categorisation strategy.

	Minimum	Maximum	Mean	SD
Perceptual Categories (PCs)	0	4	.81	.88
Items used for PCs	0	8	1.70	1.85
Thematic Categories (TCs)	0	5	.77	1.17
Items used for TCs	0	15	2.10	3.35
Questionable (QS)	0	4	.78	.89
Items used for QS categories.	0	9	1.71	2.10

Responses were analysed from 86 participants.

Approaches to the task varied considerably between participants. Some participants simply matched pairs of items throughout, whilst others sought to continually expand and reorganise the materials. The thematic category of "dinner time" comprised the highest number of items. The only other common conceptual web involved the washing machine, washing line and iron. Only two participants devised stories to link pictures, one incorporated aspects of shopping, preparing and eating dinner and the other involved teddy having a bath in the washing machine.

Twenty-two participants devised stories to link the toys. These mainly comprised the king and queen having a tea party, taking a trip on one of the vehicles or playing football (one 39-month-old participant from Cohort 1 started with the king kicking the ball, before involving the queen, he commented, "Girls can play football too. She's good at it!") One participant (C1, male, 45-months-old) linked all 27 toys into a story about two kindly giant birds leaving food gifts for the king and queen. Twenty-six participants (30.23%) created at least one thematic category using images; 62 participants (72%) created at least one thematic category using toys. Participants generally formed more perceptual categories but larger thematic categories. Ninety-three point six percent of participants began with a perceptual category. Three participants began with a thematic category when working with images, and eight when working with toys.

6.4.4.11.3. Data Screening

In light of the high levels of skewness and kurtosis, z values were calculated from raw scores. For the number of perceptual categories formed (M = 0.81, SD = 0.86, z = 3.52); the number of items used in the construction of perceptual categories (M = 1.70, SD = 1.85) z = 3.76); the number of thematic categories formed (M = .77, SD = 1.17) z = 6.55, the number of items used in the construction of thematic categories (M = 2.10, SD = 3.35) z = 7.42. Data thus failed to meet parametric assumptions and was subject to a Mann Whitney U Test in order to compare differences between groups.

6.4.4.11.4. Inferential Statistics

No significant difference was found between boys and girls in the number of categories created using perceptual criteria (U = 750.50, p = .12, r = 0.38) or the number of items used to create perceptual categories (U = 748.50, p = .12, r = 0.41). Nor was any significant difference found between boys and girls in the number of categories created using thematic criteria (U = 900.50, p = .88, r = .71) or the number of items used to create thematic categories (U = 902.50, p = .89, r = .80).

No significant difference was found between cohorts in the number of categories created using perceptual criteria (U = 759.50, p = .13, r = 0.38) or the number of items used to create perceptual categories (U = 748.50, p = .12, r = 0.41). Nor was any significant difference found between cohorts in the number of categories created using thematic criteria (U = 838.500, p =

.40, r = .71) or the number of items used to create thematic categories (U = 843.50, p = .43, r = .80).

Once again, no significant differences were found between either the sexes or the cohorts on entry.

6.4.4.12. School Assessments

All available school assessment data for participants in both cohorts was analysed. Data was missing for six recent arrivals. Little fluctuation was found between assessments for the seven areas of learning, so only numeracy, speaking, writing, reading and understanding the world are analysed here.

6.4.4.12.1. Descriptive Statistics.

Table 18: School Assessment Grades for September

	Minimum	Maximum	Mean	SD
Number	7	13	11.03	1.29
Speaking	7	14	11.45	1.59
Writing	7	12	9.22	1.63
Reading	6	13	11.24	1.32
World Understanding	8	13	10.85	1.00

Data was subject to a series of one way ANOVAs. No significant difference was found between boys and girls with regard to assessment of their ability in number (F (1, 88) = .2.06, p = .16, η^2 =.023); speaking (F (1, 88) = 1.16, p = .28, η^2 =.01); writing (F (1, 88) = .02, p = .89, η^2 =.0001); reading (F (1, 88) = .54, p = .47, η^2 =.006) or understanding the world (F (1, 88) = .15, p = .69, η^2 =.002).

When cohorts were analysed, no significant differences were found with regard to number (F (1, 88) = .34, p = .56, η^2 =.004), speaking (F (1, 88) = 3.25, p = .075, η^2 =.035) or reading (F (1, 88) = 2.04, p = .16, η^2 =.02) but significant differences were found in writing (F (1, 88) = 61.40, p <.001, η^2 =.0.41) and understanding the world (F (1, 88) = 15.87, p <.001, η^2 =.5.02), with the children of Cohort 1 being rated lower by the staff.

6.5. Material Development.

Following analysis of September responses, a second set of cards was devised. Each of these cards replicated the key taxonomic attributes of the first set and had the same balance of superordinate, basic and subordinate categories available (for instance, the King and Queen of the first set were replaced by a male and female doll in the second set; the bus and train were replaced by a police car and ambulance and the apple by a tomato). As a set, they also allowed the same number of perceptual and thematic matches as the first set, with the same mix of pairs and large potential clusters. An attempt was also made to ensure that the gradient of difficulty was similar to that in the first test. The football and beach ball, which had been the highest scoring match across modalities, were the only items to be included once again as a means of boosting participant confidence.

The artist produced thirty new images which were tested for familiarity and recognition by an opportunity sample of children from the researcher's neighbourhood. A pilot study was conducted with children from Cohort 2 (N = 5, 2m, 3f) and twenty-seven images selected for use.

A set of twenty-seven toys, matched to the images, was subsequently procured for use.

6.6. Pupils Pursuits.

As the researcher had been visiting both settings regularly for two years, certain differences of approach had become apparent. It was decided to attempt to capture a taste of these differences through the use of pupil pursuits and "snapshots" of pupil activity. The resultant data, whilst limited, was felt to be representative of the philosophy and the routines of each setting. Four pupil pursuits were conducted in each of the two settings. In each instance, participants were selected by means of random sampling. One parent subsequently withdrew their consent regarding use of the material and another pursuit does not appear at the setting's request. Only six of the pupil pursuits are therefore provided in full in Appendix 9. ~~Several clear differences emerged~~ However, it is felt that they serve to illustrate the clear differences that existed between the two locations specifically with regard to:

- The number of individual interactions the child had with a member of staff. An "interaction" was classified as any exchange exclusively conducted between the member of staff and the child e.g.

  Billy makes a cake out of play-dough and takes it to Ms N. who pretends to eat it. He says he's put crisps inside it and Ms N. says it's really crunchy. He asks if she wants some coffee to go with her cake, she says she does, so he goes to the Home Corner to make some.

- The number of instructions or closed questions from staff to pupils.

  James gets a painting apron and puts it on but Ms S. tells him he cannot paint until Ms P. has finished doing the group work.

- The number of open questions or scaffolded activities.

  Saffron is "being a baby" and is pretending to cry. Ms N. asks what will make the baby happy. Saffron says the baby needs a rattle. Ms N. wonders if Saffron could make one. Saffron goes inside to the craft table.

- The number of discreet free-play activities, i.e. the number of different autonomous imaginative play activities the child was involved in and how long was spent on them.

  Carter knocks on "the door" and says he has brought baby food. Sam offers the baby a cup of tea and a sausage. Carter says, "Babies can't have cups of tea!" Carter and Sam leave to go back to the shop.

- The number of structured play activities and the time spent on them. Structured play is classified as anything with pre-determined outcomes such as jigsaws.

  Grayson and Makayla are at the computer. They play a touch screen game which involves finding things that are hidden in drawers. They complete the game and she bounces on her chair in excitement.

A breakdown of the major findings for each of the six children is presented next. However, given the size of the sample, results should be interpreted with caution.

Table 19: Distribution of time, activity and interaction with Staff during two-hour period.

Cohort Sex Age in months	C1 Male 48	C1 Female 48	C3 Male 39	C3 Male 40	C3 Female 45	C3 Female 37
Number of individual interactions with staff	2	5	9	15	15	26
Number of Instructions/ Closed Questions from Staff to Child	4	9	4	7	5	3
Scaffolding/ Open Questions from Staff to Child	1	0	4	10	10	12
Number of discreet free play activities	6	4	9	18	13	16
Minutes spent in free play	20	39	38	61	59	37
Number of discreet structured play activities	5	4	8	7	5	18
Minutes spent in structured play	27	16	16	26	20	34

Children in Cohort 3 were involved in more play activities and spent longer actively engaged in play than children in Cohort 1. Children in Cohort 3 also had more interactions with Staff, most of which involved staff supporting, rather than instructing the children.

It was also apparent from the "snapshot" data (see Appendix 8) that there were a greater variety of play activities on offer each day in Cohort 3 (partially because of the size of the accommodation); children in Cohort 3 therefore spent less time at each activity. In Cohort 1 there was more evidence of children simply sitting still or wandering around the room.

6.7. Study 3(b) Time Point 2 (December 2014)

The researcher returned to the two locations. As far as possible, each child was tested exactly twelve weeks after their initial participation, although inevitably, pupil absence delayed the testing of a few children by up to four days.

6.7.1. Materials

6.7.1.1. Shape Matching

Eight 10cm x 10cm 480 GSM white cards; 4 with a blue triangle mounted on to them at different angles and 4 with a blue square. (See Appendix 3)

6.7.1.2. Colour Matching

Twelve 10cm x 10cm 480 GSM white cards; four with a 7cm x 7cm yellow square; four with a 7cm x 7cm green square and four with a 7cm x 7cm square divided equally between yellow and green. (See Appendix 4)

6.7.1.3. 2D Categorisation

The 27 images which had been developed following analysis of 3(a) were presented. As previously, all images were mounted on 10cm x 10cm 480 GSM white card. (See Appendix 1)

6.7.1.4. 3D Categorisation

Twenty-seven play items, matched as closely as possible to the 2D images were used. (See Appendix 2). The toys were presented in an attractive, colourful box.

Record Sheet (see Appendix 5)

Notebook for initial records and observations.

6.7.2. Participants

The participants were the same as for Study 3(a). Data collected in September from participants who were subsequently absent in December, was analysed within 3(a) but excluded from further analysis.

6.7.3. Procedure

Participants were reminded that they had played some sorting games with the researcher earlier in the term and asked if they would like to play again with some different cards and toys. Once

again, the battery started with shape, then colour and images and toys were alternated. All other procedural details were as for Study 2 (see section 5.4.3.)

6.7.4. Results

6.7.4.1. Analytical Strategy

Descriptive statistics for all tests are provided here. These are followed by inferential statistics for the September / December change-scores.

Hypothesis 1. *Girls will perform better in categorisation tasks than boys* was investigated by means of a one-way ANOVA.

Hypothesis 2. *Children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups* was investigated by means of a one-way ANOVA.

Hypothesis 4. *Children who experience a play-based intervention at nursery will, over twelve weeks, make greater gains in all measures of categorisational ability than those who experience a more formal curriculum and pedagogy* was investigated by means of a series of one-way ANOVAs.

6.7.4.2. Shape

Ninety-five participants completed the test. Forty-eight of these children were from Cohort 1, (20m, 28f) and 47 from Cohort 3 (22m, 25f).

Ninety participants (94.7%) correctly categorised the cards on the basis of shape. Five participants (5.3%) were unable to categorise on the basis of shape. Of this number, two were from Cohort 1 (2m, 0f) and three from Cohort 3 (1m, 2f). This shows a reduction of 7.9% over twelve weeks. In Cohort 1 two of the four participants who had been unable to categorise on the basis of colour were now able to do so; in Cohort 3, six of the nine participants who had been unable to categorise on the basis of colour were now able to do so. Of the male participants, 3.16% remained unable to categorise on the basis of shape; of the female participants, 3.77% remained unable to categorise on the basis of shape.

6.7.4.3. Colour

Ninety-five participants completed the test. (C1, 20m, 28f; C3, 22m, 25f). Ninety-three of these participants (97.9%) correctly categorised the cards on the basis of shape. Two participants (2.1%) were unable to categorise on the basis of shape; these were both males from Cohort 1. This shows a reduction of 15.6% over twelve weeks. In Cohort 1, two males and two females had learnt to categorise on the basis of colour and in Cohort 3, all ten children (3m, 7f) who had previously been unable to categorise on the basis of colour were now able to do so. Thus 100% of females and 95.24% of males were now able to categorise on the basis of colour.

