THE ROLE OF CHILDREN, SOCIAL PARTNERS AND OBJECTS TRIAD IN CHILDREN'S ENVIRONMENT AND LEARNING

by

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Declaration

I declare that this thesis is my own work and completed under the supervision of Prof. Gert Westermann and Dr. Katherine E. Twomey, and that it has not been submitted in substantially the same form for the award of a higher degree elsewhere.

Signature

Date

Abstract

It is well established that children's learning is shaped by social partners and by non-social aspects of their environment. However, most work in this field has been based on relatively constrained settings where the experimenter controls the order and duration of children's experiences. Therefore, the current thesis aimed to explore how children's learning environments are affected by different features in controlled but relatively unconstrained settings through the triad of child, object and social partner. The first study examined how two-year-old children's attention to, and exploration of objects were affected by the presence or absence of labels. Between conditions, objects were either handled by children or by their social partner. Within each condition the objects were either labelled or non-labelled. Children looked longer at the objects and at their social partner's face when the objects were handled by the social partner. Looking at labelled or non-labelled objects did not differ. Lower vocabulary predicted longer looking at the social partner's face and more eye-gaze switches and fewer eye-gaze switches, and lower vocabulary predicted better label retention when the experimenter handled the objects. Thus, social partner's actions affect children's experiences when actively involved during play. The second study examined caregivers' actions and language while playing with familiar and novel objects with their nine- or 18-month-old child. Overall, the results suggested that object novelty affected caregivers' interactive and non-interactive actions and infant directed speech (IDS) characteristics (number of words, pitch range, first utterance duration) while playing with their children. Children's age also affected caregivers' actions: caregivers of 18-month-old children used more interactive actions compared to caregivers of the younger age group. Children's receptive vocabularies and caregivers' educational levels predicted caregivers' actions and IDS characteristics. Hence, object types, children's age and individual differences influence caregivers' actions and language characteristics and consequently children's experiences and learning input. In the third study caregivers and their two-year-old children played with 3D novel objects in which the perceptual distances between objects were controlled. Caregivers generated sequences in which they handed objects to their child. Caregivers' object choices were not the same as their children's preferences (indicated by child's longer looking time). Agreement between infant's and caregiver's object choice was higher for less securely attached children. While caregivers showed a tendency to generate higher to intermediate novelty sequences (i.e. perceptual distances between successive objects) of objects, this result was not systematic. Caregivers of shyer children generated sequences of higher novelty between the objects. Overall, caregivers' object sequences were not systematic, and they did not choose the objects their children preferred; however, children's individual characteristics influenced caregivers' behaviours during play. Overall, children, social partners and objects, as well as individual characteristics, play an important role in the construction of children's experiences. The manipulation of these features provided evidence regarding the influence these features have on each other and consequently their effect on children's experiences, which in turn influences children's learning and development. Exploring these influences provides a deeper understanding of children's early learning and development throughout their everyday experiences.

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A PhD is a long journey with many ups and downs along the way, and is not just a degree, but a life process, where you learn about yourself and grow stronger and more knowledgeable. Thank you all who supported my own PhD journey from the bottom of my heart.

Dedication

To my parents, Stella and Marios, for everything.

To my sister, Elena, for being my best friend.

To my biggest supporter, Lefteris, for the ups and downs.

Statement of Authorship

Chapter 3: THE EFFECT OF LABELLING AND OBJECT HANDLING ON CHILDREN'S NOVEL OBJECT EXPLORATION

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Acquisition of data: **Marina Loucaides**
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Chapter 5: CAREGIVERS SHAPING CHILDREN'S LEARNING ENVIRONMENTS: AGREEMENT, SYSTEMATICITY AND CHILDREN'S INDIVIDUAL DIFFERENCES

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We the undersigned agree with the above stated “proportion of work undertaken” for each of the above chapter contributing to this thesis:

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Conference Presentations

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Loucaides, M., Westermann, G., & Twomey, E, K., (2018). *The effect of object novelty and children' age on caregiver-child interactions.* Lancaster Conference on Infant and Early Child Development, Lancaster, UK.

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Epigraph

"Do not train a child to learn by force or harshness;

but direct them to it by what amuses their minds,

so that you may be better able to discover with accuracy

the peculiar bent of the genius of each."

Plato (BC 427-BC 347)

Chapter 1: Introductory Chapter: Exploring How the Triad of Children, Social Partners and Objects Influences Children's Environments and Learning

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Introductory Chapter: Exploring How the Triad of Children, Social Partners and Objects Influences Children's Environments and Learning

1.1. Background

Children's learning environments are busy and filled with new information ready to be explored and learned. Previous literature explored how children learn often in constrained settings, such as laboratory and controlled experiments where children were asked to look at a screen. A new growing literature investigates how children learn in relatively unconstrained settings where they actively play with objects either alone (e.g., Kretch, Franchak, & Adolph, 2014; Ryan & Deci, 2000) or with their social partners (e.g., Pereira, Smith, & Yu, 2014) as they normally do in their everyday activities. For instance, it has been suggested that children's first view experiences differ substantially compared to those of adults. When children hold an object, this object is located close to their face and blocks all the other object competitors compared to adults' visual fields, which are broader and wider with many objects in view at the same time (e.g., Pereira et al., 2014; Smith, Yu, & Pereira, 2011). Therefore, children are able to structure their experiences and learning input independently (Mather, 2013).

However, while children structure their own environments and learn autonomously, children also spend a lot of time with their social partners and especially their parents and/or caregivers. Therefore, these environments are constructed by children and/or their social partners while they play with different types of objects. When social partners and objects are present in children's environment, they form a triad in which these elements interact. In the current thesis I aimed to investigate a few of the pathways in this triad (see Figure 1.1.) in order to understand how children's environments are structured and influenced.

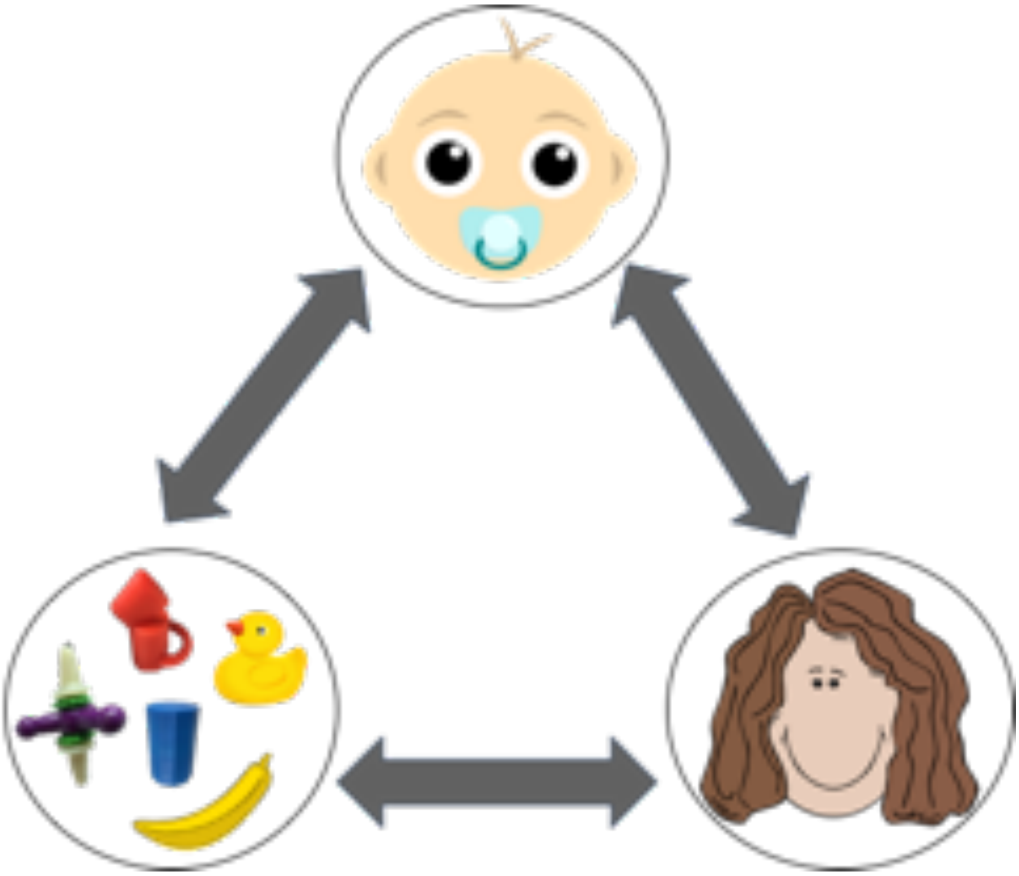

Figure 1.1. The triad: child, social partner and objects.

1.1.1. Children and Objects

Previous research suggests that children's interactions with objects enhance and affect children's learning (e.g., Yu, Smith, Christiansen, & Pereira, 2007). For instance, children's understanding that objects persist in time and space is developed through object manipulation (Needham, 2000). This understanding later enhances children's language and cognitive development (Oakes & Madole, 2000). The ability to manipulate objects at the age of six months has been positively linked with cognitive and language performance at children's second year of life (Siegel, 1981). While children play with objects, they usually experience language from their social partners that provides information for those objects (e.g., Deák, Triesch, Krasno, de Barbaro, & Robledo, 2013). This information includes labels for the objects and children are expected to associate the label they hear with the object they see (Carey, 1978; Carey & Bartlett, 1978). Interestingly, previous research (Baldwin &

Markman, 1989) suggested that the presence of labels can increase looking times to the labelled objects even after labelling occurred. However, whether labelling affects children's looking behaviours while actively manipulating objects from their own perspective has not be investigated. Therefore, Chapter 3 in the current thesis aims to examine children's looking behaviours during the presence or absence of labels when actively manipulating objects and when objects are only manipulated by the experimenter and children explore them from a distance. Children's retention of the novel labels is also examined.

1.1.2. Caregivers and Objects

Object novelty affects children's behaviours. Specifically, children use undirected and expected actions when playing with familiar objects, whereas when playing with novel objects children use more sustained and longer times of attention (Piaget, 1945). Object novelty also affects caregivers' behaviours while playing with their children (e.g., Danis, 1997; Stern, Spieker, Barnett, & MacKain, 1983). For instance, Danis (1997) suggested that caregivers allowed their prelinguistic children to explore novel objects alone while providing more verbal information and less interactive actions, whereas when the object was familiar caregivers were more actively involved and used known stories and games. Therefore, object novelty affects caregivers' behaviours while playing with their prelinguistic children. However, whether caregivers' behaviours are influenced by children's developmental stages when playing with familiar and novel objects is unknown.

Caregivers adjust their behaviours towards children to enhance their children's learning (e.g., Donovan, Leavitt, Taylor, & Broder, 2007). For instance, caregivers' infant directed speech (IDS) is influenced by children's developmental stages (e.g., Saint-Georges et al., 2013; Stern et al., 1983). IDS has smaller pitch range and pitch mean within caregivers' utterances when interacting with children at a verbal stage of 12 months of age compared to caregivers who interact with prelinguistic nine-month-old children. This diversity in pitch is needed to encourage nine-month-old children to vocalize, whereas IDS is not the primary cue to vocalization and alertness in older children (Stern et al., 1983). Therefore, caregivers adjust their IDS based on their children's needs and abilities. However, whether caregivers' IDS characteristics are influenced by object novelty when playing with their children has not yet been examined.

Chapter 4 in the current thesis aims to investigate whether object novelty affected caregivers' behaviours and IDS characteristics (pitch, pitch range, number of words, first utterance duration) while playing with prelinguistic or children in the early stages of language development. Caregivers' educational level is also investigated since IDS and gestures are influenced by caregivers' socioeconomic status (e.g., Rowe, 2008; Rowe & Goldin-Meadow, 2009) and academic achievement (e.g., Augustine, Covanagh, & Crosnoe, 2009; Collahan & Eyberg, 2010).

1.1.3. Children, Caregivers and Objects

During play, a social partner provides opportunities to children to learn from observation, while the social partner supports and encourages play (Bornstein, Venuti, & Hahn, 2002; Goldwater-Adler, Wozney, & McGath, 2018). Specifically, caregivers are sensitive towards their children's learning, play abilities and individual characteristics, such as shyness (e.g., Dixon & Hull Smith, 2003) and attachment (e.g., Grusec & Goodnow, 1994). For example, caregivers of shyer children tend to get involved at the first sign of difficulty from their children when they try to solve problems compared to caregivers of less shy children that allow children to solve problems alone and develop their problem-solving skills (e.g., Dixon & Hull Smith, 2003). Further, caregivers are able to provide guidance and extensive instructions to their children to overcome a state of uncertainty, following their sensitivity towards their children's abilities (Vygotsky, 1978, 1980). Therefore, caregivers' sensitivity towards their children influences children's learning experiences and input.

Further, recent research (e.g., Kidd, Piantadosi, & Aslin 2012; 2014) suggests that children prefer intermediate novelty/complexity when leaning but whether their caregivers can generate this type of novelty systematically for them has not been examined. We would expect that caregivers' sensitivity towards their children's behaviours and abilities (e.g., Donovan et al., 2007) would prompt similar behaviours from the caregivers as those of children. Caregivers have a substantial influence on the structure of their children's experiences and environments; thus Chapter 5 aims to investigate whether this structure is systematic, and in response to children's behaviour. That is; whether caregivers choose the objects their children show preference to. Children's shyness and attachment levels are also examined.

Taken together, children's self-generated environment and the input they create for themselves is key for later development, alongside with the learning experiences influenced by social partners and different object types, as well as children's individual characteristics. Examining the three aspects of the triad in relatively unconstrained settings will provide meaningful information in relation to how children's environments and learning are structured. In the current thesis I aim to understand how this triad shapes children's experiences as well as the influence that each aspect of the triad has on the other aspects when manipulated.

1.2. Rationale for Alternative Format

This thesis comprises three studies (Chapters 3 to 5) written in paper format 'ready for submission' for publication. Given that the methodologies and research questions between the papers were different and each study could stand separately, it felt appropriate to use the alternative format for this thesis.

1.3. Construction of the Thesis

This thesis, following this introductory chapter, includes a literature review (Chapter 2), three chapters one for each study (Chapters 3 to 5), written as publishable papers and finally a discussion chapter (Chapter 6) summarising the results from the three studies, the implications to the existing literature and limitations alongside with ideas for future research, as well as general conclusions.