6.7.4.4. 2D Images

Eighty-seven participants completed the test (C1, 18m, 24f; C3, 21m, 24f).

In light of the skewness and kurtosis in the earlier presentation of this test, z scores were calculated. When creating categories from images, scores ranged from a minimum of 0 to a maximum of 15 *(M* = 6.83, *SD* = 2.89) z = -1.2. The number of image cards used to create categories, ranged from a minimum of 0, to a maximum of 44 (*M* = 17.55, *SD* = 8.86) z = 0.24. Data thus meet parametric assumptions.

Table 20: Number of Categories Formed and Cards Used by Date, Sex and Cohort

	Categories from images September	Number of cards September	Categories from images December	Number of cards December
Male Mean	2.55 (SD 2.81)	5.76 (SD 6.55)	6.97 (SD 2.84)	18.67 (SD 9.13)
N	42	42	39	39
Female Mean	2.20 (SD 2.04)	5.12 (SD 5.42)	6.71 (SD 2.95)	16.65 (SD 8.63)
N	49	49	48	48
Cohort 1 Mean	2.84 (SD 2.69)	6.50 (SD 6.77)	6.55 (SD 2.59)	17.31 (SD 8.70)
N	44	44	42	42
Cohort 3 Mean	1.91 (SD 2.06)	4.40 (SD 4.91)	7.09 (SD 3.15)	17.78 (SD 9.10)
N	47	47	45	45
Total Mean	2.36 (SD 2.42)	5.42 (SD 5.94)	6.83 (SD 2.89)	17.55 (SD 8.86)
N	91	91	87	87

With regard to both the number of categories formed and the number of cards used, Cohort 1 scored more highly in September and Cohort 3 scored more highly in December. Boys entered Nursery marginally ahead of girls and maintained their superior performance in December. There were considerable deviations in performance across all measures.

6.7.4.5. 3D Toys

Eighty-five participants completed the test (C1, 16m, 24f; C3, 21m, 24f).

Regarding the number of categories created using toys, scores ranged from a minimum of 2 to a maximum of 17 (*M* = 10.26, *SD* = 3.41) z = -1.09. Regarding the number of toys used in order to create categories, scores ranged from a minimum of 6 top a maximum of 47 (*M* = 27.52, *SD* = 9.71) z = -0.10. Data thus meet parametric assumptions.

Table 21: Number of Categories Formed and Toys Used by Date, Sex and Cohort

	Categories from toys September	Number of toys September	Categories from toys December	Number of toys December
Male Mean	5.60 (SD 2.73)	15.24 (SD 6.96)	9.90 (SD 3.26)	27.13 (SD 9.31)
N	42	42	39	39
Female Mean	6.12 (SD 2.13)	16.06 (SD 6.39)	10.56 (SD 3.54)	27.83 (SD 10.11)
N	49	49	48	48
Cohort 1 Mean	6.34 (SD 2.37)	17.05 (SD 6.80)	10.02 (SD 3.44)	25.79 (SD 9.32)
N	44	44	42	42
Cohort 3 Mean	5.45(SD 2.42)	14.40 (SD 6.27)	10.49 (SD 3.41)	29.13 (SD 9.89)
N	47	47	45	45
Total Mean	5.88 (SD 2.43)	15.68 (SD 6.63)	10.26 (SD 3.41)	27.52 (SD 9.71)
N	91	91	87	87

With regard to both the number of categories formed and the number of toys used, Cohort 1 scored more highly in September and Cohort 3 scored more highly in December. Girls entered

Nursery marginally ahead of boys and maintained their superior performance in December. There are considerable deviations in performance across all measures.

6.7.4.6. School Assessments

School assessment data for those children who had been analysed in September was investigated. Once again, little fluctuation was found between assessments for the seven areas of learning, so only numeracy, speaking, writing, reading and understanding the world are considered here.

Whilst each setting was happy to share their data with the researcher, one of the cohorts requested that specific details, including change scores, were not included in this thesis. Therefore, only descriptive statistics are reported.

6.7.4.6.1. Descriptive Statistics.

Table 22: School Assessment Grades for December

	Minimum	Maximum	Mean	SD
Number	8	15	12.79	1.23
Speaking	7	15	12.88	1.50
Writing	9	14	12.07	1.14
Reading	10	15	13.07	1.03
World Understanding	9	15	12.96	1.02

Data was subject to a series of one way ANOVAs. No significant difference was found between boys and girls with regard to assessment of their ability in number (F (1, 88) = .01, p = .94, η^2 =.006); speaking (F (1, 88) = .30, p = .59, η^2 =.008); writing (F (1, 88) = .24, p = .62, η^2 =.002); reading (F (1, 88) = 1.22, p = .27, η^2 =.01) or understanding the world (F (1, 88) = .002, p = .96, η^2 <.001).

When cohorts were analysed, no significant differences were found with regard to number (F (1, 88) = 2.26, p = .14, η^2 = .03), reading (F (1, 88) = .04, p = .85, η^2 <.001) or understanding

the world (F (1, 88) = 2.17, p = .15, η^2 = .02); significant differences were found in writing (F (1, 88) = 34.06, p <.001, η^2 = .28) and speaking (F (1, 88) = 21.38, p <.001, η^2 = .19) with staff at Cohort 1 now rating the children as above those of Cohort 3 (this represents a reversal of the position in September).

6.8. September – December Gains

Change scores were calculated for each participant and then z scores calculated. The change scores recorded the difference between participant performance over the two time points and thus allow a distinction to be drawn between normative maturational progress and additional cognitive gains.

With regard to the number of categories created using cards, change scores ranged from a minimum of -4 to a maximum of 10 (M = 4.45, SD = 2.78), z = -1.42. With regard to the number of cards used to create categories, scores ranged from a minimum of -1, to a maximum of 30 (M = 12.16, SD = 7.88), z = 0.66. With regard to the number of categories created using toys, scores ranged from a minimum of -6 to a maximum of 11 (M = 4.31, SD = 3.57), z = -0.83. With regard to the number of toys used to create categories, scores ranged from a minimum of -19 to a maximum of 34 (M = 11.8, SD = 10.36), z = -1.48. Data thus met parametric assumptions and was analysed using a series of one-way ANOVAs in order to determine whether there were any significant differences between groups.

6.8.1. Number of Categories Created Using Cards.

Participants in both cohorts increased the number of categories they created using cards. The difference in participant change scores was significant (F (1, 85) = 6.79, p = .01, η^2 = .08), with Cohort 3 making greater gains (M = 5.18) than Cohort 1 (M = 3.66). These results support Hypothesis 4.

There was no difference between change scores for girls and boys (F (1, 85), p = .82, η^2 = .0006).

6.8.2. Number of Cards Used to Create Categories.

Participants in both cohorts increased the number of cards they used in creating their categories. In Cohort 1, the mean gain was 10.78 cards; in Cohort 3, the mean gain was 13.45 cards. This did not represent a significant difference between cohorts (F (1, 85) = 2.49, p = .12, η^2 = .03). These results do not support Hypothesis 4.

There was no difference between change scores for girls and boys (F (1, 85), p = .48, η^2 = .006).

6.8.3. Number of Categories Created Using Toys

The difference in participant change scores was significant (F (1, 85) = 4.90, p = .03, η^2 = .004), with Cohort 3 making greater gains (M = 5.11) than Cohort 1 (M = 3.44). These results support Hypothesis 4.

There was no difference between the change scores for boys and girls (F (1, 85) = .28, p = .60, η^2 = .0002).

6.8.4. Number of Toys Used to Create Categories

The difference in participant change scores was significant (F (1, 85) = 10.54, p = .002, η^2 = .001), with Cohort 3 making greater gains (M = 15.14) than Cohort 1(M = 8.22). These results support Hypothesis 4.

There was no difference between change scores for girls and boys (F (1, 85) = .09, p = .57, η^2 = .0001).

Thus, no differences were found between boys and girls in any measure. These results do not support Hypothesis 1.

No significant difference was found between the cohorts in terms of the number of cards they used to create their categories, but in every other measure, children from Cohort 3 showed significantly greater gains than those from Cohort 1. These results support Hypothesis 4.

6.9. Discussion

6.9.1. Study Background

In Studies 1 and 2, children from higher socio-economic groups scored consistently better than their more disadvantaged peers. However, the results from differing cohorts within each demographic band were relatively cohesive. This supported previous research work which has suggested that relative poverty during early childhood serves to constrain cognitive and academic development (Brooks-Gunn, Duncan & Maritato, 1997; Bulut, 2013; Connolly, 2006; Noble et al, 2015; Williams-Shanks, Kim, Loke & Destin, 2010). Furthermore, a significant difference was found between the performance of girls and boys, with girls scoring more highly than boys in every element of each test battery. This again accords with the findings of other research into cognitive development (Badham & Maylor, 2015; Chow & Conway, 2015; Gopnik & Meltzoff, 1997; Halpern, 2012; Junaid & Fellows, 2006; Martin & Szkrybalo, 2002; Patman & Kehily, 2004; Smith, Cowie & Blades, 2003 Strand, 2014; Wallace & Russ, 2014). An interaction was found between socio-economic status and sex such that middle-class girls performed well across the board, whilst disadvantaged boys floundered throughout. This finding is in keeping with the divisions in academic attainment which are apparent throughout the education system (Bulut, 2013; Duncan & Magnuson, 2013; Gupta, 2000; McKinney, McClung, Hall, Cameron & Lowden, 2012; Mensah & Kiernan, 2009; Snook & O'Neill, 2010). It was noted, however, that participants from Cohort 3 scored slightly higher than those from Cohort 1 despite living in more disadvantaged circumstances. As the two Nursery Units had a very different approach, it was postulated that this apparently analogous result was attributable to the increased guided play opportunities afforded to children in Cohort 3 (Alfieri, Brooks, Aldich & Tenbaum, 2011; Cheng & Johnson, 2010; Dee & Sievertsen, 2015; Orr & Geva, 2015). This exploratory study therefore sought to investigate whether the development of categorisational ability may be influenced by the differing pedagogical approaches of the two settings.

6.9.2. Discussion of Time Point 1 Results

Testing on entry to Nursery in September showed no significant differences between the two cohorts, although, in accordance with demographic status, Cohort 1 performed somewhat better in every element of the test battery. Twenty-two of the Cohort 3 children had spent a term in

the Pre-School for two-year-olds as part of a new Government initiative aimed at supporting vulnerable families. They were thus more familiar with the norms and routines of Nursery than the children starting in Cohort 1. This may therefore have served to boost Cohort 3 performance and suggest greater equitability than would otherwise have been the case.

6.9.3. Discussion of Cohort Differences

Observations within the two settings during the ensuing eleven weeks demonstrated (as they had done over the previous two years) that children in the Cohort 3 Nursery were involved in a greater range of child-led activities and spent longer in all forms of play. They also had more interactions with staff, most of which were supportive rather than instructional. Cohort 1, being attached to a Primary School, was subject to the same "inevitable downward pressure… to teach formal literacy and numeracy lessons to prepare children for KS1" (Whitebread & Coltman, 2014, xxv) that is experienced by many nurseries in this position (Lillard, 2013: Zigler & Bishop-Josef, 2004). Children therefore participated in daily numeracy and literacy sessions and were encouraged to engage in more structured activities such as letter work at the "pencil table" and by "signing in" at the beginning of each session.

Thus, whilst both settings adhered to the Statutory Guidance provided within the EYFS, the role and position of play within each differed considerably. As has already been noted, Cohort 1included more formal learning activities, including daily small and whole group sessions, bearing the hallmarks of didactic instruction. In these, children were required "to conform to regulatory practices such as sitting still, putting up their hands to answer, not calling out, taking turns or waiting to answer" (Wood, 2013, p73) (See Appendices "James" and "Kamaya"). Play activities within Cohort 1 comprised a mixture of free-, guided and structured-play, generally within the confines of the classroom. Cohort 3, however, gave the majority of each session over to guided play, interrupted only by "family time" (registration and story), snack time and session review and singing prior to home time.

The pupil pursuit data provides an indication of the typical differences in daily schedules found between the two cohorts and, whilst it is recognised that the number of pupil pursuits reported is too small to adequately evidence these differences, they are considered to be illustrative of what the researcher witnessed during the years she was there. The nature of the research required an individual researcher to complete two batteries, each of four tests with over one

hundred three-year-olds during a single term. Testing could not extend beyond that point as staffing changes, pupil movements and the Christmas holiday would have introduced a range of potentially confounding variables. Similarly, pupil pursuits and snapshot data gathered during a different term, may have demonstrated a different dynamic due to changes in personnel. During the time between the two test periods, the researcher also needed to analyse all September data in order to produce a new test battery that allowed the same range and number of categorisation options. The researcher was thus under considerable time constraints but was satisfied that the data reflected her experience and informal observations over the previous years. However, it is accepted that the use of additional researchers, (rigorously checked for inter-rater reliability), would have increased the quantity of data. Given the exploratory nature of this study, it is recommended that any follow-up work utilises a team of researchers in order to quantify the child's experiences more precisely.

6.9.4. Discussion of Time Point 2 Results

Broadly speaking, participant performance improved in all tests between September and December. As no participants had been "corrected" during the initial test, improved performance was not attributable to recall or habituation. However, it was clearly, to some extent explicable in terms of maturation. As the researcher alternated between settings during testing periods, any changes which were potentially attributable to experimenter effect were applicable to both cohorts.

The improvement was, however, significantly greater amongst the children who had spent the term involved in guided play activities with supportive adults than amongst those who had been engaged in more formal learning activities. A few weeks after these tests were completed, the Cohort 1 Infant and Nursery School was visited by Ofsted and adjudged to be "Good", with the staff of the Nursery drawing particular and repeated praise for all aspects of their work. The results are therefore not attributable to inherent, context specific weaknesses within Cohort 1. Nor are they related to sex, socio-economic status or any known environmental change. It is therefore suggested that regular involvement in child-led, supported play was the key factor in Cohort 3s improved performance.

Analysis of each school's assessment data suggested that the children in Cohort 1 entered school marginally behind those in Cohort 3 but ended the term having made greater progress.

This is not consistent with the findings of this study, Local Authority data or the analysis offered by Ofsted. Consideration of local and national data shows children in both settings to be below national norms on entry, particularly with regard to speaking and writing. Whilst these sources also highlight the poor performance of White British boys from both cohorts, the demarcations found in previous studies were not so apparent here. Indeed, in the image condition, boys actually did better than girls. It is suggested that this apparent anomaly is linked to the sample's gender imbalance and the exceptional performance of a few individual boys who exponentially boosted mean scores.

In contravention of developmental norms (Bornstein, 2006; Bornstein, Kessen & Weiskopf, 1976; Franklin & Davies, 2004), on entry to Nursery, a number of participants were unable to categorise on the basis of colour and shape. This was twice as prevalent amongst children in Cohort 3 as in Cohort 1. The majority of children, however, grasped these concepts during their initial term in Nursery, whether formally instructed or learning through play.

6.9.5. The Development of Categorisation

Images once again generated a limited range of thematic categories and elicited few conceptual webs. Thematic categorisation and storytelling increased substantially when participants were presented with toys. The gap between toy and card use narrowed, however, in the second test. This trend was also apparent in Study 2 amongst both the older children and those who were scoring particularly highly. It would seem that once categorisation is secure, modality ceases to be important.

The developmental trajectory that had been apparent in Study 2 was replicated here. Once again, colour and shape categorisation were the first to become secure (Mandler & McDonough, 1993; Mareschal & Quinn, 2001), followed by an ability to categorise toys (Mandler, 2004; Oakes & Plumert, 2002), then images. There was also evidence of perceptual classifications generally preceding thematic, with younger and less conceptually confident participants demonstrating a marked reliance on matching pairs with strong phenetic similarities (Quinn & Eimas, 1996). This was especially notable if the items shared key distinguishing features (Quinn, 2004) and were conceptually aligned (Blanchet, Dunham & Dunham, 2001; Gelman & Davison, 2013). In such instances, visual cues serve to increase perceptual salience (Sloutsky, 2003), reduce cognitive load and boost processing speed (Taylor & Fiske, 1978; Unsworth, 2015). Typicality and familiarity further augments this process as category membership can be rapidly affirmed (Rosch, 1975). For instance, the common carrot

was often used when forming categories, whereas the more specialised football boots featured infrequently. This trend was especially apparent in the image condition. All children appeared less inclined to utilise atypical items, those which required superordinate criteria and those which could only be classified thematically. Categorisation in its nascent stages thus appears to be driven largely by accessibility and salience.

6.9.6. Considering the Differences between Cohorts

It is proposed that the differences in approach apparent within the two cohorts were reflective of differing notions of childhood and of learning that were held by, or imposed on the setting. Cohort 1 was subject to the downward pressure of the National Curriculum and thus required to implement the sort of knowledge- based curriculum (Yandell & Brady, 2016) appropriate to an "empty vessel" philosophy (Kagan & Lowenstein, 2004), with periods of didactic instruction and less guided play or playful learning. Cohort 3, on the other hand, adopted a "whole-child" approach (Hirsh-Pasek, Golinkoff, Berk & Singer, 2009), emphasising holistic development through play. Each of these cohorts were situated in areas of considerable disadvantage, with a high rate of lone parents and adults without qualifications or recognised skills (Office of National Statistics, 2014) and thus at increased risk of financial instability (Barnardo's, 2007; Hill & Ybarra, 2014), low self-esteem, depression, mental and physical illness (Williams Shanks, 2007). The children are therefore likely to have experienced reduced parental involvement (Evans, 2004; Hoff, 2003), low levels of interactive play (Dilworth-Bart, Poehlmann, Hilgendorf, Miller & Lambert, 2010), and fewer toys and educative experiences (Snook & O'Neill, 2010; Trawick-Smith, Wolff, Koschel & Vallarelli, 2015). The needs of these children are therefore far broader than those of their middle-class peers. A whole-child curriculum (as opposed to one which is more academically focussed) self-evidently, prepares the whole child for school and for a life beyond, rather than focussing exclusively on a limited range of scholastic achievements (Broadhead & Burt, 2012). This difference in approach was evident within the two cohorts, with Cohort 1 being required to conduct daily formal literacy and numeracy sessions, while Cohort 3 children spent each day engaged in guided play. Whilst many theorists make a compelling case for the wholesale adoption of a truly play based pedagogy (Hirsh-Pasek, Golinkoff, Berk & Singer, 2009), it is perhaps even more salient for children living near the poverty line (Milteer & Gingsburg, 2012), whose needs are multifarious and therefore unlikely to be met by the provision of academic instruction alone (Gunn &

Duncan, 1997; Kintrea, St. Clair, & Houston, 2011; McKinney, McClung, Hall, Cameron & Lowden, 2012; Yoshikawa, Aber, & Beardslee, 2012). It is thus plausible that the breadth of experience offered within Cohort 3, aided children's holistic development or initiated a (potentially non-linear) trajectory that aided categorisational development.

It has been argued that play helps to develop a wide range of physical (Clark & Metcalfe, 2002; Faulkner, Bluing, Flora & Fusco, 2009), social (Baker-Sennett & Matusov, 2008; Hughes, 2011; Pellis, Pellis & Bell, 2009) and cognitive abilities (Nath & Szucs, 2014; Pesce, Masci, Marchetti, Vazou, Saakslahti & Tomporowski, 2016). These are further enhanced by the provision of a stimulating environment (Bagby, 2012; Ferguson, Cassells, MacAllister & Evans, 2013; Gottfried, Gottfried, Bathurst, Wright-Guerrin & Parramore, 2012) and staff committed to the guided play ethos (Baumer, Ferholt & Lecusay; Hakkarainen, Bredikyte, Jakkula & Munter, 2013). The enactment of a whole-child curriculum and effective guided play was enabled by the spending priorities within Cohort 3, who bought less resources, but employed more staff. This facilitated the greater staff-pupil interaction that was apparent in the pupil pursuits and snapshot data. Clearly, this also helped to redress some of the personal privations experienced by children at home and facilitated more one-to-one involvement. Furthermore, higher staff-pupil ratios enabled active support through "scaffolding" (Wood, Bruner, & Ross, 1976), allowing children to manipulate and internalise new ideas. As Vygotsky (1978) and Bruner (1976) argued, engagement in joint activity with an appropriate "guide", increases motivation and involvement, allowing the child to achieve optimal functionality.

The children in Cohort 3 therefore reaped the benefits, not merely of the play itself, but of the ideology that drove it and the people who subscribed to its principles. This is discussed in greater detail in Chapter 7.

6.10 Summary

This Chapter has documented an exploratory investigation into the impact of differing pedagogical practices on the development of categorisational abilities during the preschool period. It has demonstrated that, whilst maturation enables progress in all children during their first term at Nursery, children who participate in child-centred, guided play, appear to make significantly greater gains than those who are exposed to more formal instruction. It is

suggested that this may be attributable to play as a specific entity, or to other environmental or ideological factors. Each of these possibilities are explored in greater detail in the final chapter.

Chapter 7

Discussion

PhD Aim

To assess the extent to which sex, socio-economic status and participation in child-led play, facilitate the development of categorisation and schemata.

PhD Objectives

1. To develop a means of testing preschool children for schema-based automaticity.

2. To develop a means of testing preschool children's ability to categorise.

3. To explore the role of sex / gender on the development of categorisation in pre-school children.

4. To assess whether socio-economic status impacts the development of categorisation in pre-school children.

5. To explore the impact of dimensionality on pre-school children's ability to categorise.

6. To extend psychological understanding of how differing forms of categorisation emerge and develop.

7. To explore the impact of play on the development of categorisation and schemata.

Hypotheses

1. Girls will perform better in categorisation tasks than boys.

2. Children from high socio-economic groups will perform better on categorisation tasks than those from lower socio-economic groups.

3. All participants will perform better on categorisation tasks when presented with objects than when presented with images.

4. Children who engage in a curriculum based on child-led play will perform better in categorisation tasks than children who engage in a formal, instructional curriculum.

7.1. Chapter Overview

The preceding chapters have outlined the theoretical and empirical justifications for this research, and documented the process and its outcomes. This final chapter seeks to extrapolate and evaluate the most salient aspects of all that has been discovered.

The chapter begins by outlining the major findings to emerge from this thesis before moving on to briefly reconsider some of the dilemmas and potential bear-traps that are frequently encountered when conducting psychological research with young children. It is argued that blunt test instruments and the use of inappropriate methodologies have undermined the external and internal validity of much previous research. It is argued, however, that exhaustive preparation and continual refinement rendered this work both valid and reliable. In order to support this assertion, each of the research objectives is discussed in turn. There follows a consideration of some theoretical implications and a series of recommendations for future research

The results from Study 3 demonstrated that categorisational development was more greatly enhanced by a playful approach to learning than by formalised teaching techniques. This raises the possibility that play is a causal executant in the development of rudimentary automaticity. Consideration is therefore given to some of the neural and cognitive overlaps between learning and play in order to examine this notion. It is also considered plausible that the differences in performance are attributable to the quality of adult-child interaction, staffing levels or to effective scaffolding. Each of these alternative explanations are explored. It is concluded that this study's findings are in accordance with previous empirical and neurological evidence and point towards play, particularly play that is supported by a sensitive and skilled adult, as a key conducer in cognitive development.

A consideration of the merits of present trends in pre-school education, especially recent calls for more formalised instruction, are then discussed in light of the available theoretical and empirical evidence. It is contended that play is vital not only to children's mental and physical health but that, at every stage and in every form, it fulfils a vital role in neural, social and cognitive development and ultimately, in the embedding of several automatic processes.

7.2. Summary of Findings

As a unitary whole, the results of this research have helped to clarify the trajectory of concept acquisition in typically developing children. They have, for instance, substantiated prior claims regarding the importance of perceptual similarity and conceptual coherence. However, the individual studies have also revealed a number of disparities, provided some new insights, and highlighted areas worthy of future research. The major findings from each study are outlined below.