1.4. My Contribution

In the current thesis all research investigations were conducted by myself, alongside guidance from my supervisors Professor Gert Westermann and Dr. Katherine E. Twomey. The design of each experiment as well as its accomplishment was achieved by me with guidance from my supervisors. Dr. Han Ke designed and printed the objects that were used in Chapter 5 and provided guidance in using R-statistic.

Chapter 2: Introduction: Children's Learning Environment Structured by Children Themselves, Social Partners and Objects

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Introduction: Children's Learning Environment Structured by Children Themselves, Social Partners and Objects

2.1. Introduction

Children from the day they are born start to interact with their social partners and later with social partners and objects together. Through these interactions, children learn about their surroundings and the world (Yu, Smith, Christensen, & Pereira, 2007). The last decades of research suggest that features in children's environments, such as social partners and objects, influence children's learning input and experiences as children are sensitive towards changes in their environment (e.g., Kretch, Franchak, & Adolph, 2014; Pereira, Smith, & Yu, 2014). This environment offers new information for children to explore, learn and structure their own learning and development while playing alone (Smith, Yu, & Pereira, 2011) driven by their own intrinsic motivation and curiosity (Mather, 2013). Alongside children's ability to learn autonomously, children spend a lot of time with their social partners where social partners' behaviours structure and influence children's experiences, learning environment (i.e. the broader environment that the child is experiencing with different types of information available to be learnt/explored under different settings such as home or school), and learning input (i.e. the exposure to specific information provided within the learning environment with the aim to internalize it and later apply it; e.g., Tudge 1992). Naturally, these social partners during children's early years are children's parents/caregivers. Previous research strongly suggests that parents/caregivers significantly affect the learning experiences and input of children and consequently their early socio-cognitive development (Goldwater-Adler, Wozney, & McGath, 2018). Taken together, since social partners influence children's environments when present while children are exploring objects, we suggest that these three features (children, social partners, objects) form a triad where each feature influences the others (see Figure 2.1.). While many studies have explored how children learn in environments with objects with or without a social partner, little work has explored the three features of the triad together and the influence they have on each other. Therefore, in the current thesis I aim to investigate how children's exploratory behaviours change when they interact with objects alone and when the social partner is actively involved, how caregivers' behaviours and speech characteristics are influenced by object novelty and whether caregivers structure their children's learning environments systematically in relation to their children's behaviours. Children's individual characteristics such as vocabulary, shyness and attachment and caregivers' educational level are also examined.

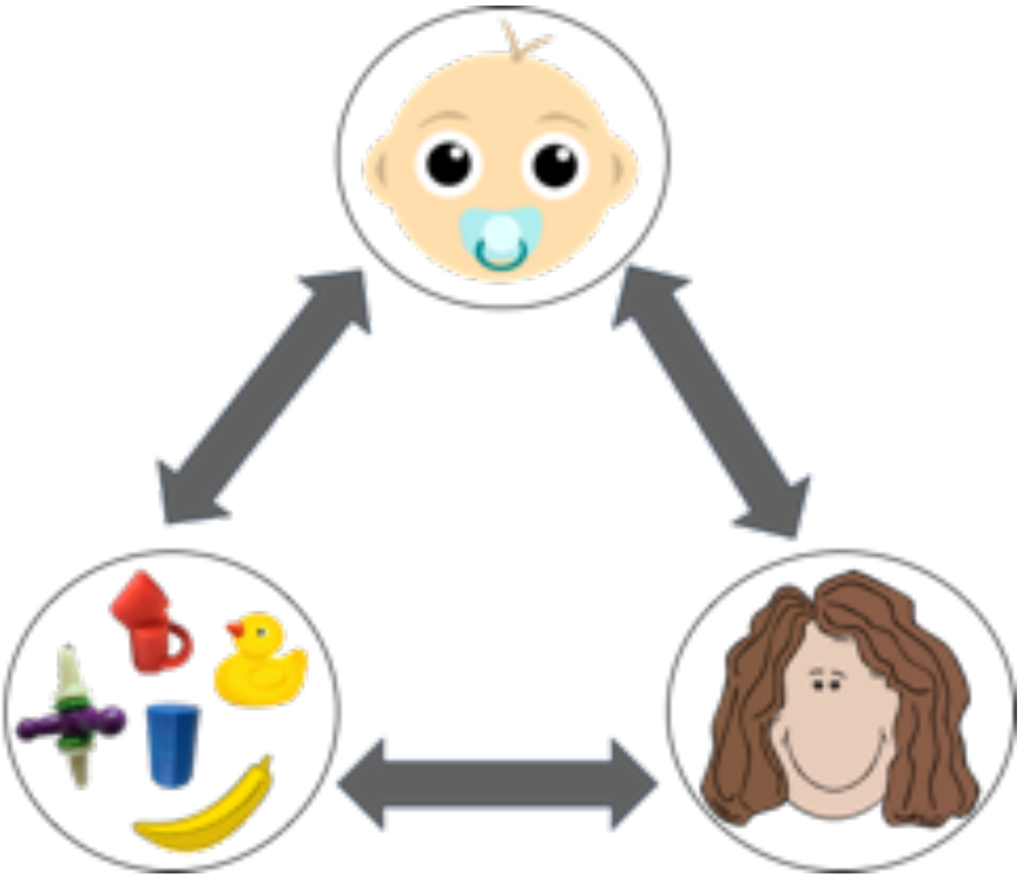

Figure 2.1. The triad: child, social partner and objects.

The following literature review aims to bring together some of the themes that can be found as strings within the triad of child, objects and social partners. First, there is a broader review about the environment and how it is structured by the child alone and how it is affected when the social partner is involved. Then, attention and joint attention are discussed since they are crucial for learning during interactions between children and their social partners. The role of objects in children's learning environment is included as a main feature of the triad, where different types of objects, novelty between objects and whether caregivers and children choose the same objects during joint play are discussed as strings within the triad that can affect children's learning environment and input. During play the social partners use speech and actions to communicate with children. These characteristics are influenced by object novelty and children's age, therefore a section introducing these strings is also included. One of the many ways of learning new words is during joint interaction with adults. Since the triad suggests that children interact with adults, children's language learning is included in the literature review as another string that might affect the interactions of the features that constitute the triad. Lastly, children's individual characteristics (i.e. vocabulary, attachment and shyness) are considered as strings in this triad that can also affect the interactions between the three main features of the triad. The purpose of the literature review is to set the bigger picture about how the environment affects children's learning and discuss explicitly some of the manipulations on the features of the triad (i.e. child, adult, objects) and how these can affect children's learning environments and consequently children's cognitive development.

2.2. The Relationship Between the Environment and Learning

The environment is described as a physical environment, with its own surroundings located at a specific setting (Vickerius & Sandberg, 2006). Children's first physical environment is the home and it varies depending on children's age, motor abilities and, on their interests, as well as the presence of caregivers and/or other adults (Aureli, Presaghi, & Garito, 2018). Usually children's environments are full of toys to promote exploration by biting, grasping, and/or throwing the toys, as well as providing opportunities to crawl, pull themselves up when start practising standing and space to practice walking later on (Vance &

Boals, 1989). Children's functioning is not a given, but it is a result of the children's interaction with their environment, which includes social interactions, physical features such as toys and daily routines with their caregivers. All these features create children's environments and promote children's learning from their surroundings within a specific setting, for example the home (Thurman, 1997; Keity, 2019).

A well-organised environment is able to enhance children's learning through activities and materials such as objects (Oudeyer & Kaplan, 2009). Children are active in their environments and explore their surroundings while at the same time they can work out how to respond to and communicate with their social partners. Play is children's main way to engage with their environment and enhance their learning through interactions with the objects provided and their social partners who are present (Chaillé & Silvern, 1996). Children are exposed to a variety of objects; however, they choose with which object to play using their thinking. Unavoidably then, what is available in children's environment (e.g., objects, social partners) will consequently influence their learning since not all environments provide the same learning opportunities (e.g., different objects are present, social partners behave differently). For instance, research suggests that in homes where the primary caregiver is unresponsive towards children, the children show impaired cognitive development compared to children who live in more responsive environments (Evans et al., 2010). Thus, children's learning is influenced by their environment, and this influence depends on what that environment contains and how it is structured.

Therefore, children's environments are constituted by many different features which are subject to change. However, these features promote and influence children's learning. The main features of this environment are children themselves, objects/toys and social partners/caregivers. To fully understand and gain more knowledge about how changes in the environment affect children's learning and cognitive development we need to examine these three features under different circumstances and several manipulations (e.g., during different developmental stages of children, with different object types).

2.3. The Learning Environment Constructed by The Child

Piaget (1952) suggests that children are like "little scientists" who are not passive, but active explorers of their environment. In the last decades, developmental psychologists have been interested in investigating the nature of the input that children experience through their everyday activities. Children from a very young age learn from their surroundings and collect information during their everyday exploration (Yu et al., 2007). One of the ways that children's learning input is shaped is through their own exploration that happens autonomously without feedback from adults (Mather, 2013). This exploration is usually driven by children's curiosity (Twomey & Westermann, 2018) with the aim to investigate the information available (Dember & Earl, 1957). This information seeking is characterized by children's intrinsic motivation where an external reward is not necessary to guide them in new information and experiences. For instance, children play with objects and show their intrinsic motivation to learn new information by grasping, biting or throwing objects with the aim to learn more about the objects, such as what noises they make or their texture (Oudeyer & Kaplan, 2009).

Developmental psychologists have been using third-person cameras (a view of an outsider observer) to explore how children play with objects and social partners. However, recent research suggests that the scenes straight in front of children are highly selective in relation to the visual information in the larger environment (Smith, Yu, Yoshida, & Fausey, 2015). Specifically, the properties of children's own perspective scenes vary systematically from third-person perspective scenes (Yoshida & Smith, 2008; Yurovsky, Smith, & Yu, 2013), from adult-perspective scenes (Smith et al., 2011), and are not easily predicted by adult intuitions (Franchak, Kretch, Soska, & Adolph, 2011; Fausey, Jayaraman, & Smith, 2016). In real world interactions what children observe critically depends on their own actions as these actions carry information in and out the learner's sensory field and differ for children at different ages and developmental abilities (Fausey et al., 2016). Therefore, in order to understand children's everyday interactions and activities and how they learn through these, we need to examine children's experiences in more naturalistic, relatively unconstrained environments and from their own perspective.

Recent studies have used head cameras and/or head-mounted eye-trackers to investigate children's experiences when actively interacting with objects from children's own perspective. For instance, Yu, Smith, Shen, Pereira and Smith (2009) examined children's visual environment and how they selected visual information. Children between 19 and 23 months of age freely explored novel objects with their parents. A head camera measured the visual information from children's perspective. Children's experiences depended primarily on their own actions and on their parent's actions. Interestingly, some parents were more active in directing children's attention to individual objects than others. Children's manual actions had a significant role in generating visual experiences in which one object was dominated in their visual field. The filtering and the selection of objects during children's actions offered clear and controlled visual input.

Similarly, Smith et al. (2011) investigated how children's visual experiences are structured when they physically play with objects and their parent. Children between the ages of 17 and 19 months and their parent both wore a head camera and played with objects across a table. Children's visual fields usually included only one object close to children's face while blocking all other available competitor objects on the table. Generally, objects moved in and out of children's visual field constantly and fast, whereas adults' view was more stable and broader. Therefore, the self-generated learning environment of children is profoundly different from an adult's environment. Children's body size, interests and activities are different from those of an adult and these features influence what children experience (Smith et al., 2011). For instance, children have shorter arms than adults which affects the information in children's visual field as the objects they hold are closer to their face due to their arm's length (Smith et al., 2011; Yu et al., 2009).

These results suggest that children's self-generated learning environment constitutes a critical input for children's early learning and offers a window into the understanding of children's development. Therefore, in order to understand children's learning and development, researchers also need to examine children's experiences from their own perspective (Kretch, et al., 2014). However, it is important to consider that children's learning input and development do not take place only when children play and explore alone, but they also occur for a significant amount of time when they interact with a social partner (e.g., Yu et al., 2009). Therefore, to construct a bigger picture about children's cognitive development, researchers need to investigate all the possible changes in the environment that can affect children's learning input, such as playing alone, with a social partner and/or with different types of objects.

2.4. The Learning Environment Influenced by The Social Partner

While children learn and structure their own environment, they also experience play events when social partners are involved. Social partners, and especially caregivers are present in children's everyday environments (i.e. the environment that the child is experiencing as a daily routine) and from the very first months of a child's life a dyadic interaction between the caregiver and the child is developed (Aureli et al., 2018), where vocal, postural and facial expressions between them are exchanged in face-to-face events (Van Egeren, Barrat, & Roach, 2001). At around nine-months of age, this dyadic interaction develops into a triadic interaction (Tomasello, 1999). This drastic change is called '9-month revolution' and is characterised by the child's ability to understand to some extent his/her physical and social world (Tomasello, 1999). During this time important triadic behaviours start to develop, such as the coordinated interaction between the caregiver, the child and a referent, usually an object. The presence of a referent in the interaction reinforces the communication between the partners (Carpenter, Nagell, Tomasello, Butterworth, & Moore 1998) that enhances children's abilities to communicate their interests to their caregivers using eye-gaze, object examination, gestures and vocalisations (Aureli et al., 2018), and also reinforces caregivers responses to their children's communicative signals using actions and language (Tamis-LeMonda, Kuchirko, & Song, 2014). As a result, the child is in a 'shared attention' triangle that involves another person and an object or event to pay attention to (Lindblom & Ziemke, 2006). According to Tomasello (1999), these triadic interactions enhance humans' understanding that other people are intentional agents as themselves, they have goals and are able to make their own choices. Therefore, the development of the triadic interaction is essential for children to benefit from the learning that takes place while interacting with social partners. In the current thesis the development of this interaction is central since without the ability to engage in triadic interactions then the suggested triad that constitutes children's environment for a significant amount of time would not be beneficial for their learning and cognitive development (see Figure 2.1).