7.2.1. Study 1

Approximately a fifth of three-year-old participants were unable to categorise on the basis of shape and/or colour. This was particularly prevalent amongst boys and amongst children from more disadvantaged backgrounds. These findings are at odds with previous research (Bornstein, 2006; Franklin & Davies, 2004; Mareschal & Quinn, 2001) and with acknowledged developmental trajectories which assert that colour and shape categorisation emerge in infancy.

A minority of participants, primarily socially disadvantaged boys, were unable to name common items. Whilst the reasons for this were unclear, it was initially suggested that it may reflect neural immaturity or atypicality, limitations in vocabulary and/or restricted life experience.

Participants selected mainly basic level categories but were also able to form categories at a superordinate level. When grouping image cards, basic level items with strong perceptual similarities appeared to be the most secure and accessible format for children in this age band. Indeed, this was frequently the sole criteria used by low-scoring participants and was particularly prevalent amongst socially disadvantaged boys. The tendency to use perceptual categories was further bolstered if the items were typical of the category; if their names shared aural features which provided lexical and auditory links, and if they had sufficient perceptual salience to boost processing speed. These findings support suggestions from previous research that, as with adults, three-year-old participants' first recourse is to those categories requiring the least cognitive effort (Mandler, 2003; Rosch, 1978). However, it was also clear that many three-year-olds (primarily girls) were able to form thematic categories. Indeed, in some tasks, participants selected almost as many thematic as perceptual matches, particularly if they encountered personally salient items or recently stored representations. This finding runs

contrary to previous research in the field which had suggested thematic categorisation emerges much later (Blaye, Bernard-Peyron, Paour & Bonthoux, 2006; Liu, Song & Seger, 2012; Murphy, 2002).

Girls performed better, and often significantly better, than boys in all tests. They also showed higher levels of abstraction and less reliance on perceptual similarities. The findings from this study thus add to previous assertions that girls reach developmental milestones sooner than boys (Eriksson, Marschik, Tulviste, Almgren, Pereira, Wehlberg & Gallego, 2012; Wallace & Russ, 2015).

Children from higher socio-economic backgrounds scored more highly than their disadvantaged peers in almost all tests. This mirrors the findings of previous research regarding the link between deprivation and academic achievement (Emerson, 2012; Gupta, 2000; McKinney, McClung, Hall, Cameron & Lowden, 2012). It was therefore suggested that the combination of maleness and deprivation served as a 'double whammy' in terms of supressing the performance of the working class boys.

Almost all participants identified more categories and used more items when working with toys than when working with images, appearing to confirm Mandler's (2004) assertions regarding the use of objects for testing very young children. It is proposed that toys reduce reliance on stored representations, thus easing cognitive load and increasing processing speed. Children also performed marginally better when presented with photographs than when presented with drawings, although this did not reach a level of significance. However, correlational analysis within Study 2 showed a clear relationship between the number of categories participants created in each modality, with participants either scoring highly or struggling across the board.

When participants were tested using a classic match-to-sample technique (Blaye, Bernard-Peyron & Bonthoux, 2000; Blaye, Paour & Bonthoux, 2006), more participants were unable to complete the task than when the toolkit devised for this thesis was used. This was taken to demonstrate the sensitivity of the newly devised testing mechanism, especially for capturing nascent and emerging abilities. It also brought into question some of the conclusions reached on the basis of match-to-sample research.

7.2.2. Study 2

A proportion of participants were unable to categorise on the basis of colour or shape. The majority of these were males. This finding is anomalous to the broader population as most children acquire this skill during infancy (Franklin & Davies, 2004; Gleason, 2014). However, colour and shape categorisation always appeared to emerge first, followed by an ability to categorise toys, then images. This trajectory replicates the findings of prior researchers (Bornstein, 2006; Franklin & Davies, 2004).

Once again, girls performed better than boys across the board and children from middle-class backgrounds scored more highly than their disadvantaged peers. A significant interaction was also found between the two, thus middle-class girls achieved the highest scores and working-class boys the lowest. Whilst the differences between social groups were pronounced (Cohort 1 and Cohort 4, $p = .001$; Cohort 1 and Cohort 5, $p < .001$; Cohort 3 and Cohort 4, $p < .001$; Cohort 3 and Cohort 5, $p < .001$) there was relative homogeneity within each band (Cohort 1 and Cohort 3 $p = 1.00$).

Participants continued to find more categories and use more items when working with toys than when using images. However, this gap lessened with older and with high scoring children.

7.2.3. Study 3

This study sought to investigate whether differences in curricular provision and pedagogy impacted the development of categorisational abilities over a twelve-week period. When participants were tested on entry to Nursery in September, Cohort 1 (participants from a disadvantaged area who were later to experience a formal curriculum) scored more highly on the test battery than Cohort 3 (participants from a disadvantaged area who were later to experience a play-based curriculum). However, at this stage, none of the differences found between the two cohorts were found to be significant on any measure or in any test within the battery. This was in line with the findings from Study 1 and Study 2 and showed the cohorts to be broadly similar in terms of categorisational ability and school assessment criteria on entry. School based EYFS assessments conducted by staff within the settings scored Cohort 3 more highly than Cohort 1 at this time point.

As with previous studies, throughout the tests the majority of participants selected a perceptual match with key defining features first. However, toys produced more thematic categories and complex conceptual webs than images.

An analysis of children's activity and interactions with staff demonstrated that children in Cohort 3 were involved in more play activities and spent longer actively engaged in play than children in Cohort 1. Children in Cohort 1 spent more time engaged in formal learning activities and received proportionally more instructions from adults than children in Cohort 3. It is acknowledged that the number of pupil pursuits presented within the study is relatively small. The requirement to conduct tests with two full cohorts in two locations, analyse the resultant data and use it to produce a new test battery for use that same term, rendered time constraints exceptionally tight. The sample was larger, but the researcher's strict observation of ethical protocols led to the exclusion of several full-session observations. The researcher considered the remaining full observations and snap-shot data to be representative of her observations during the two years she spent in each setting. It is recognised, however, that the paucity of material presented in this section renders it illustrative rather than evidential.

When re-tested in December, it was found that all children had made gains across the twelve weeks. However, change scores indicated that children in Cohort 3, which focussed on child-led, supported play made greater gains than Cohort 1, which followed a formal curriculum. These gains were significant for the number of categories created using cards, the number of categories created using toys and the number of toys used to create categories.

7.3. Testing Preschool Children

Objective 1. To develop a means of testing pre-school children for schema-based automaticity.

Objective 2. To develop a means of testing pre-school children's ability to categorise.

7.3.1. Procedures and Materials

As noted in Chapter 3, conducting research with young children and in pre-school settings is inevitably beset by practical and logistical difficulties (Buscemi, Blumstein, Kong, Stolley, Schiffer, Odoms-Young, Bittner & Fitzgibbon, 2015; Jorm, Kelly & Morgan, 2007; Risko, Laidlaw, Freeth, Foulsham & Kingstone, 2012). Not only must research design be

demonstrably valid and reliable (Bergman, 2011), it must also meet the needs of participants and the physical environment in which it is to be conducted. Three-year-olds are enthusiastic but socially inexperienced participants (Frith & Frith, 2001; Pruett, Kandala, Petersen & Povinelli, 2015); who have certain neurological (Chau, Synnes, Grunau, Poskitt, Brant & Miller, 2013; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014; Raznahan, Greenstein, Lee, Clasen & Giedd, 2012) and cognitive limitations (Darki & Klingberg, 2015; Lillard & Kavanaugh, 2014; Putko, 2010; Sabbagh, Hopkins, Benson, & Randall, 2010; Sebastian, Fontaine, Bird, Blakemore, De Brito, McCrory & Viding, 2011); all of which must be addressed during both planning and testing. As detailed in Chapters 3-6, an exhaustive process of trialling, piloting and refining materials was thus undertaken in order to remove as many potentially confounding variables as possible from this research and ensure test functionality. The components of Study 1 collectively demonstrate that the resultant "toolkit" is both valid and reliable. It allows for a wide range of responses from simple perceptual matching through to the creation of complex conceptual webs. Consequently, it provides relatively fine-grained differentiation between pre-school participants. It is also easily administered, portable and enjoyable for participants – all of which help to ensure valid, reliable and ethically sound results. The production of such a demonstrably valid toolkit is considered to be a major strength of this research.

Whilst children with a tentative grasp of categorisation were unable to complete match-to-sample tasks, the toys in this toolkit provided a range of cues which enabled success. At the other end of the continuum, children with a more secure grasp had the option to formulate complex, conceptual webs. Toys which offer a variety of relational patterns thus afford opportunities for participants from a wide range of abilities to succeed.

Through utilising the natural inclination to play amongst the chronologically and functionally "younger" participants, this research enabled responses from children whom match-to-sample tasks adjudged unable to categorise. It would thus appear that, in the past, conclusions reached on the strength of image-matching tests have underestimated young children's categorisational abilities, particularly with regard to thematic categorisation (Liu, Song & Seger, 2012). This is discussed in greater detail later.

7.3.2. Participants

Despite the best efforts of the researcher, there will always also be some difficulties with recruitment and retention. Families are more inclined to move house when they have young children, especially if they have been living in a disadvantaged neighbourhood (van Ham, Manley, Bailey, Simpson & Maclennan, 2013). The prevalence of infectious diseases and the speed with which they spread frequently leads to periods of substantial absenteeism, particularly amongst families living in poverty (Barnardo's, 2015). School rolls are also bedevilled by fluctuations in the birth rate, political change and local circumstance (GOV.UK, 2015). Thus, within this research, a number of recruited participants did not ultimately complete the full battery of tests, meaning that, at points, some of the intended sample balance was lost. Nonetheless, 16,970 individual tests *were* successfully conducted with 451 young participants across five locations by a single researcher. In the vast majority of instances therefore, samples sizes remained large enough to provide reliable data and produce statistically significant results.

Given that this sample was socially dichotomised and drawn from a relatively small geographic area, it is recommended that the studies should be replicated with a more diverse sample in order to assess the generalisability of these findings. This may necessitate the use of several researchers in different locations. Whilst there would be a need for rigorous inter-rater reliability checking, greater sample balance could be achieved, thus strengthening potential conclusions.

7.3.3. The Importance of Environment

The inadvisability of conducting lab based studies with young children is well documented (Buscemi, Blumstein, Kong, Stolley, Schiffer, Odoms-Young, Bittner & Fitzgibbon, 2015; Murray, 2013), the reasons being many-fold. Unfamiliar places and people can heighten emotional valence (Evans, 2001) and create stress (Jorm, Kelly & Morgan, 2007) thus generating uncharacteristic behaviour such as fear-responses (Bruce and Meggitt, 2002). Attentional Control Theory (Eysenck, Derakshan, Santos & Calvo, 2007) and its precursor, Processing Efficiency Theory (Eysenck & Calvo, 1992) suggest that anxiety also interferes with processing capacity within working memory; depleting temporary storage facilities and constraining attentional resources. Whilst the effects on the visuo-spatial sketchpad are less

marked (Rapee, 1993), even mild generalised anxiety impacts the central executive and the phonological loop, constraining attention, planning, organisation and verbal performance. Anxiety thus constricts cognitive performance in participants of all ages and is particularly noticeable during short tasks conducted under laboratory conditions (Eysenck, Derakshan, Santos & Calvo, 2007). The immaturity of pre-school children's attentional resources (Coates, 2004: Ma & Wei, 2015; Murray, Scratch, Thompson, Inder, Doyle, Anderson & Anderson, 2014) further compounds these issues. Subsequently, the reliability and validity of lab-based, memory-dependent tests with pre-school aged children, such as those conducted by some previous researchers in the field, are brought into question (De Loache & Brown 1979; Wellman & Somerville, 1980, Rogoff, 1991). Not only do such tasks constrain cognitive performance, they lack ecological validity (Risko, Laidlaw, Freeth, Foulsham & Kingstone, 2012) and create disequilibrium for participants (Jorm, Kelly & Morgan, 2007). Test reliability improves (Mayall, 2008) and child participants are most at ease when they are in familiar places, with familiar people interacting in a familiar way (Buscemi, Blumstein, Kong, Stolley, Schiffer, Odoms-Young, Bittner & Fitzgibbon, 2015). It is clear that the uncommonly lengthy process of familiarisation undertaken by the researcher and the use of familiar environments served to augment the validity and reliability of this research and ensure ethical probity (Barker & Weller, 2003). The researcher knew each participant well enough to gauge any required amendments to delivery style and to proffer appropriate responses. Whilst these were not of a sufficient magnitude to impact reliability, they did enhance participant experience and ensure that each result was a true reflection of the individual.