For instance, Tomasello and Farrar (1986) examined caregiver-child triadic interactions including novel objects when children were 15 months old. Joint attention episodes were characterized by shorter sentences, frequent use of utterances and comments which created longer conversations between caregivers and children. The maternal references to the novel objects at the moment their children focused their attention at the objects, positively predicted children's vocabulary at the age of 21 months. Conversely, maternal references that aimed to redirect children's attention were negatively correlated to children's vocabulary. Thus, children's learning experiences and learning are highly influenced within joint attention episodes by their social partner.

2.4.1. Caregivers' Sensitivity Towards Their Children

Caregivers as social partners show a sensitivity towards their children's abilities throughout their development while exploring new information which in turn influences what children experience and learn (Bornstein, Venuti, & Hahn, 2002; Donovan, Leavitt, Taylor, & Broder, 2007). The sensitivity that caregivers show to these abilities is found in the behaviours of caregivers that facilitate *scaffolding*. Scaffolding behaviours enhance learning where a more skilled social partner guides and encourages a child to overcome a difficulty (Wood, Bruner, & Ross, 1976). The difference between what a child can do without help and what a child could do after guidance and encouragement, is known as *zone of proximal development* (Vygotsky, 1978; 1980). Caregivers, as advanced social partners, structure interactions with their children with the aim to help them overcome this difficulty. Therefore, when the new information to be learnt by children is highly demanding, caregivers help their children by reducing the cognitive demands through extended information and further guidance (Neitzel & Stright, 2004).

For example, Damast, Tamis-LeMonda and Bornstein (1991) during a play behavioural task investigated caregivers' responses towards their 21-month-old children. Caregivers showed scaffolding behaviours towards their children by following children's cues (e.g., objects focus, actions) to adjust their responses at children's level of play or higher. For instance, if a child was manipulating a phone toy, the caregiver encouraged the child to "talk on the phone" showing a response regarding children's level of play. A higher level of play was indicated, for example, when a child was "off-task" and the caregiver suggested the exploration of an object. Caregivers who were more knowledgeable about their children's play development (see Tamis-LeMonda, Damast, & Bornstein, 1994 for the questionnaire used) provided higher levels of play. Thus, caregivers with more knowledge about their children's play development provide more challenging play interactions at the appropriate level of complexity, which in turn promotes their children's development through play.

Caregivers are also sensitive towards their children's communicative cues (e.g., Bornstein & Tamis-LeMonda, 1989). Children communicate while playing with their caregivers to show their preferences or share information using cues, such as eye-gaze direction (e.g., Csibra, 2010; Senju & Csibra, 2008), pointing (e.g., Cameron-Faulkner, Theakston, Lieven, & Tomasello, 2015; Lucca & Wilbourn, 2018; Southgate, Van Maanen, & Csibra, 2007), holdouts (Boundy, Cameron-Faulkner, & Theakston, 2018), vocalisations and language when their vocabulary is developed (e.g., Bates, Camaioni, & Volterra, 1975; Camaioni, 2017). Tamis-LeMonda, Kuchirko and Tafuro (2013) examined how caregivers responded to their 14-month-old children's cues while playing with objects. Caregivers were more responsive when their children were active in the task by providing responsive behaviours that included object exploration and didactic and multimodal referential language. To illustrate, the caregiver was showing exploratory behaviours towards an object when her child was exploring that object. Conversely, when children were off task, maternal responsive behaviours were reduced. For instance, if the child stopped exploring and was off task, then the caregiver was more likely to be off task following her child's behaviour. Therefore, caregivers show sensitivity and are responsive to their children's cues and behaviours within a task, which highlights the important role that caregivers have in the structure of children's learning environments and the influence these responses have on children's experiences.

Taken together, social partners, and especially caregivers are influencing children's play and learning experiences. Caregivers' sensitivity towards their children's abilities and behavioural cues affects their behaviours and responses towards their children. This sensitivity also influences the scaffolding techniques that caregivers use during joint interaction/play to enhance their children's learning (e.g., Belsky, Goode, & Most, 1980; Tamis-LeMonda & Bornstein, 1991). The above evidence suggests that children learn from what is available in their environment, and the influence of the social partner in the structure of this environment is consequently related to children's learning input.

2.5. Attention and Joint Attention Between Social Partners and Children

2.5.1. Attention

Attention to environmental stimuli is a complex set of behavioural and physiological processes (Choudhury & Gorman, 2000). The main goal of attention is to direct a person's cognitive resources to a specific situation to collect information about that situation (Lang, Simon, Balaban, & Simons, 2013). For young children attention has two major mechanisms: attention oriented to a stimulus and sustained attention (Berg & Richards, 1997). Attention that is oriented to a stimulus happens when an individual becomes aware of a stimulus and/or identifies changes in the environment. This type of attention is also known as 'attention-getting' (Cohen, 1973; Sokolov & Cacioppo, 1997). The importance or the novelty of the information available is processed and the individual decides whether to keep his/her attention to the stimulus or disengage. Sustained attention is characterised by the individual's use of cognitive resources towards the stimulus and processing stimulus' information (Richards & Hunter, 1998). Importantly, during sustained attention almost all information about the stimulus is explored and most cognitive processing (e.g., encoding, planning, storage, problem-solving) takes place (Lansink & Richards, 1997; Richards & Hunter, 1998). Children's ability to sustain attention has been a good predictor for their future development, since early deficits in sustained attention can predict future diagnosis of attentional disorders (Yu & Smith, 2016). The significant difference between the two major mechanisms is that sustained attention is controlled by the individual and it is voluntary (Choudhury & Gorman, 2000).

Sustained attention is often considered as an individual property of a child and depends on his/her interests and surroundings (Choudhury & Gorman, 2000). One of the main ways used to measure children's attention during experiments is looking times (i.e., in the current thesis we will use looking times to explore children's looking behaviours and attention; Aslin, 2012). Children choose where they want to look based on what is more interesting and novel according to their current knowledge in order to explore and learn the new information (Franchak et al., 2011). An example is violation of expectancy, this violation occurs when children look longer at an event that it is impossible to happen compared to an event which is possible to happen based on their current knowledge. Further, longer looking times are interpreted as children's discrimination of stimuli, for instance, preferential looking paradigms where children look longer at the novel stimulus over the familiar stimulus (Aslin, 2012; Franchak et al., 2011). This difference indicates children's preference towards novelty when compared to familiarity. Therefore, these differences in looking times between events typically reflect different underlying cognitive processes, but the same duration of looking might also reflect quite different underlying cognitive processes (Aslin, 2012).

2.5.2. Joint Attention between Children and Social Partners

During joint play events between a child and a social partner, joint attention, where the two social partners attend to the same referent, is usually established. Joint attention behaviours from children can be divided into two categories: responses from children to others' cues or spontaneous initiations from children (Mundy, et al., 2007). Responses from children to others' cues refers to children's ability to follow others' gestures and eye direction to attend to a common referent, such as an object. Conversely, spontaneous initiations from children refers to children's ability to use eye contact and gestures to direct others to attend to themselves, to objects or to an event (Mundy & Newell, 2007). In order to successfully establish joint attention, the social partner and the child need to coordinate their attentional focus. Coordination among social partners has been found to be important for many aspects of human development and behaviour (Yu et al., 2009), such as language development (e.g., Hoff, 2006).

Wass et al. (2018) investigated whether 12-month-old children's attention towards objects was influenced by whether the children were involved in joint play with their parent or play alone. During joint play events, the child and the parent shared the same objects and played together across a table, whereas during play alone events the child and the parent sat across a table with a divider allowing only eye contact but not the sharing of objects. Each participant was able to play with their own objects, while talking from the parent was not allowed in either condition. Looking times using a third view camera were recorded. Children attended more to the objects during joint play where moments of inattentiveness were shorter, and fewer compared to solo play. Parents' attentiveness to the objects influenced children to also attend to the objects, however children's attentiveness did not affect parents' attention. This suggests that social partners' behaviour may drive children's behaviour during joint attention. Therefore, children's attention to the objects might have not been influenced by children's endogenous control but affected by parents' exogenous attentional scaffolding behaviours during joint play.

Further, Pereira, Yu, Smith and Shen (2009) conducted a study with 18- to 24-month-old children to assess parents' and children's real-time coordinated gestures and visual information as they engaged in object-play, while wearing a head-mounted camera. What children perceived was mostly based on their own and their parents' actions while interacting with an object and these actions influenced children's visual perception. Interestingly, the actions that were produced by both partners offered more constrained and clear input to the child, that is, more than half of children's first view frames included a dominant object, which blocked all other available objects. This eliminated the need to internally filter and handle irrelevant information, since children's bodily selection determined this information elimination extrinsically. Therefore, children's and social partners' actions during a triadic joint attention event affect children's visual input and consequently, children's experiences.

Yu and Smith (2016) investigated whether social context matters for the duration of sustained attention episodes with one-year-old infants during playing with toys. They used head-mounted eye tracking to record moment-by-moment gaze data from parents and children between 11 and 13 months. When the parents visually attended to the object that children attended, children after their parents' look extended their duration of visual attention to that object. Recently, Suarez-Rivera, Smith and Yu (2019) investigated whether parents' hand contact with the objects and parents' use of speech affected 14-month-old children's attention during joint attention events. Again, children's attention to the objects was longer during joint attention events. However, parents' talk, and touch occurred more frequently when both social partners attended at the objects at the same time. Parent talk was the most effective behaviour that concurred with children's longer looking times.

Therefore, children's attention to the objects is also established through talking for and touching the objects during play. For example, Yu and Smith (2013) suggested that one-year-old children rarely look at their parent's face or eyes during joint play, but they tend to look more at their parent's hands. The dyads established joint attention without gaze following but through the objects that children and parents were holding. Therefore, joint attention and the share of information between social partners and children could also occur through eye-hand coupling. Similarly, Yu and Smith (2017) examined whether dyad differences regarding eye-hand coordination predicted differences in joint attention for 11-to-24-month-old children and their parent. Children who were more actively involved during play coordinated their looking behaviour with their parent and spent more time in jointly attending the same objects. Joint attention was higher through the successful coordination of eye-gaze and manual actions on the objects while both partners attended to their partner's object manipulations.

Overall, children experience joint attention events everyday which allow the social partners to communicate and exchange information. Importantly, parents'/caregivers' behaviours during these events affect children's learning input, actions and sustained attention. Therefore, to fully understand children's experiences, we also need to investigate the features that could influence children's social partners' behaviours during joint play.

2.6. Role of Objects in The Learning Environment

Children's object exploration starts at a very young age and it is considered a foundational ability for their later development across several domains (e.g., Baumgartner & Oakes, 2013; Needham, 2000). Children who explore longer with a larger variety of exploratory behaviours have more opportunities to encode more characteristics of objects, such as shape and weight, and gather more information, such as the object's name (Baumgartner & Oakes, 2013). When children manipulate objects, their understanding that objects persist in space and time (Needham, 2000) enhances their later cognitive and language development (Oakes & Madole, 2000). Children's ability to manipulate objects from the age of six months was positively linked with language and cognitive performance at the age of two (Siegel, 1981) and with higher academic achievement and intellectual functioning in their school years (Bornstein, Hahn, & Suwalsky, 2013).

2.6.1. Object Types

In children's everyday environments, different types of objects are available for manipulation, such as familiar objects and/or objects with different levels of novelty (see Horst, Samuelson, Kucker, & McMurray, 2011). Piaget (1945) has suggested that children show different exploratory behaviours for familiar objects compared to novel objects. That is, when children play with familiar objects, they do not require information and guidance from a social partner since they use undirected and expected actions. To illustrate, when they play with a banana, they might pretend to peel it or eat it. Conversely, when children play with novel objects, they use more sustained and longer attention. For instance, Oakes and Tellinghuisen (1994) examined seven-month-old and 10-month-old children's attention when playing with familiar and novel objects. Children from both age groups spent more time exploring novel objects compared to familiar objects and less time exploring simple objects compared to more complicated ones. Further, older children explored objects longer compared to younger children, which could be explained as the development of object exploration ability and the development of motor abilities. Generally, then, different types of objects prompt different behaviours from children, and children's age influences the manipulation of these objects.

Similarly, social partners' behaviours towards objects while playing with children are influenced by object novelty. Danis (1997) investigated how caregiver-child interactions changed in relation to caregivers' behaviours when playing with familiar and novel objects. Caregivers with their five- to nine-month-old children were given familiar and novel objects to play. Children showed more autonomous behaviours (e.g., choosing alone with which novel object to play) and led the session when the object was novel, and spent more time looking at novel objects compared to familiar objects. Caregivers allowed children to manipulate the novel objects alone before providing comments or actions. When children were attentive to a novel object the caregivers decreased their interactive actions and increased their verbalizations. For the familiar objects, the caregivers introduced known 'games' and 'stories' to maintain children's attention in the task. This formed a more playful and joyful learning environment as quantified by children's greater number of eye-gaze switches between their caregivers' faces and the objects and by often events of laughing. When they played with novel objects, the caregivers provided more verbal information regarding objects' properties, which elicited a more didactic and serious exploration from the dyads, since eye-gaze switching and laughing between the two partners were limited. These behaviours from caregivers can be interpreted as arising from caregivers' sensitivity towards their children's learning needs (e.g., Bornstein et al., 2002; Donovan et al., 2007) and behaviours (Piaget, 1945).

These results highlight the importance of object types when caregivers and children play together: familiar and novel objects produce different behaviours from the caregivers, which influence the learning environment at children's prelinguistic stage. However, it is important to consider that Danis' (1997) is the only published research (to the author's knowledge) that examined how object novelty influenced caregivers' behaviours. Since we know that caregivers influence what children experience and that object novelty prompts different behaviours from caregivers, this effect needs to be examined in more detail. For instance, investigating whether these maternal behaviours change through children's developmental stages will provide meaningful information for possible changes regarding children's learning input.

2.6.2. Perceptual Novelty/Complexity Between Stimuli

As discussed, different types of objects can promote different behaviours from children and their caregivers during play. However, objects and generally stimuli also differ regarding perceptual differences, which might affect learning. For instance, Son, Smith and Goldstone (2008) examined whether novel objects with simple information would enhance category generalisation compared to novel objects with more complex information. To illustrate, complex objects had the same shape and contained more information such as lines and shapes of several colours, whereas simple objects had the same shape and only differed in colour without containing any lines or shapes. Children between the ages of 15 and 20 months played with either only simple or only complex objects while object labels were provided by the experimenter. Children who played with simple objects were more likely to generate categories based on shape similarity, compared to children who only experienced complex objects. Therefore, using objects which contain little information enhances children's ability to generalise between objects based on their shape since unnecessary complex information is absent (see also Kidd, Piantadosi, & Aslin, 2012, 2014).

Similarly, recent research suggested that children use a learning strategy known as a Goldilocks effect, where children are the "Goldilocks" surrounded by significant amounts of information and stimuli of different novelty/complexity, but learning is optimal when stimuli are of intermediate predictability (Kidd et al., 2012, 2014). Children may use this strategy to avoid using their cognitive resources for predictable events that are easily understandable or highly surprising events and thus difficult to understand. Conversely, other empirical research (Mather & Plunkett, 2011) suggested that 10-month-old children generated more robust categories when familiarised with stimuli within orders of exemplars of maximized inter-stimulus perceptual differences compared to orders of exemplars of minimized perceptual differences.

Earlier, Dember and Earl (1957) proposed that each individual has his/her own preferred level of novelty/complexity and chooses information that contains the amount of novelty/complexity he/she prefers. Similarly, Berlyne (1960) suggested that the optimal strategy of learning is driven by a person's complexity preference of new information (see also Yerkes & Dodson, 1908). In line with these, we know that children prefer novel stimuli over familiar stimuli (Fantz, Ordy, & Udelf, 1962; Sokolov, 1963). While a child is exploring a novel stimulus, he/she gets more familiar with it, which indicates habituation. When a child is in habituated state and a new novel stimulus appears then the child will choose to attend at the more novel stimulus over the habituated novel one. Therefore, increases in novelty prompt increases in children's attention. However, it is not clear what amount of novelty and/or complexity within children's environments generate an optimal amount of novelty/complexity which could then facilitate learning.

Taken together, evidence from previous empirical and computational studies (e.g., Kidd et al., 2012, 2014; Twomey & Westermann, 2018) suggests that children might prefer intermediate novelty/complexity when learning new information. This raises the question of whether caregivers can generate that level of complexity for their children. Children's learning also takes place when they spend time with their caregivers and caregivers' behaviours influence children's learning (e.g, Danis 1997). We know that caregivers are sensitive towards their children's learning abilities (e.g., Donovan et al., 2007) suggesting that this sensitivity might influence the way they structure the environment regarding novelty/complexity. Caregivers also adjust their behaviours while playing following their children's play behaviours and abilities to enhance their learning (e.g., Belsky, Goode, & Most, 1980; Tamils-LeMonda & Bornstein, 1991). Therefore, caregivers might generate sequences of intermediate novelty since previous results suggest that this might have been children's scaffolding behaviour to overcome the gap between their already known information and new information available to be learnt (i.e. *zone of proximal development*; Vygotsky, 1978). Exploring whether caregivers systematically generate a specific level of stimuli novelty for their children can provide further information about how caregivers structure their children's environments. It would be expected that caregivers will aim to provide intermediate novelty to their children to promote learning through an intermediate gap between known and new information.

2.6.3. Do Caregivers Choose the Same Objects as Their Children?

Corter and Jamienson (1977) were interested in whether caregivers chose the same objects as those their children would later choose to play with. Twenty children between the ages of 14 and 16 months and their caregivers took part. The caregivers were presented with objects of different complexities and were asked to choose the object they thought their child would choose in the play session later. Eighteen of the twenty caregivers chose the most complex object as their child's preference; however, only nine children chose the most complex object, eight the intermediate complex object and three the simple object. Next, caregivers provided guesses about children's choices between familiar and novel objects. Thirteen out of the twenty caregivers chose the novel, five the intermediate novel and two the familiar object, whereas all children chose the novel object except one. Children preferred novel and high to intermediate complexity objects, in line with what recent research suggested about children's preferences regarding novelty/complexity (e.g., Kidd et al., 2012, 2014), whereas caregivers did not make accurate choices in line with what their children preferred.

Corter and Jamieson (1977) is the only published paper (to the author's knowledge) that explores whether caregivers and children choose the same objects. However, in this study caregivers and children were not playing together, and caregivers made guesses as to what they believed their child would prefer. It is well established that when a social partner is present children use communicative cues during joint attention such as eye-gaze (e.g., Csibra, 2010), language (e.g., Harding & Golinkoff, 1979) or pointing (e.g., Cameron-Faulkner, et a., 2015; Lucca & Wilbourn, 2018). Caregivers are responsive to these cues during play events (Tamis-LeMonda et al., 2013). Therefore, examining whether caregivers choose the objects their child prefers while they play together, when the child is able to show his/her preferences, can provide more information about how children's experiences are structured and influenced by the presence of a social partner.

2.7. Infant Directed Speech

When caregivers and children play together, caregivers use language to engage children, provide more information about the game or the features of an object and provide guidance. Caregivers who are verbally responsive towards their children's exploratory activities offer further support to children's language development, as they produce labels for objects and events during joint attention (Loy, Masur, & Olson, 2018). The language caregivers use with their children is known as infant directed speech (IDS). IDS is preferred by children (Hayashi, Tamekawa, & Kiritani, 2001; Newman & Hussain, 2006) and it enhances children's word learning (Hoff, 2003; Singh, Nestor, Parikh, & Yull, 2009; Ma, Golinkoff, Houston, & Hirsh-Pasek, 2011), helps adults as an ostensive cue to direct children's attention towards the appropriate referent (Fernald & Kuhl, 1987; Saint-Georges et al., 2013; Stern, Spieker, Barnett, & MacKain, 1983; Song et al., 2010) and has arousing properties that enhance associative learning (Kapla, Goldstein, Huckeby, & Cooper, 1995; Saint-Georges et al., 2013). Previous research showed that IDS can increase and influence children's looking times among object presentations on a screen suggesting that IDS serves a functional role in directing children's attention. For instance, Senju and Csibra (2008) using eye tracking found that six-month-old children followed an adult's gaze towards an object only when such act was presented alongside direct gaze and IDS.

IDS has characteristics that are usually found within caregiver-child dyads and are measurably different to adult directed speech (ADS) characteristics. These characteristics are higher repetitiveness, lower mean length of utterance (Gergenly, Faragó, Galambos, & Topál, 2017), overall higher pitch and pitch range (McRobberts & Best, 1997; Papoušek, Papoušek, & Symmes, 1991), frequent use of names and a large number of questions (Saint-Georges et al., 2013). The characteristics of IDS can be affected by environmental factors that are subject to change. For instance, caregivers adjust their speech characteristics based on their children's age or on their linguistic and cognitive development. For instance, Fernald et al. (1989) found caregivers to use a wider pitch range when speaking to their children between birth and 24 months of age compared to when talking to adults. Additionally, previous research (Stern et al., 1983) suggests that caregivers' speech has greater pitch range and higher within-utterance mean pitch when interacting with children at a prelinguistic stage of nine months of age compared to 12-month-old children, whose language comprehension is more developed. Further, caregivers use higher pitch and pitch range when they play with their children in relatively unconstrained settings, such as actively playing with an object, compared to when reading a story from a story book (Shute & Whezldall, 1995).

Further, IDS is important in children's development as it enhances language acquisition. For example, Thiessen, Hill and Saffran (2009) examined whether IDS facilitates word segmentations. Children were able to distinguish words from syllable sequences only after hearing IDS, but not after hearing ADS. This suggests that IDS facilitates word segmentation and therefore is useful for language acquisition. Similarly, Ma et al. (2011) investigated whether IDS enhances word learning for children at 21- and 27-months of age. The younger age group only learned words when they were presented with characteristics of IDS, however, those with relatively larger vocabularies also learned in the ADS condition. The older children learned words within both speech conditions. Therefore, characteristics of IDS facilitate word learning and consequently language acquisition, but its impact decreases as the development of language grows.

Clearly, then, IDS is crucial for children's language acquisition and it is adjustable towards children's needs at different developmental stages. While important evidence shows a strong relationship between maternal input through IDS and children's language development, little work has been done about whether different features in the environment, such as object novelty could influence caregivers' characteristics of IDS and therefore children's learning input.

2.7.1. Does Maternal Education Status Affect IDS?

Previous studies explored IDS characteristics and how they were influenced by socio-economic status (SES). Children from lower SES backgrounds show slower rates of language and cognitive development, which are detectable from children' second year of life and continue to exist throughout their school years compared to children from higher SES backgrounds (Hoff & Tian, 2005). Caregivers from higher SES produce longer length of utterances, greater numbers of words and utterances, and more replies related to children's attentional focus compared to caregivers from lower SES backgrounds. Caregivers from lower SES use fewer words, ask fewer questions, talk less and are more directive when interacting with their children compared to caregivers from higher SES (Hoff, Laursen, & Tardif, 2002). Caregivers with higher SES use greater number of different types of words and topic-continuing replies compared to caregivers from lower SES backgrounds. These characteristics of caregivers' IDS predicted children's vocabulary, where children from lower SES backgrounds had slower rates of vocabulary development (Hoff, 2003).

An earlier study by Hoff-Ginsberg (1991) explored how caregivers from working-class and upper-middle-class used speech when they interacted with their 18- to 29-month-old children during toy play, book reading, dressing and mealtime. Upper-middle-class caregivers were more contingent towards their children's speech compared to working-class caregivers, that is, caregivers' speech content was related to their children's interests throughout the four different events. For instance, the caregivers responded to their children's attentional focus and did not aim to redirect children's attention. Caregivers from upper-middle-class backgrounds established a more continued conversation with their children, as they provided more topic-continuing replies to children's utterances when interacting.

SES is usually approximated using income, occupation and parental education, individually or using a combination of these measures (Conant, Liebenthal, Desai, & Binder, 2017). However, it has been suggested that maternal education alone can predict children's educational attainment, reading and language development (Bradley & Corwyn, 2003; Raviv, Kessenich, & Morrison, 2004). This might be due to the strong relationship between maternal education and other parenting features (Augustine, Covanagh, & Crosnoe, 2009; Collahan & Eyberg, 2010), for instance cognitive stimulation within the environment (Raviv et al., 2004), children's developmental knowledge by the parent and quantity and quality of IDS (Rowe, 2008). Therefore, maternal education alone can be used as another way to interpret maternal characteristics of IDS and children's development.

Rowe (2008) explored the relationship between caregivers' communication with their 30-month-old children and caregivers' SES background. Caregiver-child dyads took part in a naturalistic environment while playing with objects. Caregivers from different SES backgrounds had different knowledge about their children's developmental milestones. Children of more educated caregivers experienced more complex and diverse talking with a smaller proportion of utterances but longer utterances overall. Caregivers used those utterances to direct children's behaviours. Children of less educated caregivers experienced greater proportion of utterance but shorter utterances. Children's vocabulary skills were predicted a year after the behavioural testing by maternal characteristics of IDS and mediated by caregivers' knowledge about their children's development, where children of more highly educated caregivers showed higher vocabulary skills.

Overall, these studies suggest that SES influences the characteristics of caregivers' IDS and therefore children's learning input. Vocabulary skills of children were predicted by IDS characteristics, which further support the strong impact that social partners have on children's language and cognitive development. However, whether caregivers' educational level could predict caregivers' IDS characteristics while playing with familiar and novel objects with their prelinguistic or children in the early stages of language development is currently unknown.

2.7.2. SES backgrounds and parents' interactive gestures

Rowe and Goldin-Meadow (2009) examined parents' use of gestures towards their 14-

month-old children using videotaped events in their everyday environments and later assessed children's vocabulary at 54 months of age. Parents from higher SES backgrounds used more gestures with their children than parents from lower SES backgrounds. In turn, children who experienced more of these gestures performed those gestures and showed higher vocabulary by the age of 54 months. Therefore, this extensive use of communicative gestures by higher SES parents might have influenced children's vocabularies. While gestures by parents have been linked to vocabulary, whether gestures of parents, and specifically caregivers, from different backgrounds could have being influenced by object novelty is currently unknown. We know that caregivers are sensitive towards their children's learning (e.g., Donovan et al., 2007) and allow their children to explore novel objects alone, whereas they are more involved when the objects are familiar (Danis, 1997). We also know that caregivers from more highly educated backgrounds are more knowledgeable about their children's development (Rowe, 2008). Therefore, caregivers of higher educational backgrounds are expected to show higher sensitivity to their children's play behaviours towards familiar and novel objects compared to caregivers of lower educational backgrounds.

2.8. Learning of New Words

Children's environments are busy and filled with opportunities to acquire new information. Within these busy environments, children come across several complex learning tasks that they have to solve. However, the most challenging and remarkable of these tasks is learning language. Language is a multilevel system of production, perception and representation (Yu, Ballard, & Aslin, 2005). Infants' world is filled with objects with unknown names that must be learned by mapping objects in the visual field to auditory words. Children as young as six months of age correctly look to images that illustrate everyday items after they hear the correct label and by the age of 10-months they show understanding of everyday actions (Bergelson & Swingley, 2012). However, children's learning environment includes several potential referents for a word they hear, which makes the mapping of the correct word to the correct referent challenging. For instance, Quine (1960) has suggested that children are challenged since a word they hear could have infinite potential referents, known as *referential uncertainty*. To illustrate, a child might hear the word *book*, this word could refer to the book itself, but could also refer to the colour of the item, the shape and so on. It might even refer to where the item is or not to that item at all.

2.8.1. Children's Learning of New Words

Children's ability to map a word they hear with a referent they see, is usually referred to as *fast mapping* (Carey, 1978; Carey & Bartlett, 1978). Simply mapping a word to a referent does not indicate that this mapping is learned. Several empirical studies (e.g. Heibeck & Markman, 1987) examined whether children are able to map a previously learned label to the correct referent after an amount of time and show successful *retention* of the mapping (see Horst & Samuelson, 2008; Kucker, McMurray, & Samuelson, 2015) and whether they are able to extend this knowledge by showing *generalization* (e.g. Dollaghan, 1985) to other referents from the same learned categories. Learning the mapping of a new word to a referent occurs over time and gradually as the associations between them get stronger (e.g. Horst & Samuelson, 2008; Munro, Baker, McGregor, Docking, & Arculi, 2012). While children might be using several mechanisms to generate successful object-label mappings, in the current review we will focus on the *socio-pragmatic* mechanism where a social partner is actively involved in children's learning (for a review of other mechanisms see Twomey & Hilton, 2019).