It is therefore asserted that the degree of attention afforded to children's generic and specific needs by the researcher has rendered Studies 1-3 conspicuously valid and reliable.

7.4. The Impact of Sex / Gender

Objective 3. To explore the role of sex / gender on the development of categorisation in pre-school children.

Participant performance during the trialling of materials (see section 4.4.2), and previous empirical research (Badham & Maylor, 2015; Chow & Conway, 2015; Gopnik & Meltzoff, 1997; Strand, 2014; Wallace & Russ, 2014), had created an expectation that girls would perform better than boys. The extent of the statistical significance, however, came as a surprise.

Categorisational abilities begin to emerge in early infancy and are based on discernible properties (Mandler & McDonough, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997). Whilst language is therefore not a prerequisite of inductive inference (Baldwin, Markman & Melartin, 1993), or elemental categorisation, it enables conceptualisation to move through levels of increasing sophistication and abstraction (Anderson, 1991; Colunga & Smith, 2005; Gelman, Coley, Rosengren, Hartman & Pappas, 1998; Millikan, 1998). Furthermore, accessing the phonological loop enables dual processing (Baddeley, Lewis & Vallar, 1984), semantic encoding and deeper level processing (Craik & Tulving, 1975; Unsworth, 2015). An ability to provide category labels thus aids categorisation for both adults (Lupyan, Rakison & McClelland, 2007) and children (Althaus & Plunkett, 2015; Dewar & Xu, 2009). The counterpoint is that lexical deficits may plausibly serve to constrain encoding, categorisation and recall. Given the acknowledged linguistic superiority of girls and middle class children (Eriksson, Marschik, Tulviste, Almgren, Pereira, Wehberg & Gallego, 2011; Goldin-Meadow, Levine, Hedges, Huttenlocher, Raudenbush & Small, 2014; Gopnik & Meltzoff, 1987; Gopnik & Meltzoff, 1997; Schaadt, Hesse & Friederici, 2015), it is possible that linguistic competency is a key factor in boys subjacent performance, with the issues magnified for those from impoverished backgrounds (see 7.5.)

As was noted in Chapter 2, girls are significantly more likely to participate in pretend-play than boys (Gmitrova, Podhajecka, & Gmiitrov, 2009). Given the role of play in promoting the development of cognition and language (Goncu 1993, Haight & Miller, 1993; Howes, Unger & Matheson, 1992; Vygotsky, 1978), this involvement may have served to boost girl's test performance. Furthermore, as girls are inclined to focus on family-related themes (Anggard, 2011), this possibly increased the salience of the "home" items and allowed them to recreate groupings discovered during play. In order to investigate whether the themes selected for the test batteries were biased towards female participants, it is recommended that a group of participants should be tested with both these and a matched set of more stereotypically "male" images.

7.5 The Impact of Socio-Economic Status

Objective 4. To assess whether socio-economic status impacts the development of categorisation in pre-school children.

Within Studies 1 and 2, a consistent link was found between socio-economic status and performance, with children from disadvantaged backgrounds creating fewer categories and using fewer items across conditions than their middle-class peers. Demographically, Cohort 1 and Cohort 3 comprised a high rate of lone parents and adults without qualifications or recognised skills (Office of National Statistics, 2014). Many of these families therefore face financial instability due to unpredictable employment patterns (Barnardo's, 2007; Hill & Ybarra, 2014), with the difficulties being proportionally greater for lone parents. Children living in poverty or close to the poverty threshold are more likely to experience difficult living conditions and poor nutrition which impact their physical (Loprinzi, Cardinal, Loprinzi & Lee, 2012) and neurological development (Blair & Raver, 2012). Parents living with financial insecurities are more likely to suffer from low self-esteem, depression, mental and physical illness (Williams Shanks, 2007). Each of these reduces parental capacity to nurture and support children (Budinger, Drazdowski & Ginsberg, 2012) which has further implications for children's neurological (Blair & Raver, 2012) and cognitive development (Schoon, Jones, Cheng & Maughan, 2012) as well as their mental health (Yoshikawa, Aber & Beardslee, 2012). Furthermore, women living in relative poverty are more likely to give birth to pre-term or low birth weight babies. These children frequently suffer delays or impairments to working memory performance and visuo-spatial processing, with the deficits persisting throughout childhood. (Bhutta, 2002; Taylor, Minich, Bangert, 2004).

Therefore, for reasons of parental health, education and working hours, children from homes with lower SES generally experience less parental involvement during the pre-school period (Evans, 2004; Hoff, 2003) including lower levels of interactive play (Dilworth-Bart, Poehlmann, Hilgendorf, Miller & Lambert, 2010). A lack of money in the home usually also means that children have less toys and less educative experiences (Snook & O'Neill, 2010; Trawick-Smith, Wolff, Koschel & Vallarelli, 2015). A lack of money in the neighbourhood is associated with an absence of play facilities and increased levels of crime (Van Ham, Manley, Bailey, Simpson & Maclennan, 2013). As a result, parents are less likely to allow their children to play outside, having genuine (and often well founded) fears for their safety (Children's Society, 2009; Hooper, Gorin, Cabral & Dyson, 2007). The area surrounding Cohort 3, for

instance, is ringed by several busy major roads and is the worst area in the authority for fouling, needles, violence and crime. It may thus be suggested that the extensive outdoor play area and the high staffing ratio provided by Cohort 3 both helped to counterbalance some of the lesser recognised consequences of childhood poverty.

Children from lower SES families have more screen time than their middle class peers. This includes an increased likelihood of televisions, DVD players, iPad and gaming facilities in their bedrooms (Tandon, Zhou, Sallis, Cain, Frank & Saelens, 2012). Lower SES families also hold television in higher regard than do the middle classes and consequently spend more time watching television programmes and videos as a family (Tandon, Zhou, Sallis, Cain, Frank & Saelens, 2012). These parental attitudes have a further impact on children's play opportunities (Gustafson & Rhodes, 2006). Children living near the poverty threshold spend less time in physical play and are more likely to suffer from adiposity, obesity (Faulkner, Bluing, Flora & Fusco, 2009), respiratory problems (Twisk, 2001) and a range of associated health problems (Loprinzi, Cardinal, Loprinzi & Lee, 2012).

Growing up in poverty or near the poverty threshold is thus associated with a raft of disadvantages which serve to constrain neural growth (Blair & Raver, 2012), reduce opportunities for childhood experiences and ultimately restrict cognitive and academic performance (Brooks-Gunn, Duncan & Maritato, 1997; Bulut, 2013; Connolly, 2006; Emerson, 2012; Gottfried, Schlackman, Gottfried & Boutin-Martinez, 2015; Gupta, 2000; Kintrea, St Clair & Houston, 2011).

It is thus apparent that the participants drawn from Cohorts 1 and 3 were exposed to a variety of factors liable to inhibit cognitive growth. Given the cognitive benefits of play detailed in 7.2.1. and the score increases recorded amongst the children who played in Study 3, it appears plausible that paucity of play opportunities acted as an additional factor in the lower scores recorded amongst children from the disadvantaged cohorts (Bulotsky-Shearer, Bell, Romero & Carter, 2012). In light of the change scores recorded for Study 3, it is also proposed that improved play opportunities and increased opportunities to engage in playful activity with supportive adults during the first three years of life, may help to redress some of the effects of financial deprivation for children living in disadvantaged areas.

7.6 The Impact of Dimensionality on Categorisational Abilities

Objective 5. To explore the impact of dimensionality on pre-school children's ability to categorise.

Despite Mandler's (2004) assertions that the use of images constrains performance in infants and pre-schoolers, many researchers in the field have persisted with their use, generally as part of a match-to-sample task. The original research conducted for this thesis supports Mandler's position. Participants, almost without exception, performed better when presented with toys than when presented with images. Simple sensory exploration of items allowed participants with the most tentative grasp on categorisation to attain a degree of success. The use of objects afforded participants functioning at a more sophisticated level the opportunity to investigate relational patterns and formulate complex conceptual webs. Those participants who engaged in play with the toys, were also able to see relational patterns as they utilised the items to construct their stories. As Vygotsky (1967) claimed, in play, children are indeed a head taller than themselves. The use of "play" or informal object manipulation as a testing mechanism therefore provides enhanced insights into nascent and emerging understandings and into children's true potentialities. It is therefore recommended, on the basis of this research, that toys and objects should be used more widely in child-based research, especially when working with the very young, or those who have a tenuous grasp on the matter under investigation. It would appear however, (see Studies 2 and 3) that the impact of using toys as opposed to images narrows as concepts become secure. Unfortunately, as the researcher failed to record whether participants "played" or simply manipulated the objects, it is impossible to quantify, on the basis of these results, the extent to which play affords a different level of understanding. It is therefore recommended that in future studies, the nature of participant interaction with the objects should be recorded and analysed.

Children's superior performance when presented with toys instead of images is also potentially linked to linguistic ability. As articulatory suppression is able to disrupt visual short-term memory, memory for visually presented items is often considered to be associated with the phonological loop (Salame and Baddeley, 1982). Consequently, participants who are able to name items are able to hold them in working memory longer than children who are unable to do so. Borst, Niven and Logie (2012) suggest that visual and phonological information utilise a passive, non-conscious store. Objects, on the other hand, access the visuo-spatial sketchpad and the more substantial conscious store. The use of toys therefore allows young participants

to draw on a range of episodic and semantic information about familiar objects, with the familiarity of the items further aiding working memory performance (Sandrini, Fertonani, Cohen & Miniussi, 2012). Furthermore, the freedom to physically manipulate objects increases understanding of the object and its properties (Mandler, 2004) as well as capturing attention, with all of the allied benefits this brings to processing (Eysenck, Derakshan, Santos & Calvo, 2007). It has been apparent throughout this research that children performed better when asked to categorise toys. It is thus proposed that the use of toys/ objects when testing young children, reduces reliance on stored representations, easing cognitive load and increasing processing speed.

Improved cognitive performance resultant from playful activity has been a recurrent theme throughout this thesis. In every study, participants identified more categories and utilised more items when working with toys. In Study 3, playful learning served to enhance children's test performance. It is thus proposed that play both reflects and consolidates developmental change. Object centred play in infancy, for instance, has long been known to encourage a range of skills including motor control and visual selective attention (Squire, Noudoost, Schafer & Moore, 2013). Both voluntary motor control and attention have well defined neuronal links with working memory - selective attention through shared usage of the prefrontal and parietal control regions (Gazzaley & Nobre, 2012) and motor control through the basal ganglia (Ullman, Almeida & Klingberg, 2014). Ullman, Almeida and Klingberg's (2014) longitudinal research demonstrates that this inter-relationship allows future working memory capacity to be inferred from the structure and activity of the infant's basal ganglia and thalamus. The discovery of links between what had previously been considered to be disparate areas, signals exciting new insights into neurological development which will increase understanding of cognitive growth. Thus, whilst causality cannot be inferred at this stage, research appears to link the voluntary motor control of early object play to a raft of cognitive, executive and emotional functions including reasoning (Leisman, Braun-Benjamin & Melillo, 2014) and certain forms of implicit learning (Foerde & Shohamy, 2011). Thus, it may be propounded, just as the opportunity to manipulate objects enabled participants to score more highly on 3D than on 2D categorisation tasks, so play, even at the most basic of levels, provides some of the stimulation required to foster cognitive growth. If this is the case, then the range of play activities experienced by children in Cohort 3 (see Appendix 8) may have aided their development of motor control, selective attention and subsequently, working memory. By contrast, children in Cohort 1 had periods of passivity (see Appendix 8) and apparent

disengagement whilst being addressed as a full class, during which time there was frequent need to recall them to task.