2.8.2. Social Partners' Role When Learning New Words

Since children interact with adults in their everyday environment recent research suggests that children use a *socio-pragmatic* mechanism (Tomasello & Farrar, 1986) to map words to their referents. That is, the learning of language is fundamentally and systematically social. Children learn language from the adults around them while children try to understand adults' intentions and meanings. In order to achieve this, joint attention needs to be established, where an adult and a child attend to the same object at the same time (Baldwin, 1995; Deák, Triesch, Krasno, de Barbaro, & Robledo, 2013; Yu & Smith, 2017). Joint attention is also key for *natural pedagogy theory*, which is characterised by humans' ability to understand cultural information even before the merge of language. This is understood through three core elements: sensitivity to ostensive-signals such as eye-gaze, differentiate between referential cues and cues without a reference and a subsequent referential expectancy (Gergely & Csibra, 2013). In this theory we assume that children are able to differentiate adults' speech that aims to communicate with them from adults' speech that is noncommunicative. While social partners use speech when introducing words, they also use other ostensive cues such as pointing and/or eye-gaze direction (e.g, Csibra, 2010).

Baldwin (1991) examined whether children could follow their social partner's gaze to successfully map novel words to their referents. Children between the age of 18 to 19 months participated in two conditions, a follow-in labelling condition and a discrepant condition. In both conditions, children were holding an object and another object was hidden in a bucket. In the follow-in labelling condition, the social partner had eye contact with the child. During that time, the social partner switched his/her eye-gaze between the child and the object that the child was holding and provided the object's label. In the discrepant condition the experimenter did not look at the child and was labelling only the hidden object. The children learned the labels in the follow-in condition whereas in the discrepant condition they did not learn the label, but interestingly some children did not choose an object when they heard a label. Children in this task actively checked the experimenter's eye-gaze direction. Therefore, children by this age understand that ostensive cues from their social partners within a joint attention event are likely to refer to their joint attention referent and that ostensive cues when joint attention is not established might not refer to their own attentional focus.

Striano, Chen, Cleveland and Bradshaw (2006) explored whether nine- and 12-month-old children would show different looking behaviours after taking part in a joint attention condition or an object only condition. In the joint attention condition, the experimenter talked about an object and switched eye-gaze between the object and the children, whereas in the object only condition the experimenter talked about the object and switched eye-gaze between the object and the ceiling and never looked at the child. The children were presented with the object that was used in the social interaction conditions and a novel object they never saw before. The nine-month-old children who experienced the joint attention condition looked longer at the novel toy compared to the children who experienced the object only condition. However, the 12-month-old children looked equally at the novel object despite the social condition they experienced. Therefore, joint attention enhanced object processing and familiarization with objects only for younger children.

Pereira et al. (2014) explored children's visual scenes in relation to object-label mappings. Children between the age of 16-to-25-months of age wore a head camera that recorded their first-person views during play events with novel objects with their parents. The parents were given a label for each novel object and were asked to label the objects while playing with their children as they would normally do. After the play session, children's label retention was tested. The experimenter provided the objects on a tray in groups of three and asked children to point to each object in turn. The retention of the novel labels was successful when the names of the objects were heard at the time that the objects were centred, visually larger and stable in the children's view and blocked the competitor objects that were present in the playing area. Thus, children's own actions and interests, by moving the object close to their face, and the labelling by their parents at the right time enhances children's learning of new object-label mappings. Importantly, this is the result of joint attention between the children and the parents since in order to provide a label parents have to be attentive to what their children are attentive at.

2.8.3. The Contribution of Labels to Word Learning

The previous section discussed how children learn object-label mappings, especially with their social partners. We know that for a mapping to be successful a label and a referent need to be present at the same time and children have to be able to look at that object. But what do children do when an object is present, but its label is absent? Baldwin and Markman (1989) investigated how children in their early stages of language learning form object-label mappings by examining whether children would be more attentive towards novel objects when language was present. In the first study, children between the age of 10 to 14 months experienced a condition including labelling phrases and a no labelling condition while handling novel objects in both conditions. Children's looking times were coded using a third view camera. Children looked longer at the novel objects for which they heard a label from the experimenter. This suggested that labelling increased children's attention to the labelled objects.

In the second study they explored whether the labelling of objects enhanced children's attention together with pointing to the objects compared to pointing alone. Children of two age groups, 10 to 14-months and 17 to 20-months of age were shown pairs of novel objects within each condition. Children looked at the objects when pointing was performed the same amount of times regardless of whether labelling occurred or not. At test, children saw the objects without any labelling and showed longer looking times for the previously labelled objects. Therefore, labelling objects can increase looking times even after labelling occurred despite of pointing behaviours by the social partner. Thus, labels made objects more interesting.

The above study explores children's looking times at the objects from a third-view camera. Based on recent research, we known that children's own views are highly different from adults' views (e.g., Yoshida & Smith, 2008; Yurovsky et al., 2013) and children's view are not easily predicted by adults' intuitions (Fausey et al., 2016; Franchack, Kretch, Soska, Babcock, & Adolph 2011). Therefore, in order to fully understand whether the presence or absence of labels could affect children's looking behaviours we need to investigate this from children's own perspective.

2.8.4. Eye-Gaze Switches and Label Learning

Gaze direction during joint attention is one potentially informative referential cue for successfully forming object-label associations (e.g., Pereira et al., 2014). Children from the age of six months start to switch their eye-gaze, and thus attentional focus, between their social partner and an object (e.g., Baldwin et al., 1996). Children's ability to switch their attention between objects and their social partner allows children to attend to object-label associations. When children look at their social partners' face and hear what their partners say, this might prompt children to focus their attention on the utterance available and extract the relevant information for the object present. This might help in mapping the object they see to the label they hear from the social partner (Gogate, Bolzani, & Betancourt, 2006). The ability to perform these switches might be a precursor for children's development regarding their ability to follow their social partners' eye-gaze direction during joint attention events which are key to language comprehension (e.g., Gogate et al., 2006; Silvén, 2001). Hence, if children fail to perform such switches, they might make wrong object-label associations (Vaish, Demir, & Baldwin, 2011).

For instance, Gogate et al. (2006) explored whether temporal synchrony between moving objects and spoken words and children's attention to object labelling, would predict successful object-label mappings for six-to-eight-month-old children. After a five minute free play, the caregivers taught two novel words for two objects to their children during a three minute play session. Immediately after the play session children's object-label retention for the two objects was tested. Children's attention during play and caregivers' use of temporal synchrony was associated with correct object-label mappings. Particularly, children who performed more eye-gaze switches between their caregivers' face and the objects during labelling formed successful object-label associations (see also Matatyaho & Gogate, 2011; for more evidence about switching, see Oakes & Ribar, 2005). Clearly then, children's ability to switch their eye-gaze between their social partner and an object while they hear the associated label can enhance children's word learning. However, whether different environmental features, such as the absence and/or presence of labels and/or actively handling the objects or explore them from a distance, could affect children's eye-gaze switching behaviour and in turn label-object associations have not been examined before (to the author's knowledge).

2.9. Children's Individual Differences

Children's individual developmental patterns differ (Scarr, 1992). Children come from different backgrounds and have different intrinsic characteristics. Individual intrinsic features, such as temperamental characteristics (e.g., Paul & Kellogg, 1997; Hilton & Westermann, 2017) and extrinsic features such as maternal educational level (e.g., Rowe, 2008), have been found to influence children's vocabulary development, children's behaviours within their environments and social partners' behaviours towards children.

2.9.1. Vocabulary Development

For each child their vocabulary development follows a different trajectory. Previous research (Fenson et al., 1994; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991) suggested that children have noticeable differences within their productive vocabularies. For instance, 16-month-old children show a large degree of variability in vocabulary learning, that is children in the top 10% percentile produced 180 words and children in the lower 10%

percentile fewer than 10 words. Similarly, children at the age of two show the similar pattern where children in the top 10% percentile produced more than 528 words and children in the lower 10% percentile fewer than 66 words (Kelly, 1998).

These large individual differences in productive vocabulary could be explained through extrinsic differences in children's learning environments. For instance, previous research argues that children from higher SES backgrounds acquire language quickly as their language input is richer (Hart & Risley, 2003), with fewer utterances from their caregivers that aim to redirect their behaviour, and more diverse vocabulary (Rowe, 2008). However, variability between children's vocabulary scores could also be explained through children's intrinsic differences. For instance, children show different reactions to their environment from early infancy. One child might have a difficulty to concentrate for a long period of time and might cry even at moderately stimulating play, whereas another child might not be easily distracted, enjoys vigorous play and seek out exciting events, which facilitates learning (Rothbart, 1981, 2007). Individual characteristics regarding both intrinsic and extrinsic individual differences, suggest that children will show different behaviours and will process information differently, which leads to differences in language development (Hilton, Twomey, & Westermann, 2019). Therefore, children's differences in the speed of language development need to be considered in research as children from the same age groups might have large variations between their vocabulary scores.

2.9.2. Temperament and Shyness

Children's temperament is associated with children's language development (Rothbart, 2007), where specifically shyness has been negatively related with children's vocabulary sizes (Paul & Kellogg, 1997; Slomkowski, Nelson, Dunn, & Plomin, 1992), with reduced verbal interaction from children within familiar and novel contexts (Asendorpf & Meier, 1993; Crozier & Badawood, 2009) and discomfort in unfamiliar social contexts (Putnam, Gartstein, & Rothbart, 2006). Interestingly, since shyer children talk less this impacts children's ability to respond (e.g., Smith Watts et al., 2014), which suggests that these children do not necessarily have slower language development, as this assumption might be the result of not demonstrating their actual language skills due to their shyness. Another explanation is the environment, where shyer children show reduced interaction within socially novel settings, which as a result restricts their experience of language compared to less-shy children (e.g., Evans, 1987).

For instance, Hilton and Westermann (2017) examined two-year-old children's performance in a fast-mapping task and also examined their shyness levels. Shyer children showed a reluctance to pick a novel object at the retention trials when they heard the novel label compared to less-shy children who chose an object and showed retention of the object-label mappings. Similarly, Hilton et al. (2019) demonstrated that shyer children's attention to the target objects during labelling was decreased. Children at the age of 20 and 26 months experienced a looking-while-listening task, where familiar and novel objects were presented alongside familiar and novel labels. Children divided their attention between familiar and novel objects when the label heard was novel and sustained attention to the familiar object when they heard its related label. However, shyer children showed reduced attention to the target object in either familiar or novel label conditions. Later, retention showed that children with increased attention to the novel objects were more likely to correctly retain the object-label mappings. Thus, shyer children show less successful retention in these tasks since their attention towards the target object is reduced. Clearly, then, children's temperamental characteristics, and specifically shyness, affect children's language learning and development.

Children's temperamental characteristics also influence their parents' behaviours. Specifically, shyer children tend to prompt overcontrolling and protective reactions from their parents (Coplan, Prakash, O’Neil, & Armer, 2004). This might occur as parents are more prone to perceive their children as more vulnerable (Paulussen-Hoogeboom, Stams, Hermanns, & Peetsma, 2007). Caregivers intervene in their children’s activities more at the first indication of difficulty and distress and prevent their shy children from overcoming the situation alone and use their own coping strategies. This behaviour also prevents children from practising and developing their own coping strategies. For instance, previous studies (Fagot & Gauvain, 1997; Gauvain, 1995) demonstrated that children who showed difficult temperaments received extensive levels of cognitive assistance from their caregivers when solving a cognitive task. Thus, caregivers intervene and did not provide to children the necessary space and time to solve the task alone in order to enhance their problem-solving skills. To illustrate further, Dixon and Hull Smith (2003) examined caregivers’ behaviours in relation to their children’s cognitive and temperamental characteristics. Forty caregiver-child dyads participated in a longitudinal study that collected behavioural data from play sessions at the laboratory and temperamental data from questionnaires between children’s five to 20 months of age. Maternal playing styles were predicted longitudinally through the temperamental characteristics of their children. Specifically, caregivers of children who showed higher negative temperaments appeared to appease children more, to provide higher levels of play and to present a larger selection of toys to their children. The authors argued that caregivers’ effort to maintain their children’s attention to the task and keep the children satisfied prompted these behaviours towards children with difficult temperaments. Overall, caregivers are sensitive towards their children’s temperament characteristics, which influence their behaviours while interacting with their children.

To our knowledge, research about specific temperamental characteristics and their influence on caregivers’ behaviour while playing with their children is fairly limited. Clearly, the previous discussion showed the importance of these characteristics, and particularly shyness, as a characteristic in the structure of children's learning environments and consequently children's learning input. Thus, investigating whether different levels of children's shyness influence caregivers' behaviours while playing with their children is crucial to understand how children's environments are structured and influenced by their caregivers.

2.9.3. Securely and Insecurely Attached Children

In line with temperamental characteristics, attachment also influences maternal behaviours towards children. Children and caregivers form an attachment relationship that has been studied in detail during the last decades. Attachment is understood as the internal working models of a cognitive network that is developed by the children and affects their understanding of their self, others' behaviours and generally the world (Bowlby, 1969). Attachment has been linked to children's exploratory behaviours: children who form secure attachment with their caregivers use their caregivers as a secure base and a source of security and comfort when they explore the world (Donavan et al., 2007). Similarly, securely attached children tend to follow their caregivers' requests more (Van de Mark, Bakermans-Kranenburg, & Van Ijzendoorn, 2002), show more willingness to cooperate (Grusec & Goodnow, 1994) and show higher levels of self-recognition (Schneider-Rosen & Cicchetti, 1984) in comparison to less securely attached children. Conversely, children with insecure attachment with their caregivers show less positive involvement in problem-solving tasks (Ainsworth, Blehar, Waters, & Wall, 1978). In sum, children's experiences during play are influenced by the attachment level with their caregivers. Therefore, examining attachment levels during joint play could provide information about how children's environments are structured differently by their caregivers and consequently understand how this special relationship influences children's experiences.

Overall, children's characteristics provide further understanding as to why children behave or learn in certain ways and speeds. In this thesis I aimed to accommodate vocabulary, shyness and attachment as children's individual characteristics. Investigating these would provide more information about children's learning and about how children's social partners' behaviours change in relation to these characteristics.

2.10. Thesis Aims

The current thesis examines how the triad of children, objects and social partners, affect children's experiences and learning input. The previous review demonstrated that children's self-generated environment is important for their later development (e.g., Pereira et al., 2014; Yu et al., 2007) as well as important is the environment that their social partners develop for them during joint play (e.g., Danis, 1997; Suarez-Rivera et al., 2019; Wass et al., 2018). Therefore, the current thesis aims to provide information about how the interactions between the features of this triad shape children's experiences and how each feature affects the other features within the triad. In order to achieve this, the experiments within this thesis investigate different combinations of these features with several manipulations. Examining this triad in relatively unconstrained settings provides meaningful information in relation to how children's environments and learning are structured in their everyday environments.

The first experiment (Chapter 3) investigates children's experiences from their own perspective when they play with novel objects while the social partner (the experimenter) is actively involved or not actively involved in objects' manipulation. Labels have been found (Baldwin & Markman, 1989) to increase children's attention towards the objects, however this has not been studied through children's own perspective (to the author's knowledge). Therefore, Chapter 3 examines whether the presence or absence of labels and handling the novel objects by children or exploring the objects from a distance while the experimenter handles them, affect children's looking times and novel label retention.

In the second experiment (Chapter 4) the focus shifts towards the caregiver and particularly mothers. Usually the caregivers that children spend a lot of their playing and learning time with are their parents, and especially their mothers. Thus, instead of including a strange person, the mother of each child took part as their social partner. Previous research suggests that caregivers' and particularly mothers' behaviours are affected by object novelty (Danis, 1997) but whether this occurs with mothers' characteristics of IDS is currently unknown. Similarly, we know that children's developmental changes affect the characteristics of IDS (e.g., Fernald et al., 1989; Stern et al., 1983), but whether this appears with object novelty has not been examined. Therefore, Chapter 4 investigated whether object novelty and children's developmental stages, that is; before and after the onset of speech influence caregivers' behaviours and IDS during joint play events. Children's vocabulary abilities and caregivers' educational level are also examined in relation to caregivers' characteristics of IDS and behaviours.

In the third experiment (Chapter 5) caregivers (specifically mothers), children and objects are all included. Recent research suggests that children might prefer intermediate novelty/complexity when learning new information (e.g., Kidd et al., 2012, 2014), but whether caregivers generate environments of new information with this level of complexity for their children has not been examined. Since caregivers are sensitive towards their children's behaviours and abilities (e.g., Donovan et al., 2007) it can be expected that they might show similar behaviours as those behaviours of children. Thus, Chapter 5 examines whether caregivers structure their children's learning environment systematically, and if they do, whether caregivers structure this environment in relation to their children's behaviour. To investigate a possible systematicity in complexity, caregivers are provided with sequences of novel objects: within each sequence the systematic differences between objects are controlled. Caregivers have to choose successive exemplars to play with their two-year-old children creating learning sequences. Children's preferences as to which object they prefer to play with are measured using longer looking times with head-mounted eye-tracking. Attachment and temperament (regarding shyness) questionnaires are collected to examine whether individual differences of children affect caregivers' behaviours within these settings.

Overall, we know that children structure their learning experiences either alone or with social partners while playing with objects. However, we do not know in detail how environmental features such as object novelty, handling or non-handling of the objects and individual characteristics of children and social partners can affect social partners' behaviours while playing with children, and in turn influence children's experiences and learning. The current research aims to shed light on how children's experiences are structured in relatively unconstrained settings closer to children's everyday experiences including objects and social partners, while forming a triad which is present in children's everyday experiences. Understanding the relationship between the features of this triad and how they affect each other will provide further knowledge about children's cognitive development in their early years through their everyday interactions.

Chapter 3: The Effect of Labelling and Object Handling on Children's Novel Object Exploration.

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Abstract

The way in which children explore objects in a dynamically complex everyday environment has been little studied. Here we investigated how children's object exploration is affected by the presence or absence of labels, when children handled the objects and when the objects were only handled by their social partner. This study used head-mounted eye-tracking to investigate how children at 24 months ($N = 24$) interact with objects. Children were assigned to a *handling condition,* in which they were allowed to interact with objects for 30 s each*,* and to a *no handling condition*, in which only the experimenter handled the objects for 30 s. Within each of these groups half of the novel objects were *labelled* with novel labels, and half were *non-labelled*. Afterwards children's retention of object-label mappings was tested. Children looked longer at the objects in the no handling condition compared to the handling condition. Looking times to labelled and non-labelled objects did not differ in either condition. Children also looked longer at the experimenter's face during the handling compared to the no handling condition, whereas labelling did not have an effect. In the no handling condition, lower productive vocabulary predicted longer looking times at the experimenter's face and more eye-gaze switches during play. In the no handling condition fewer eye-gaze switches and lower productive vocabulary predicted better retention of the novel words. This research helps to enhance our understanding of early cognition by demonstrating how different environmental settings can influence children's interaction with objects and its relationship to word learning. Looking longer at the objects that children were not allowed to handle might be a way of communicating to their social partner their desire to handle the objects; a desire that may be driven by the social partner's actions. Overall this work highlights the importance of the social partner in children's learning environment.

Keywords: naturalistic learning, word learning, object exploration

The Effect of Labelling and Object Handling on Children's Novel Object Exploration.

3.1. Introduction

Children from a very young age learn from their surroundings and collect information during their everyday activities (Yu, Smith, Christensen, & Pereira, 2007). During early development, children learn to control their eye-gaze to sample their learning environment. Eye-gaze offers an important window into children's learning processes before language begins (Gredebäck, Johnson, & von Hofsten, 2010). The everyday visual world offers many potential opportunities to explore a complex environment, where children as active learners structure their own development and learning through their own activities (Smith, Yu, & Pereira, 2011), driven by their curiosity (Twomey & Westermann, 2018). They are intrinsically motivated to learn and do so autonomously and often without feedback (Mather, 2013). This self-generated learning environment is profoundly different from an adult's learning environment: the child's body size, interests and activities are different from those of an adult and they influence what children experience (Smith et al., 2011). For example, children have shorter arms than adults which affects the information in children's visual field as the objects they hold are closer to their face due to their arm's length and consequently affects their available learning input (Pereira, Smith, & Yu, 2014). The self-generated learning environment constitutes a critical input for children's early learning and offers a window into the understanding of children's development, learning (Kretch, Franchak, & Adolph, 2014) and children's curiosity-based exploration (Twomey & Westermann, 2018).

3.1.1. The Learning Environment Constructed by The Child

Developmental psychologists have long been interested in the nature of the child's input in the everyday environment, the experiences that characterize early childhood, and the role of those experiences in children's cognitive development. Traditionally, researchers have studied this learner-environment interaction from the perspective of an outside observer, for example using video taken from a third-person camera. These studies offer valuable insight into children's exploration. For example, Meltzoff and Moore (1989) explored the underlying mechanisms that influence young infants to imitate the facial actions of their social partners during play. Children imitated their social partners face not only through oral movements, but through an active cross-modal matching process. However, the third person perspective provides a broad and fixed view that is very different from young children's view. For instance, during play children move around which results in a dynamic visual view with different experiences and opportunities for learning (Yoshida & Smith, 2008). In real world interactions, what children observe depends critically on their own actions, as these actions carry information in and out of their visual field. Therefore, the third person perspective leads to explanations of children's everyday learning environment that are centered on adults' perception of the structure of the children's experiences and not on the children's actual experiences (Yu, Smith, Shen, Pereira, & Smith, 2009). Since what children experience while learning new information is different from what their social partner is experiencing, then, to understand children's learning it is important to take children's perspective into account.

Recent developments in eye-tracking and video technology have allowed us to do this, by gathering first-person data from children while they play with objects and interact with social partners. Such studies have begun to offer important insight into the input of children's early learning. For example, Yu et al. (2007) in a study with 18- to 20-month-old children with their parent as social partner, demonstrated that the parent's visual scene was dramatically different from the children's view. Children's views as seen from head cameras revealed head-centered views during active play that were much more dynamic compared to adult views, with individual objects rapidly coming in and out of their visual fields. Additionally, Smith et al., (2011) found similar results with children between 17 and 19 months of age, again with their parent as the social partner. The child and the parent sat opposite each other at a table and played with novel toys. The goal of this study was to describe children's visual information selection in a context closer to their home environment than the laboratory environment. That is, interacting with a social partner and with objects. For this study a lightweight video camera was placed on both the parent's and the child's head. While adults' visual fields included numerous objects, children's visual fields consisted largely of a single object held near to their face, obscuring other objects and thereby blocking the view of possible competitors. Objects tended to go in and out of the child's visual field frequently, creating a continuous stream of new visual information, whereas the adult view was broader and more stable. Thus, the different developmental factors between children and adults, such as the small distance between the eyes and the hands of children due to their short arms create visual experiences for children that are highly different from adults' visual experiences in the same situation. Children's visual experiences influence the way they learn about new objects and their properties, as this is how they experience the world in their everyday life. These studies show that children are able to construct their own learning environment through natural exploration and social interaction.

3.1.2. Learning New Words and Eye-gaze Switching

Since the learning environment of children includes many potential referents for a word they hear, the meaning of new words is initially uncertain. Previous research has shown that children from the age of 15 months map novel labels to novel referents (e.g., Houston-Price, Plunkett, & Harris, 2005). Children's ability to link a novel word to an object is known as *fast mapping* (Carey, 1978; Carey & Bartlett, 1978). One potentially informative referential cue for object-word mapping is gaze direction. Children begin to switch their attention between their social partner and an object from the age of six months (Baldwin et al., 1996). When a social partner shows an object to the child, the child switches his/her eye-gaze from the social partner's face to the object when this object is present in the child's visual field (Baldwin et al., 1996). This ability to use joint visual attention, that is when a child and an adult attend at the same object, may contribute to the onset of lexical development (Byers-Heinlein, & Werker, 2009). Specifically, it has been suggested that if children shift their eye-gaze between their social partner's eye-gaze during labelling to the target object, this may assist in learning new word-object associations as joint visual attention would be established through these eye-gaze switches between the child, the object and the social partner (Baldwin, 1993). Conversely, if children fail to make such eye-gaze switches they might be more likely to make mistakes in word-object mappings as the lack of these eye-gaze switches prevents the formation of joint visual attention with their social partner (Vaish, Demir, & Baldwin, 2011).

Previous studies by Baldwin (1991, 1993) examined what types of information children use to guide their inferences about word meanings and mappings. In these studies, 18- to 19-month-old children were given novel objects. There were two conditions: follow-in labelling and discrepant labelling. In both conditions the child played with one toy while the other was hidden in a bucket. In follow-in labelling, the experimenter labelled the object the child was holding, when the child was looking at it. In the discrepant labelling condition, the experimenter labelled the hidden toy and did not look at the child. The children were switching their eye-gaze between the experimenter's gaze direction and face and between the object the children held, regardless of whether follow-in versus discrepant labelling occurred. During the retention trials, children selected the object that the experimenter looked at during labelling and not the object they were able to look and hold. Some children avoided selecting an object to avoid wrong object-label mappings.

Similarly, Gogate, Bolzani, and Betancourt (2006) examined successful object-label mappings for six-to-eight-month-old children in relation to temporal synchrony between moving objects and spoken words and children's attention to object labelling. The children learned two novel words from their caregivers and their retention of the object-label mappings was tested. Caregivers' temporal synchrony and children's attention while playing was associated with successful object-label associations. Specifically, more eye-gaze switching by children between the objects and their caregivers' face during labelling events predicted more successful mappings (see also Matatyaho & Gogate, 2008). Therefore, children's ability to perform eye-gaze switches between objects and their social partner's face while the object's label is uttered facilitates the formation of successful joint attention between the children and the social partners and in turn the learning of object-label mappings.

Further, Oakes and Ribar (2005) suggested that eye-gaze switching between different stimuli prompts the successful formation of categories. Children between the age of four-to-six-months came across stimuli from categories of cats and dogs between two conditions; that is; children either saw two pictures at a time or one picture. Children who saw two pictures showed more successful formation of categories compared to children who only saw one picture. The authors suggested that when two pictures were available, children performed eye-gaze switching between the pictures which facilitated comparison and the learning of categories. Therefore, eye-gaze switching to compare stimuli also facilitates the formation of categories from a young age. Clearly then, children's ability to perform eye-gaze switching between their social partners' eye-gaze and face to form successful joint attention and eye-gaze switching between stimuli enhances the learning of object-label mappings and categories and consequently the development of language. Exploring whether eye-gaze switching of children between their social partner's face and other areas of interest, (such as social partner's hands that have been found to be in children's visual fields for a significant amount of time during joint attention; Yu & Smith, 2013), could be affected by different environmental features and in turn affect the learning of novel object-label mappings would provide further information about children's learning.

3.1.3. Labels: Presence, Absence and Use

The learning of correct object-label mappings is important for the development of children's language, therefore the presence of labels in children's everyday interactions is crucial. Looking time studies have demonstrated that the presence of a label can direct 12-month-old children's attention to commonalities between category exemplars (Althaus & Plunkett, 2015), and that labels can guide children during their first year of life to form categories (Althaus & Westermann, 2016). For example, Baldwin and Markman (1989) examined how children form object-label mappings by exploring children's looking times towards novel objects when labelling was present or absent. In the first study, 10-to-14-month-old children handled objects that were paired with labelling phrases and objects without labelling phrases. Children looked at and handled the labelled objects for longer, which suggested that labelling increased children's attention. In the second study labelling objects was examined as a predictor for children's enhanced attention alongside pointing compared to pointing without labelling. Children of 10-to-14-months and 17-to-20-months of age saw pairs of novel objects within each condition. During the training session, children looked at the objects when pointing was performed the same amount of time regardless of whether the objects were labelled or not. Subsequently, children saw the objects without any labelling or pointing and looked longer at the previously labelled objects. This suggests that children look longer at labelled objects even after labelling occurred. Therefore, the use of labels increases children's attention to objects compared to non-labelled objects.

Other studies have investigated the effect of providing object labels during children's exploration of those objects. Pereira et al. (2014) examined how the toddler's general visual scene facilitates learning of novel object-label associations. The authors used head cameras to record the first-person views of 12 children between 16 and 25 months as they played with several novel objects with their parent. The parent was asked to name these novel objects with specific novel words in a naturalistic way throughout the session. Then, children's object-word associations were tested by presenting the novel objects on a tray in groups of three and asking the toddler to point to each one in turn (e.g., "Can you show me the ____?"). Children were more likely to learn the names of objects that had been centered, visually larger and blocked all other novel competitor objects that were present on the table during training. This finding suggests that the factors that can enhance word learning are children's interest and activity with the objects, labelling the objects at the right time, when the labelled object was stable in children's visual field and when visual competition between that object and the other objects was minimised.