7.7 The Development of Categorisation in Early Childhood

Objective 6. To extend psychological understanding of how differing forms of categorisation emerge and develop.

As has already been detailed in previous chapters, the debate regarding the nature and origins of early categorisation includes consideration of timings, sequential order and processing strategies. The findings of this research have served to consolidate some previous assertions, qualify others and provide some explanations for the disparities found between groups.

Prior research has demonstrated that rudimentary categorisation emerges in early infancy (Ferry, Hespos & Waxman, 2011; Mandler, 2003; Quinn, 2004; Quinn, Westerlund & Nelson, 2006; Rakison & Yermolayeva, 2010). Initially, this constitutes recognition of similarity and difference, with children as young as four months being able to discriminate between examples of superordinate categories such as animals and furniture (Mareschal & Quinn, 2001). Early forms are largely reliant on perceptual similarity (Mandler & McDonough, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997; Quinn, 2004; Quinn & Eimas, 1996) and conceptual coherence (Blanchet, Dunham & Dunham, 2001; Gelman & Davison, 2013). However, the ability to recognise physical categorisation cues (Bussey & Bandura, 1999; Intons-Peterson, 1988; Signorella & Frieze, 1993), behavioural norms (Martin, Rubel & Szkrybalo, 2006; Tenenbaum, Hill, Joseph & Roche, 2010), and structural atypicalities (Althaus & Plunkett, 2015; Poulin-Dubois, Serbin, Eichstedt, Sen, & Beissel, 2002) also emerge relatively early. Categorisation strategies become increasingly refined during the pre-school period (Althaus & Plunkett, 2015; Bornstein, 2006; Bussey & Bandura, 1999 Bornstein, 2006; Bussey & Bandura, 1999; Franklin & Davies, 2004; Mareschal & Quinn, 2001) as new skills, experiences and understanding allow the assemblage of conceptual webs (Blanchet, Dunham & Dunham, 2001; Gelman & Koenig, 2003). Thus whilst initial recognition of equivalence is explicable in terms of simple bottom-up processing (Quinn, 2004), thematic categorisation is reliant upon a successful amalgam of biological, cognitive and experiential factors (Colunga & Smith, 2005; Gopnik & Wellman, 1994; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014). Analysis of data from all three studies within this thesis revealed a disproportionate number of

participants, primarily boys from disadvantaged backgrounds, apparently locked into perceptual matching as their sole categorisational criteria. It is proposed that social disadvantage and maleness each constrain environmental stimuli in the means detailed in 7.2.2. As sensory information is checked against known criteria held in long term memory, paucity of experience will serve to limit both episodic and semantic stores and thus constrain working memory performance (Logie, 2015). Consequently, at the point of Nursery entry, children from deprived backgrounds, particularly boys who face contiguous issues, remain reliant on the categorisation skills generally associated with infancy.

As previously discussed (see 6.1), the reciprocity of linguistic and conceptual development is widely accepted (Anderson, 1991; Callanan, 1985; Colunga & Smith, 2005; Gopnik & Meltzoff, 1997; Markman, 1989). The reduced linguistic stimulus experienced by boys and by socially disadvantaged children thus serves to curb categorical and conceptual advancement. Furthermore, vocabulary limitations inhibit articulatory rehearsal and access to the phonological store, subsequently limiting strategic recall of items available for matching. Given their linguistic superiority (Eriksson, Marschik, Tulviste, Almgren, Pereira, Wehberg & Gallego, 2011; Goldin-Meadow, Levine, Hedges, Huttenlocher, Raudenbush & Small, 2014; Gopnik & Meltzoff, 1987; Gopnik & Meltzoff, 1997; Schaadt, Hesse & Friederici, 2015), this would provide a further potential explanation for the superior performance of girls and of middle-class children in both Study 1 and Study 2.

There is wide spread agreement amongst theoreticians that categorisation begins with perceptual similarities (Badger & Shapiro, 2015; Deng & Sloutsky, 2015; French, Mareschal, Mermillod & Quinn, 2004; Mareschal, French & Quinn, 2000; Quinn, Eimas & Rosenkrantz, 1993) and develops to incorporate progressively greater abstraction (Carey, 1999; Inagaki & Hatano, 2002). Most pre-school participants in this research showed an initial preference for visually similar items with clear perceptual salience (Sloutsky, 2003), for instance, the balls, the books or the two birds. Such matching is rapidly verifiable (Rosch, 1975), thus increasing confidence and boosting processing speed (Taylor & Fiske, 1978; Unsworth, 2015). These choices may also be regarded as evidence that basic level categorisation is the first of the hierarchical levels to emerge or attain consistent spontaneous use (Rosch, 1978; Rosch, Mervis, Gray, Johnson & Boyes-Braem, 1976). Their use may also be attributed to the lesser requirement for specialist knowledge (Anderson, 1991; Colunga & Smith, 2005) which means that they demand less cognitive effort than subordinate or superordinate categories (Collins and Quillian, 1969).

Many have suggested that young children lack the world knowledge to spontaneously classify (Deak, 2000; Nguyen & Murphy, 2003) on the basis of anything other than perceptual qualities (Keil, 1989; Keil & Batterman, 1984, Murphy, 2001) until they are six- or seven-years-old (Badger & Shapiro, 2012; Fang, Fang & Xi, 2012). However, the findings from all three studies in this thesis provided clear evidence that many three- to four-year-old participants (primarily girls) were able to form thematic links between items which were within their frame of reference. Many participants, for instance, categorised the washing machine and oven on the basis of usage rather than appearance. Superordinate categories, which have also been regarded as the domain of older children (Fang, Fang & Xi, 1991; Liu, Song & Seger, 2012) were also created by three- to four-year-olds if the items were familiar and perceptually salient (Mandler & McDonough, 1993; Spencer, Quinn, Johnson & Karmiloff-Smith, 1997). This was particularly noticeable with items such as food, where self-referencing had also enabled deeper-level processing (Symons & Thompson, 1997)

Physically similar, basic level categories therefore appear to be the most secure, accessible format for categorisation amongst pre-school children, with familiarity and certitude playing a key role in decision making. However, it is clear from this research that children of this age are also able to form conceptual webs if the items are salient.

The results from these studies were ambiguous regarding the importance of typicality (Rosch, 1973; Rosch & Mervis, 1975) in categorisation judgements. In match-to-sample tasks children usually selected a clear perceptual match (French, Mareschal, Mermillod & Quinn, 2004; Mareschal, French & Quinn, 2000; Quinn, Eimas & Rosenkrantz, 1993; Rosch, 1975), which was also typical of the category. However, they recognised atypical members with physical similarities (such as the atypical penguin and the typical crow) as belonging to the same category, sometimes selecting atypical items ahead of their typical counterparts. In such instances, visual criterion appeared more important to participants than defining attributes (Smith, Otherson, Rips & Keane, 1988).

In accordance with previous research (Althaus & Plunkett, 2015; Bornstein, 2006; Bussey & Bandura, 1999 Bornstein, 2006; Bussey & Bandura, 1999; Franklin & Davies, 2004; Mareschal & Quinn, 2001), this study can attest that categorisational abilities appear to emerge in a predetermined sequential order that is determined by a combination of biological capacity and environmental stimuli. It is also clear that thematic categorisation emerges earlier than had previously been thought (Badger & Shapiro, 2012; Fang, Fang & Xi, 2012; Keil, 1989; Keil &

Batterman, 1984, Murphy, 2001) and will be utilised if an item has personal salience leading to stored representations.

It is recognised that the dichotomised sample makes it difficult to generalise age norms from this research to the broader population. Given the demonstrable reliability and validity of the test procedure, it would be of interest to extend this research to include a more demographically representative sample across a wider age range.

7.8. The Importance of Language

It has already been noted within this chapter that linguistic ability is a potential factor in delineating children's emergent categorisational abilities. The reasoning behind this assertion are extended next.

Whilst strong linguistic relativity has now been widely discredited (Berlin & Kay, 1969; Pinker, 1994), debate continues as to the importance of language in the emergence and development of categorisation. Although Mandler (2004) proposes that a desire to name categories instigates language, it is more widely contended that linguistic and conceptual development are mutually enriching (Anderson, 1991; Callanan, 1985; Colunga & Smith, 2005; Gopnik & Meltzoff, 1997; Markman, 1989). However, the linguistic limitations associated with boys and with social disadvantage diminish expressive and receptive language (Gelman, Coley, Rosengren, Hartman & Pappas, 1998; Millikan, 1998), which subsequently limits the information available to embellish perceptual categories and augment concepts (Anderson, 1991; Colunga & Smith, 2005). Reduced linguistic stimuli during early childhood thus reduce the quantity and quality of received information, limits vocabulary and subsequently constrains conceptual development.

It is also postulated that children who have limited linguistic exposure or impoverished vocabularies will be less likely to verbalise or utilise internal speech during categorisation tasks and that this will further influence task performance. Baddeley, Lewis and Vallar (1988) proposed that in order to manipulate auditory information, the phonological loop is fractionated into a short-term phonological store and an articulatory rehearsal component which is able to revive the memory trace. To this Baddeley (2000) later appended the notion of an episodic buffer which is able to bind experiential information into a limited capacity store using multi-dimensional coding. Within working memory, retention times are brief. Items in iconic

memory are generally believed to decay in under a second (Sperling, 1960); whereas (in the absence of competition), echoic memory can have a duration of up to 20 seconds (Posner, 1966). These times can be increased through use of rehearsal. Rehearsal which involves articulation accesses the phonological store and articulatory rehearsal component, rendering it more memorable. It is therefore feasible that children who have limited recourse to language are less likely to use it during rehearsal, thus limiting their strategic recall of test items and material available for matching.

Linguistic ability is also potentially linked to children's superior performance when presented with toys instead of images. As articulatory suppression is able to disrupt visual short-term memory, memory for visually presented items is often considered to be associated with the phonological loop (Salame and Baddeley, 1982). Consequently, participants who are able to name items are able to hold them in working memory longer than children who are unable to do so. Borst, Niven and Logie (2012) suggest that visual and phonological information utilise a passive, non-conscious store. Objects, on the other hand, access the visuo-spatial scratchpad and the more substantial conscious store. The use of toys therefore allows young participants to draw on a range of episodic and semantic information about familiar objects, with the familiarity of the items further aiding working memory performance (Sandrini, Fertonani, Cohen & Miniussi, 2012). Furthermore, the freedom to physically manipulate objects increases understanding of the object and its properties (Mandler, 2004) as well as capturing attention, with all of the allied benefits this brings to processing (Eysenck, Derakshan, Santos & Calvo, 2007). It has been apparent throughout this research that children performed better when asked to categorise toys. Given the clear additional theoretical justification for the use of objects, the use of physical items is strongly recommended when conducting memory-dependent research with young children.

7.9 Learning and Play

Objective 7. To explore the impact of play on the development of categorisation and schemata.

As was detailed in Chapter 2, in the past play has often been regarded as a pleasurable but meaningless diversion (Spencer, 1855; Curtis, 1916) or as a means of developing broad, generalised skills (Groos, 1901). A body of theoretical and empirical research then emerged which appeared to show a causal link between play and cognitive development (Bergen, 2002;

Bruner, 1961; Lillard, 2012; Moyles, 1989; Piaget, 1945; Vygotsky, 1962; Whitebread, 2012) suggesting that play utilised and promoted development in language (Pellegrini, 1980; Vedeler, 1997), cognition (Anning, 2004; Gmitrova & Gmitrova, 2003; Gmitrova, Podhajecka & Gmitrov, 2009; Singer & Singer, 2006; Wood & Attfield, 1996, 2005) and social skills (Baker-Sennett & Matusov, 2008; Hughes, 2011; Pellis & Pellis, 2009). However, a pervasive rejection of simplistic stimulus-response paradigms and, more recently, repudiation of many pre-2012 studies for reasons of methodological unreliability (Lillard, Lerner, Hopkins, Dore, Smith & Palmquist, 2013; Rubin, Fein & Vandenberg, 1983; Smith, 1988) led interest and belief in the non-pedagogic benefits of play to wane until new (Thibodeau, Gilpin, Brown & Meyer, 2016) and recently updated research (Moyles, 2015) began to suggest a degree of legitimacy amongst many previous conclusions. These findings, coupled with the increasingly didactic nature of early childhood education (Singer & Singer, 2006; Broadhead, 2009) has prompted a recent rise in counter claims regarding the necessity of play (Bradbury, 2013; Gleave & Cole-Hamilton, 2012; Wenner, 2009) and a renewed desire to demonstrate its worth (Hirsh-Pasek, Golinkoff, Berk, & Singer, 2009).