Clearly, then, active interaction with objects enhances label learning, irrespective of whether children play alone or with their social partner, and the presence of labels facilitates more sustained attention towards the objects by the children. Holding and playing with objects creates a highly different visual experience for children compared to adults' visual experiences. Therefore, understanding in more detail the processes that help children to link words with objects will offer important insight into cognitive development. There is a growing literature exploring children's learning experiences through the children's view. However, how children's looking behaviours from their own view change towards novel objects when the objects are labelled or non-labelled and whether there is a difference in their looking behaviour when a child is handling an object or examining it from a distance has not been explored in detail. In the current study we address this gap by exploring the effect of object handling and labelling on children's looking behaviours and label retention.

3.1.4. Current Study

The current study examined how two-year-old children visually explore novel objects using head-mounted eye-tracking. We explored how object handling affected children's looking behaviours. Specifically, half of the children were given novel objects to play with, and half were shown the same objects by an experimenter. Within each condition half of the objects were labelled with novel labels and half were non-labelled to further explore whether labelling affected children's looking behaviours. After a play phase and a five-minute break, children were tested for label retention. We expected that labelling an object would increase looking times to the object compared to the non-labelled objects. We also expected that children would show different looking times towards the objects when they handled the objects compared to when the objects were handled by the experimenter. We also explored whether labelling or non-labelling of objects and children's productive vocabulary predicted looking times to the objects, looking times to the experimenter's face and the number of eye-gaze switches when the objects were handled by the children or by the experimenter. If active play and handling of an object can create the optimal time to learn a label, then children should be more likely to learn novel labels during the handling condition. We also considered eye-gaze switches as a factor for successful retention.

3.2. Methods

Participants

Participants were 24 monolingual English-learning, typically developing two-year-old children (13 females, *M* = 729.71 days, *SD* = 9.39 days, range = 718 – 755 days). Half the children were assigned randomly to the *handling* condition, and half to the *no handling* condition. Parents were asked to complete a language questionnaire to evaluate their child's productive vocabulary (UK-CDI; Alcock, Meints, & Rowland, 2018). Based on research demonstrating that children's vocabulary level correlates with their learning ability (Hills, Maouene, Riordan, & Smith, 2010; Werker, Fennell, Corcoran, & Stager, 2002), vocabulary data were collected to test whether children's language level affected their learning in the labelling condition.

Participant age and productive vocabulary did not differ between conditions (age: $t(22) = .89$, $p = .39$; handling: *M* = 731.42 days, *SD* = 10.08 days, range = 720 – 755 days; no handling: *M* = 728 days, *SD* = 8.75 days, range = 718 - 744 days; productive vocabulary: $t(22) = 1.40$, $p = .18$; handling: *M* = 275.42 words, *SD* = 78.60 words, range = 134 - 364 words; no handling: *M* = 226.75 words, *SD* = 91.57 words, range = 121 – 379 words). Data from an additional 41 children were excluded because of refusal to wear the headgear (21), poor calibration (13; the linear fit of 15 calibration looking points had to be greater than $r = .75$) and experimenter/equipment error (7).

Stimuli

Stimuli consisted of six 3D novel objects (two red, two green and two blue; approximately 9.5 x 6.5 x 5 cm) with unique shapes and salient features (see Figure 3.1.). Three novel labels (*mapoo*, *habble*, *zeebee*) were used to label the novel objects during the experiment. These labels were chosen based on a previous study as plausible non-words for English-learning children (Pereira et al., 2014).

Figure 3.1. 3D Stimuli

Head-Mounted Eye-Tracker

To record children's visual field and eye-gaze during the experiment, children wore a lightweight head-mounted eye tracker (Positive Science) with two miniature cameras to record both the movements of the child's right eye and the child's view of the world (field of view: 54.4 degrees horizontal and 42.2 degrees vertical; http://www.positivescience.com/hardware/). Both cameras were mounted on a padded, flexible band that was placed slightly above the eyebrows of the child. The headgear was attached to a flexible spandex hat with velcro tabs, which secured the headgear when infants were moving. Software (PSLive Capture**,** 1.8.3) tracked both the pupil and the corneal reflection simultaneously.

Procedure and Design

Children were seated on a highchair in front of a small table (61cm x 91cm x 64 cm) opposite the experimenter and next to their parent. The experimenter sat on a low chair such that her eyes were at approximately the same level from the table top as those of the children. The experimenter wore white clothes and the table was white to minimize the chance of shadows which could interfere with video analysis (see Pereira et al., 2014).

Before the experiment began, the parent distracted the child with toys while the experimenter placed the headgear on the child's forehead (see Yu & Smith, 2013). Then, calibration points were taken by directing the child's attention to an attractive toy that was moved to different locations on the table. At least 15 calibration points were collected. These calibration points were used after the session to calibrate eye-gaze with the head camera images (see Franchak, Kretch, Soska, Babcock, & Adolph, 2010). A third-person camera recorded the entire procedure for offline retention coding.

During the play session each child saw three objects that were labelled (*mapoo*, *habble*, *zeebee*) and three objects that were non-labelled. Trial order was pseudo-randomized with the constraint that label and no-label trials alternated. For half of the children the first trial was labelled and for the other half it was non-labelled. Each labelled object was labelled multiple times (12) in line with previous research (e.g., Axelsson, Churchley, & Horst, 2012).

Conditions. Children were randomly assigned to one of two conditions. In both conditions the experimenter presented the child with one novel object per trial. In the *handling condition* the experimenter allowed the child to play with the object. In the *no handling condition* the experimenter held the object and presented it to the child at a distance of approximately 15cm without allowing any handling. The experimenter, when holding the object, tried to keep the object in child's visual field as consistently as possible. Within each condition half of the objects were *labelled*, and the other half were *non-labelled*. During a label trial the experimenter used sentences such as "Look, it's a ___!", "This is a __!". The child heard each label 12 times. In the no-label condition the experimenter did not use a specific name for the object and only used sentences such as "Look at this!", "Do you like it?". To keep the child engaged with the procedure the experimenter continued talking about the object in both label and non-label trials. Each play phase lasted 3 minutes (30 seconds per trial). The beginning and end points for each trial were recorded using a timer.

Between the play phase and the test phase there was a five-minute break to ensure that any recall was based on novel object-label associations learned during the play phase, rather than on immediate short-term memory recall (see Horst & Samuelson, 2008).

Testing for retention. After the five-minute break, the experimenter tested whether children had retained object-label mappings formed during the labelling condition. Each retention trial consisted of the three objects that were seen during the labelling trials. The labelled objects were placed horizontally on a tray (44 cm wide) with the same distance between the objects and left-right positioning pseudo-randomised. The experimenter kept the tray away from the child, looking only at the child's eyes and never at the objects to avoid biasing responses (see Horst & Samuelson, 2008). The researcher used phrases such as "Show me the ___!" or "Get the ___!" (see Pereira et al., 2014) to encourage the child to choose one of the objects on the tray. The child heard the label of the object twice. Then the researcher moved the tray towards the child to allow the selection of an object. No feedback was given; instead, when the child pointed to or showed the experimenter the chosen object, the experimenter said "Thank you" in a neutral voice. All objects were tested twice, with the second test trial for each object occurring after all objects had been tested once. Distractors on each trial were selected randomly from other objects from the same labelling condition. Between test trials, the experimenter changed the objects on the tray out of the child's view, by placing the tray on her lap under the table (Horst & Samuelson, 2008). Each trial included one red, one green and one blue object. The location of the target object was pseudorandom across trials for all children, to ensure that children were mapping labels to objects rather than locations.

Coding

Eye-tracking data. Videos from the head camera and the eye-tracking camera were analysed using the software packages Yarbus (2.2.9) and GazeTag (0.940). This software maps a person's eye position (eye-tracking camera) to a reference scene video (head-camera) using simple calibration and image processing. This eye-gaze analysis shows precisely where children look when examining an object, both when it is shown to them and when they hold the object, by using fixation-by-fixation segments (100 milliseconds per fixation). The fixation segments are defined as the time intervals between successive saccades and a fixation segment is composed of several scene frames (approx. 30 frames/second). For each trial the raw looking times to the object, the experimenter's face, experimenter's hands, the parent's face, parent's hands and the child's hands were coded. Next, the proportion of looking time for the total trial length (90 s) regarding labelling conditions for each of these areas of interest was calculated.

Retention data. A human coder scored the video recording from the third person camera for the novel label retention task. A second coder, naive to the experimental hypothesis, scored a subset of the videos (20%). Coders' level of agreement was tested for reliability and validity. Interrater reliability was high (k = 0.89, 91.67%). Children who responded correctly on both test trials for a specific object were assigned a score of 2; those who responded correctly on only one test trial were assigned a score of 1, and those with no correct responses were assigned a score 0. The scores for each participant were added and divided by the number of the retention test trials

(6) to produce proportion correct retention scores for each participant; the chance to choose the correct object was .33.

Vocabulary data. Children's productive vocabularies were calculated using the UK-CDI by counting the words that the parents reported their child as being able to both produce and understand.

3.3. Results

Where Do Children Look in The Handling Condition?

During handling of labelled objects (see Figure 3.2.) all children distributed their looking between the novel objects (*M*= .34 *SD*= .11), the experimenters' face (*M*= .13, *SD*= .10) and the experimenter's hands (*M*= .06, *SD*= .02). Additionally, three children looked at their parent's face (*M*= .002, *SD*= .01), three at their parent's hands (*M*= .001, *SD*= .002) and five at their own hands (*M*= .003, *SD*= .01).

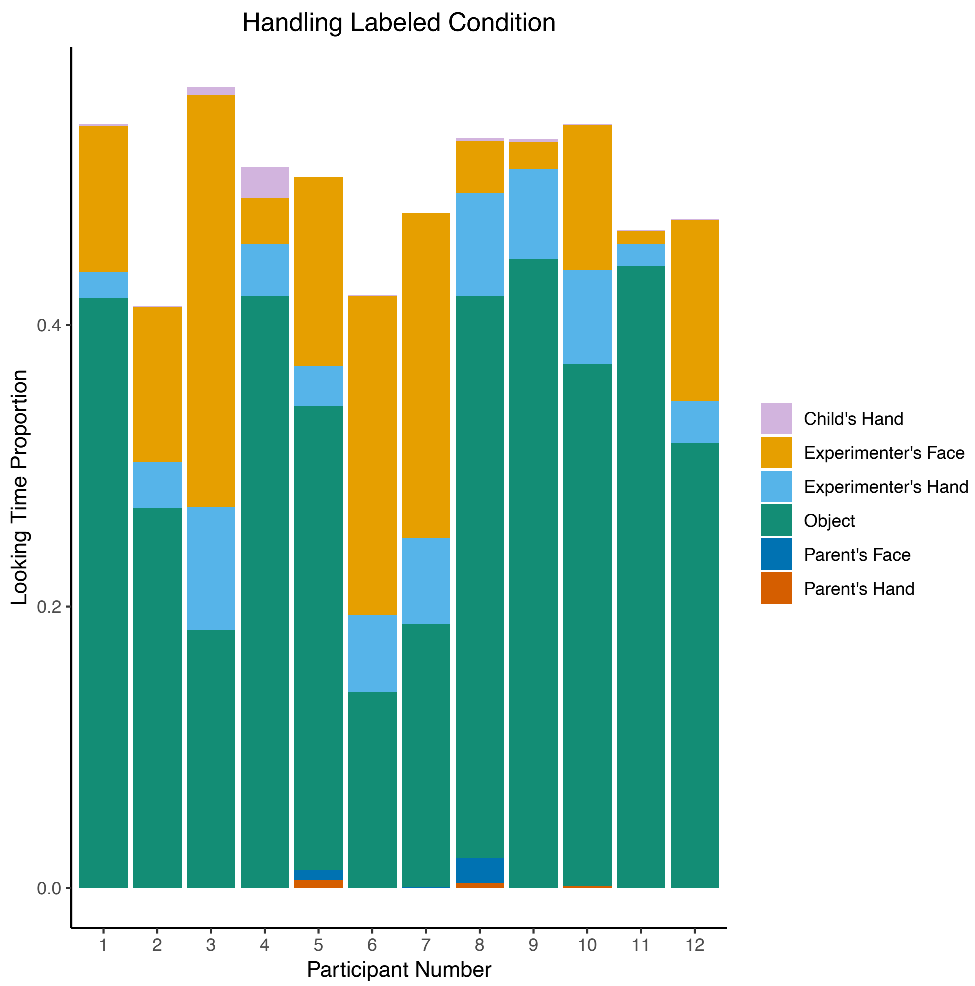

Figure 3.2. Looking times for individual participants during handling condition with labelled objects.

During handling of non-labelled objects (see Figure 3.3.), all children looked at the objects (*M*= .27, *SD*= .12), at the experimenters' face (*M*= .19, *SD*= .14) and experimenter's hands (*M*= .03, *SD*= .02). Six children looked at their parent's face (*M*= .004, *SD*= .01), three at their parent's hands (*M*= .002, *SD*= .001) and four at their own hands (*M*= .004, *SD*= .01). Figures 3.2. and 3.3. indicate substantial individual differences between participants looking behaviours.