Claims concerning a relationship between play and physical, social, oral (Holmes, Romeo, Ciraola, & Grushko, 2015; Orr & Geva, 2015) and creative skills (Worthington & van Oers, 2016) are widely accepted, but assertions regarding cognitive development have been less warmly welcomed. Physical play improves gross and fine motor control (Clark & Metcalfe, 2002), respiratory fitness (Twisk, 2001), bone mass and self-esteem, as well as reducing adiposity and stress levels (Faulkner, Bluing, Flora & Fusco, 2009). Pretend play also augments social development (Uren & Stagnitti, 2009) as children generally enact prototypes with greater functional maturity than is apparent in their normal interactions (Vygotsky, 1978). As previously noted (see 7.3.1.), it also moves thinking from concrete representations towards symbolism (Smith, 1993), abstraction (Bergen, 2002) and independent, internalised thought (Nicolopoulou, Barbosa, Ilgaz, & Brockmeyer, 2010).

Whilst there is little previous evidence of play having a direct causal role in neurological/cognitive development, unproven linear causality does not demonstrate that there is no connection (Gopnik and Walker, 2013). Advances in neurology have highlighted overlaps between areas which had previously been considered to be independent and distinct. Similarly, it is now recognised that the interaction between play and learning is more intricate than had previously been assumed (Weisberg, Hirsh-Pasek & Golinkoff, 2013) and fostered recognition

that stimulus response may be mediated by additional processes or be part of a cluster of interactions.

As key skills such as language are often fundamental to play activities, their development is naturally incorporated within an activity which is both pleasurable and relevant to the child. As a result, play helps to boost vocabulary, syntax and linguistic awareness (Holmes, Romeo, Ciraola, & Grushko, 2015; Orr & Geva, 2015; Pellegrini, 1980) particularly during socio-dramatic play which is inclined to have a strong lingual component. During the observations conducted as part of this study, language was used as a means of establishing the parameters of the play (for instance, "Let's pretend that I've brought my baby to hospital and you're the doctor" Appendix Saffron); in order to label and describe elements of the situation ("I've done it! I've mended the plug hole!" Appendix James) and to negotiate and maintain the play (Jayden, sitting in cardboard car, "Who wants to go to the seaside?" Makayla. "Me!" Appendix Makayla). As such, through play children were encouraged to use language in both a functional and social capacity. The importance of developing language is discussed below (see 6.11).

Whilst the preeminent joy of play for children may be the involvement with others (Lee & Das Gupta, 1995); interaction with older, more experienced playmates is of particular import as a means of developing understanding and cognition (Goncu 1993, Haight & Miller, 1993; Howes, Unger & Matheson, 1992). Vygotsky (1978) suggested that when children are very young or inexperienced, they require guidance to shape and labelling the play, but as they age, the balance should shift towards co-construction and thence to the child determining plot development and roles. Whilst interaction with peers will prove beneficial, (Dale, 1989; DeLoache & Plaetzer, 1985; Dunn & Dale, 1984; Fiese, 1990; Haight & Miller, 1993; Kavanaugh, Whittington & Cerbone, 1983; Miller & Garvey, 1984; O'Connell & Bretherton, 1984; Farver & Wimbarti, 1995), amongst groups of socially disadvantaged children, (such as those involved in this study), greater adult input may initially be required in order to increase engagement (Lockman and McHale, 1989) and provide guidance. Adults must ensure, however, that they provide appropriate levels of input and control. Excessively scripted activities stifle individuality and imagination (Nicolopoulou, 2010) whilst totally unstructured play may fade to aimless puttering. It is thus proposed that the mixture of unregulated play and intensely orchestrated activity observed in Cohort 1 inhibited progress, whilst the high staffing ratios and emphasis on child-led play in Cohort 3 allowed the embodiment of Vygotskian principles, with demonstrable impact.

Study 3 (see Chapter 6) found that, over a twelve-week period, children who participated in child-led play made greater gains in categorisational ability than children who followed a formal academic curriculum. In the current political landscape, where it is asserted that children, especially those from deprived backgrounds, need to begin formal education earlier rather than later (Badger & Shapiro, 2015; Badham & Maylor, 2015; Chow & Conway, 2015; Gleason, 2014; Liu, Song & Seger, 2012; Soto, Waldschmidt, Helie & Ashby, 2013), this finding appears counter-intuitive. The following section therefore seeks to evaluate the plausibility of the claim that play fosters cognitive development and aids the embedding of automaticity. It is argued that, whilst there may not be linear causality, there are demonstrable links and strings of evidence which point towards play as an antecedent of cognitive development.

Whilst cognitive development follows a largely uniform trajectory, a combination of intrinsic and environmental factors leave it subject to individual variations in terms of both speed and magnitude (Barrett, Tugade & Engle, 2004; Greenberg, McGhee & Schwartz, 1998). From an environmental perspective, every child's ecological niche comprises a unique composite of stimuli, demands and expectations (Garton, 2004). Sociocultural history has ensured that, by and large, these provide children with the tools and structures they need for development (Rogoff, 1991; Vygotsky, 1978). Transference of social norms and mores may occur through overt instruction from the family or educational provider, or through informal means such as television or play. It is clear, however, that transmission and learning is constrained by the parameters of biological capacity. Key aspects of cognition, for instance working memory, are initially reliant upon maturation of the associated neural circuitry (Alvarez & Sabatini, 2007; Nagy, Westerberg & Klinsberg, 2004; Osaka, Osaka, Kondo, Morishita, Fukuyama & Shibasaki, 2004) that are then optimised through usage (Henry, 2012; Soto, Waldschmidt, Helie & Ashby, 2013). Circuits that are not used are liable to inertia or decay (Hockfield & Kalb, 1993; Johnson, 2001). The development of planning abilities, organisational capacity and some aspects of decision making are therefore necessarily slow, progressive and sequentially predetermined (Chau, Synnes, Grunau, Poskitt, Brant & Miller, 2013; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014; Raznahan, Greenstein, Lee, Clasen & Giedd, 2012). Instructive experiences, particularly during sensitive periods, aid the development of neural circuitry within certain parameters (Erzurumlu, Guido & Molnar, 2006), but cannot occasion development beyond those boundaries. Optimal cognitive growth is thus dependent on intrinsic evolution being augmented by suitable environmental stimuli (Soto, Waldschmidt,

Helie & Ashby, 2013). Insufficient input will create stasis and leave circuitry susceptible to decay (Alvarez & Sabatini, 2007; Johnson, 2001); whilst excessive demands will increase cognitive load beyond feasible processing capacity (Baddeley, Eysenck & Anderson, 2015; Cowan, 2005, 2010). At both ends of the spectrum therefore, developmentally incongruous stimuli fails to support growth and may, given the cumulative nature of learning, have long-term impact. Furthermore, the accompanying experience of neglect or repeated failure carries risks for the child's emergent sense of competence and worth (Dent, 2013; Gillespie, 2012).

Play is multi-facetted, with each of its forms and stages both reflecting, and serving to consolidate developmental change. Object centred play in infancy, for instance, has long been known to encourage a range of skills including motor control and visual selective attention (Squire, Noudoost, Schafer & Moore, 2013). Both voluntary motor control and attention have well defined neuronal links with working memory - selective attention through shared usage of the prefrontal and parietal control regions (Gazzaley & Nobre, 2012) and motor control through the basal ganglia (Ullman, Almeida & Klingberg, 2014). Ullman, Almeida and Klingberg's (2014) longitudinal research demonstrates that this inter-relationship allows future working memory capacity to be inferred from the structure and activity of the infant's basal ganglia and thalamus. The discovery of links between what had previously been considered to be disparate areas, signals exciting new insights into neurological development which will increase understanding of cognitive growth. Thus, whilst causality cannot be inferred at this stage, research appears to link the voluntary motor control of early object play to a raft of cognitive, executive and emotional functions including reasoning (Leisman, Braun-Benjamin & Melillo, 2014) and certain forms of implicit learning (Foerde & Shohamy, 2011). Thus, just as the opportunity to manipulate objects within this study enabled participants to score more highly on 3D than on 2D categorisation tasks, so play, even at the most basic of levels, provides stimulation and growth.

Symbolic play emerges, in its most rudimentary form, towards the end of the first year (Bates, Benigni, Bretherton, Camaioni & Volterra, 1979; Qin, Cho, Chen, Rosenberg-Lee, Geary & Menon, 2014). Its initial solitary, object-focussed format gradually shifts to include toys, then people. By these means the child is able to externalise the processes of decentration (Fenson & Ramsey, 1980; Lowe, 1975; Watson & Fisher, 1977) and evolving agency (Cooley, 1902; Gillespie, 2012; Shaffer, 2005), and in doing so, rehearse the behaviours that augment understanding. Symbolic play thus has a role in the child's emerging sense of self and in the

development of abstract thought (Bergen, 2002; Nicolopoulou, Barbosa, Ilgaz, & Brockmeyer, 2010).

More complex forms, such as socio-dramatic play, involve social enactments and role-taking that helps to embed social schema, empathy and theory of mind (Fromberg & Bergen, 2006; Howes, Unger & Seidner, 1989; Hughes, 1991). Pretend play generally emerges whilst children are of Nursery age and is greatly enhanced by opportunities to interact with more proficient and socially skilled individuals (Dale, 1989; DeLoache & Plaetzer, 1985; Dunn & Dale, 1984; Fiese, 1990; Haight & Miller, 1993; Kavanaugh, Whittington & Cerbone, 1983; Miller & Garvey, 1984; O'Connell & Bretherton, 1984; Farver & Wimbarti, 1995). For the children in Cohort 3, a high staffing ratio ensured that a teacher, teaching assistant or nursery nurse was generally available to augment their play activities. The availability of such individuals provides strategies for social interaction (Bussey & Bandura, 1999: Xu, 2010) which are influential in the development of social cognition (Kelly & Hammond, 2011). The representational nature of the play subsequently enables movement away from concrete thinking, towards symbolism, voluntary cognitive control (Smith, 1993) and thence, meta-cognition (Lillard, 2012; Montessori, 1967), abstraction (Bergen, 2002) and independent, internalised thought (Nicolopoulou, Barbosa, Ilgaz, & Brockmeyer, 2010). As such, the socio-dramatic play witnessed in Cohort 3 potentially has a key role in developing social cognition and moving thinking to a quantitatively new level. Thus, whilst instructional work may develop specific and discreet individual skills, play helps to develop the cognitive architecture necessary for their conceptualisation and development. As such it provides the foundations for daily life, social behaviour and academic success.

The range of play activities experienced by children in Cohort 3 (see Appendix 8), therefore appears likely to have aided their development of motor control, selective attention and subsequently, working memory. By contrast, children in Cohort 1 had periods of passivity (see Appendix 8) and apparent disengagement whilst being addressed as a full class, during which time there was frequent need to recall them to task. The observations conducted in Cohort 1 and Cohort 3 during Study 3 (see Appendices 8 & 9) further demonstrated that whilst formal instruction was necessarily conducted with groups of children, play was individually differentiated by the children themselves. Through play, each child was able to pursue their own interests and progress at their own pace. The availability of supportive adults provided security, momentum and guidance as required. Play activities such as "building a house for baby" (see Appendix 9) allowed the children to individually and collectively plan, organise

and make decisions. Each child was able to participate fully in the game whilst operating at their own developmental level. Conversely, the children involved in the formal maths activity (see Appendix 9) were expected to achieve a predetermined measure through externally imposed means. Given the demonstrable disparity between children's conceptual understanding revealed throughout this research, these external norms are likely to have been beneath the capabilities of some group members and beyond the capabilities of others.

The frequent juxtaposition of specific play behaviours and quantifiable cognitive development points to a relationship between the two. The universality of this relationship further suggests play is an adaptive function in the young.

7.10. Play in Nursery Education

"*Adults who criticize teachers for allowing children to play are unaware that play is the principal means of learning in early childhood; it is the way through which children reconcile their inner lives with external reality. In play children gradually develop concepts of causal relationships, the power to discriminate, to make judgments, to analyse and to synthesise, to imagine and to formulate"* (CACE, [Plowden Report] 1967 in Brock et al p26)

The swinging pendulum of educational ideology has always both reflected and driven social ideals. Plowden (1967) thus utilised emergent Piagetian theory and drove the notion of children as independent individual learners whose needs were best met through curricular freedom. Some radical and much publicised responses, such as the William Tyndale affair, sent the pendulum sharply back towards greater regulation and accountability (Gillard, 2011). As noted in Chapter 2, the 1988 Education Act subsequently prepared the way for the National Curriculum and a pedagogic recontextualising (Bernstein, 1975) of Early Years education that placed the emphasis on the rigorous assessment of traditional skills and knowledge. Increasingly, nursery and preschool education have come to be viewed simply as preparation for school (Rogers & Lapping, 2012; Stirrup, Evans & Davies, 2016) and, whilst the EYFS recognises the need for play, it recommends that it should be increasingly adult-led "to help children prepare for more formal learning, ready for Year 1" (DfE, 2014, p 9). Play is thus contextualised as being purposeful and instructive rather than autonomous (Rogers & Evans, 2008).

Researchers have subsequently largely focussed on the educational benefits of play (Alfieri, Brooks, Aldrich & Tenenbaum, 2011; Cheng and Johnson, 2010; Gmitrova, Podhajecka & Gmitrova, 2009; Wallace & Russ, 2015); or investigated how play-based classroom activities can be used to boost maths (Nath & Szucs, 2014), problem-solving (Russ, 2003), language (Orr & Geva, 2015) and cognitive competencies (Uren and Stagnitti, 2009) in order that children can achieve these politically defined norms (Badger & Shapiro, 2015; Badham & Maylor, 2015; Chow & Conway, 2015; Gleason, 2014; Liu, Song & Seger, 2012; Soto, Waldschmidt, Helie & Ashby, 2013). Others, however, have argued that the increasingly didactic nature of Early Years Education (Singer and Singer, 2006; Broadhead, 2009) both restricts learning and misrepresents play (Bartlett, 2011; Bradbury, 2013; Dent, 2013; Hewes, 2006; Kellett, 2010; Lester & Russell, 2008; Whitebread, Basilio, Kuvalja & Verma, 2012). It is argued that current trends have increased teacher-directed activity and driven real play from early years' classrooms. Much of what purports to be play is actually didactic instruction using more child-friendly objects.

The undue emphasis on spoken and textual language favours girls who generally acquire language more easily and more rapidly than boys and then retain linguistic superiority throughout childhood (Eriksson, Marschik, Tulviste, Almgren, Pereira, Wehberg & Gallego, 2011; Goldin-Meadow, Levine, Hedges, Huttenlocher, Raudenbush & Small, 2014; Gopnik & Meltzoff, 1987; Gopnik & Meltzoff, 1997; Schaadt, Hesse & Friederici, 2015). The emphasis on text and vocabulary also disadvantages children from lower socio-economic backgrounds (Fernald, Marchman & Weisleder, 2013; Mensah & Kiernan, 2010; Save the Children, 2014), who are exposed to less language at home (Gottfried, Schlackman, Gottfried & Boutin-Martinez, 2015; Hoff, 2003), generally have fewer picture books (Logan & Medford, 2011) and less opportunities for the sort of imaginative play that would boost language (Serbin, Moller, Powlishta & Gulko, 1991). In Cohorts 1 and 3 children (particularly boys) entered Nursery with language considerably below local and national norms, as was apparent in the difficulty several of the C1 boys encountered in attempting to name everyday items. It is unsurprising, therefore, that Ofsted found their written skills to be below national norms at KS1. For many children born into relative poverty, these difficulties with text and language persist throughout schooling (McKinney, McClung, Hall, Cameron & Lowden, 2012) and appear resistant to increasingly early and intensive reading intervention strategies (Ofsted, 2014). Play, however, has a demonstrable impact on language acquisition (Holmes, Romeo, Ciraola, & Grushko, 2015; Orr & Geva, 2015; Pellegrini, 1980) and, being multi-modal, allows

communication and successful outcomes to be reached by alternative means. The use of symbolic representations during play also provides a functional basis for later success in reading (Vygotsky, 1978). Play thus allows more positive outcomes for children from disadvantaged backgrounds (Milteer & Gingsburg, 2012; Pellis, Pellis & Bell, 2009), regardless of gender or developmental level and provides a staged introduction to the skills which underpin later success in reading.

Young children have yet to develop selective attention (Hagen & Hale, 1973) and so are particularly unsuited to tasks which require sustained and focussed attention. Their recall is enhanced if material is meaningful (Craik & Lockhart, 1972), has been subject to consequential analysis (Craik & Tulvig, 1975; Unsworth, 2015) and to elaborative questioning (Roediger & Pyc, 2012). Furthermore, given the links between mood, memory and learning, if activities occasion energetic arousal, learning quality is improved, whilst tense arousal provides a barrier to learning (Glover, 2012). Formal learning, with its emphasis on areas children often have no interest or investment in (Whitebread, 2012) therefore frequently fails to engage, and requires skills and behaviours beyond the child's natural capabilities. Play, on the other hand, successfully garners and utilises natural interest and cognitive capabilities, allowing a breath of learning to take place.

Children's learning in the early years is both driven and constrained by a composite of biological, neurological and environmental factors. Cognitive development is optimised when children are at ease, positively engaged, and receiving appropriate information in a cognitively digestible form. Much later academic success is predicated on the efficient use of working memory (Stevens & Bavelier, 2012; Stevens, Harn, Chard, Currin, Parisi & Neville, 2011); selective attention (Xin, 2013) and semantic memory. Working memory is used for complex tasks such as planning (Cohen, 1996; Gilhooly, Phillips, Wynn, Logie & Della Sala, 1999) comprehension (Gathercole & Baddeley, 1993), mathematics (Pederson, Rook-Green & Elder, 1981; Wallace & Russ, 2015; Yawkey, 1981), and problem solving (Robert & LeFevre, 2013); whilst sematic memory deals with retention of factual information. It would therefore appear appropriate to devote the early years to establishing a strong foundation in these areas. Play has been shown to be associated with the development of working memory, together with a gamut of social skills. Study 3 has demonstrated the significant benefits of play in developing the constituents of semantic memory. Play also leads to substantial and sustained improvements in attention, with incidences of ADHD showing a marked reduction amongst children for whom formal curricular demands were delayed until age six (Stanford, 2015). Hence as was argued

within Chapter 6, whilst instructional activities serve to teach discreet and specifics skills or concepts, play helps to develop the cognitive architecture and several broad domains including executive function and visio-spatial abilities. When play activities include an element of adult guidance and support, additional sociocultural aspects are introduced which help boost the embedding of social norms and schemata (Hirsh-Pasek, Golinkoff, Berk & Singer, 2009),. Conversely, formal instruction requires functional abilities (such as selective attention) which may be beyond the child's developmental capabilities. During the pre-school period, play, particularly play with supportive adults, would therefore appear to be strongly associated with the development of the progenitors of later academic success.

7.11. Study Limitations and Future Directions

The initial intention was to produce a thesis concerning the emergence and embedding of social schema in early childhood. However, the unexpected and compelling results produced at each stage of the process, repeatedly led the work in exciting but unforeseen directions. In retrospect, it is easy to identify additional factors that should have been recorded in field notes (for instance, how participants handled and responded to the toys) and information that should have been gleaned from settings at the time, but the unfolding nature of the research and the absence of previous research in the field, rendered, particularly Study 3, largely exploratory. It is therefore recognised that there is a need to revisit aspects of this work with one eye towards possible alternative explanations. For instance, Study 3 raised a number of interesting possibilities regarding the impact of pedagogy and play on children's categorisational development. It also served to highlight a potential means of helping to reduce the juxtaposition of low socioeconomic status and educational underachievement. As this was primarily an exploratory study, conducted within substantial time constraints, it is recommended that it should be re-run by a group of researcher in order to more accurately quantify the importance of the disparate elements. The new study should use a range of settings in order to ensure that results are not contextually dependent. There is also a need to conduct more detailed analysis of provision and the nature of staff-pupil interactions in order to establish the relative importance of staffing ratios and educational philosophy. It would be of particular interest to investigate whether educational provision, specifically the differing conceptions of "playful learning" noted within EYFS, Montessori and Reggio Emilia, impact categorical development.

The studies reported within this thesis were conducted with a sample drawn entirely from one relatively small area of England. It would be of interest to test children from beyond the East Midlands and indeed, beyond the UK in order to establish the generalisability of the findings.

The studies reported here demonstrate that the development of categorisational ability is impacted by socio-economic status. However, these findings are based on a dichotomised sample. It is felt that the study could usefully be extended to incorporate participants from a broader demography in order to establish whether the relationship is linear or clustered – specifically whether proximity to the poverty threshold is a significant factor.

It was apparent throughout the research that children performed better when asked to categorise toys. Given the clear theoretical justifications for the use of objects provided in 7.6, the use of physical items is strongly recommended when conducting memory-dependent research with young children.

It would appear, however, (see Studies 2 and 3) that the impact of using toys as opposed to images narrows as concepts become secure. Further investigation of this transition is recommended as this change may indicate a point of cognitive progression. It would be of interest to explore whether it is linked to a more sophisticated use of rehearsal and concept manipulation in Working Memory; whether it is connected to developments in selective attention, or to an emergent ability to process solely on the basis of visual information.

For most typically developing children, the process of categorisation begins in infancy and therefore discussions regarding "first" categories are beyond the remit of this thesis. However, this test battery was successfully administered to Cohort 2 children who were as young as 30 months. It would therefore be of interest to run a pilot study with children in the 24-30 month age range in order to investigate some of the points of cognitive progression highlighted in this thesis. It is also recognised that the dichotomised sample makes it difficult to generalise age norms from this research to the broader population. Given the demonstrable reliability and validity of the test procedure, it would be of interest to further extend this research to an even larger sample.

Recent neurobiological research (see 1.7.6) regarding categorisation in neuro-typical adult participants (Nomura, Maddox, Filoteo, Ing, Gitelman, Parrish & Mesulam, 2007) and investigations into pattern learning (Soto, Waldschmidt, Helie & Ashby, 2013) suggest a key role for the basal ganglia until such time as proficiency capacitates automaticity. The basal ganglia's sensorimotor, cognitive and limbic subdivision foment associations, not only with

categorisation but also with motor control, the development of working memory (Ullman, Almeida & Klingberg, 2014), reasoning, (Melrose, Poulin & Stem, 2007) and planning (Grossberg, 2016). Throughout this thesis, the basal ganglia has been implicated as a central hub for a variety of processes and a key progenitor in learning. It would therefore be of interest to further investigate the role and importance of the basal ganglia through consideration of its development and the organisation of functional connectivity with the cerebral cortex during early childhood.

It would be of interest to conduct a longitudinal study using participants from this study in order to investigate whether categorisational abilities at pre-school level map onto later working memory or semantic memory performance.

Each of the units that hosted the research have requested a test set of cards having witnessed their popularity and ease of use. They have found the test to be of particular use with children who have little functional English and the information gleaned from the process has enabled them to effectively tailor support. The battery appears to have a number of potential applications as a diagnostic tool for those working with children and has already been effectively trialled with elective/selective mutes and children with pervasive language disorders. It is therefore intended to further develop the battery through the production of additional card and toy sets and to test its use with older learning-impaired children and those who are unable to fully access the curriculum.

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