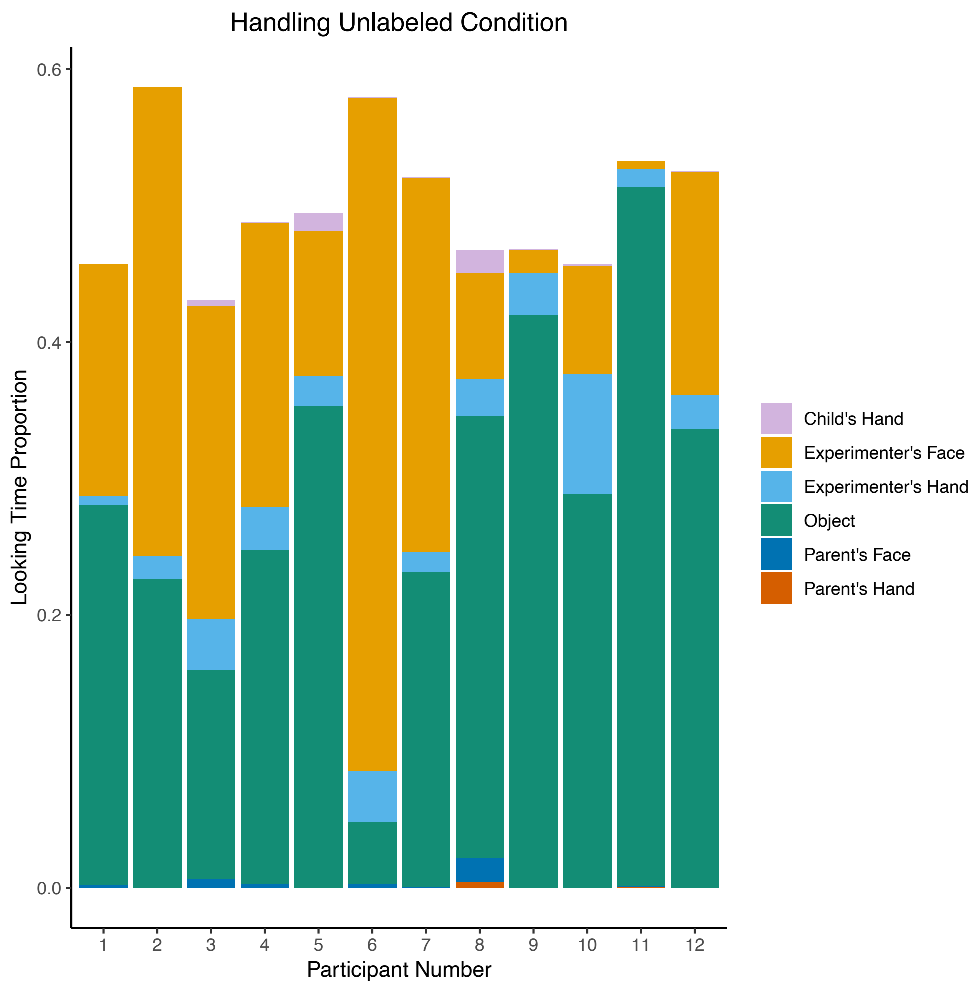

Figure 3.3. Looking times for individual participants during handling condition with non-labelled objects.

Where Do Children Look in The No Handling Condition?

When objects were labelled (see Figure 3.4.), all children looked at the novel objects (*M*= .40, *SD*= .07), and at the experimenters' face (*M*= .08, *SD*= .05) and experimenter's hands (*M*= .05, *SD*= .04). Eight children looked at their parent's face (*M*= .004, *SD*= .004), one at their parent's hands for just .0001 and two at their own hands (*M*= .002, *SD*= .002).

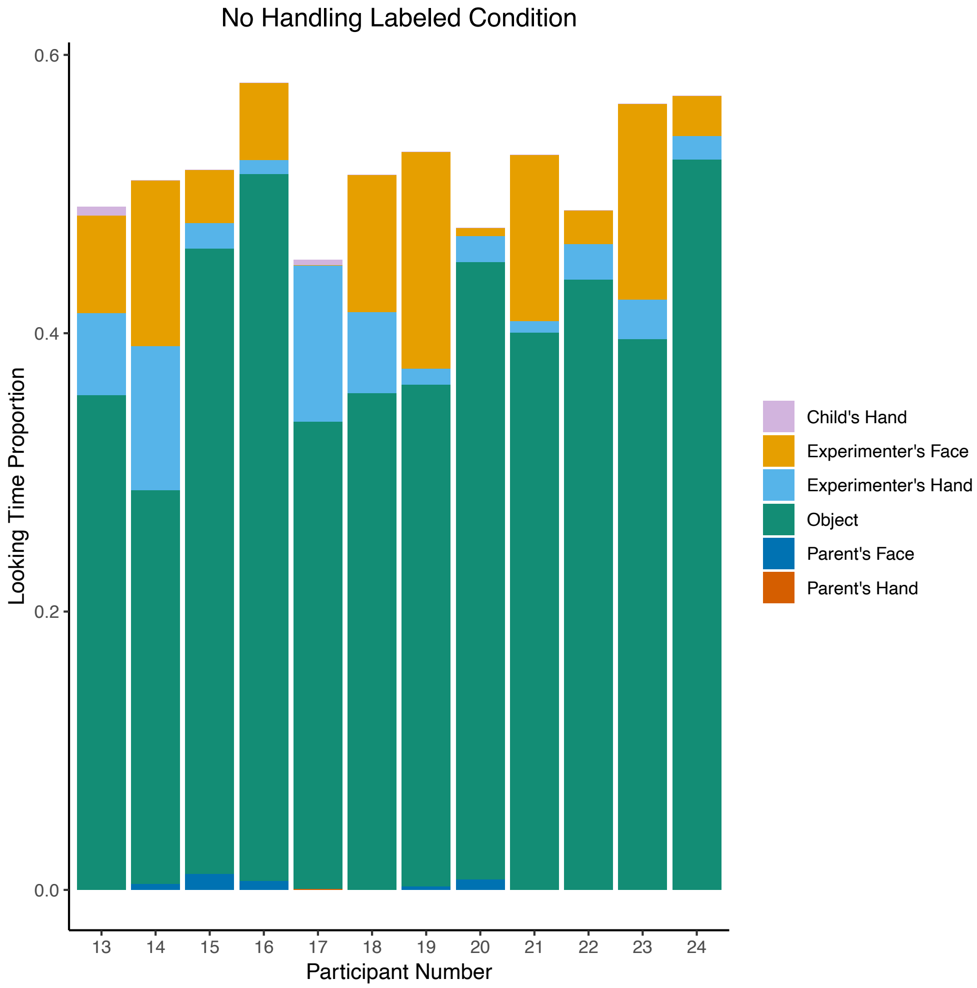

Figure 3.4. Looking times for individual participants during no handling condition with labelled objects.

When objects were non-labelled (see Figure 3.5.) all children looked at the novel objects (*M*= .39, *SD*= .08), the experimenter's face (*M*= .08, *SD*= .05) and the experimenter's hands (*M*= .04, *SD*= 3.23). None looked at their parent's face or hands and only one at his/her own hands for .0004. Again, Figures 3.4. and 3.5. indicate substantial individual differences between participants.

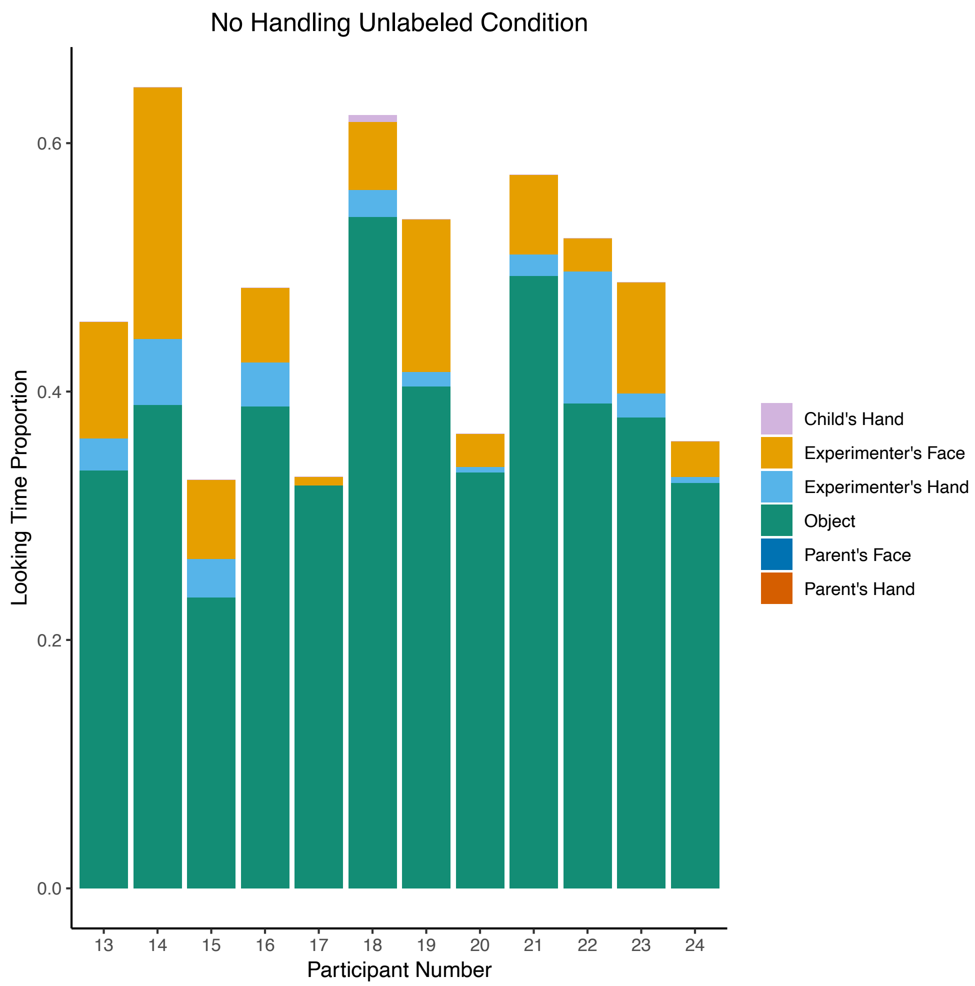

Figure 3.5. Looking times for individual participants during no handling condition with non-labelled objects.

Looking Time Between Conditions

Objects. To test whether overall children's looking behaviour at the objects differed between conditions, proportion looking times per trial were submitted to a 2 x 2 mixed ANOVA, with handling (handling, no handling) as a between-subjects factor and labelling (label, no label) as a within-subjects factor. A main effect of handling (F(1,22) = 6.17, p = .02, η^2 = .22) confirmed that looking times were greater in the no handling condition (M= .79, SD= .11) than in the handling condition (M= .61, SD= .22). However, there was no effect of labelling (F(1,22) = 3.14, p = .09, η^2 = .13), where looking times did not differ for labelled (M= .37, SD= .10) and non-labelled (*M*= .33, *SD*= .11) objects. Finally, we found no interaction between handling and labelling ($F(1,22) = .37$, $p = .55$, $\eta^2 = .02$).

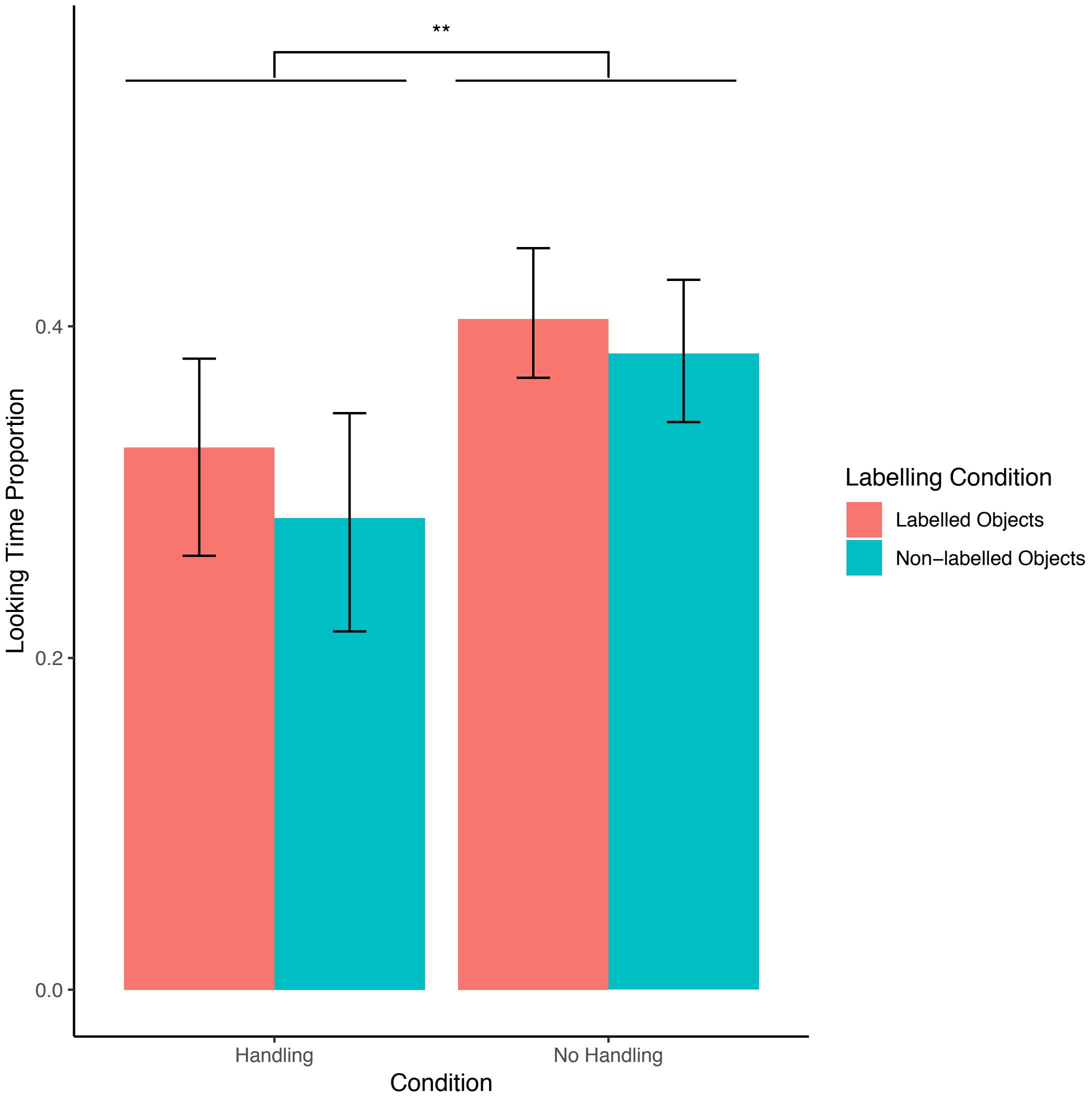

Figure 3.6. Looking times at the objects between the two conditions (handling, no handling) and within labelling conditions (labelled, non-labelled). Error bars represent +/- 2 standard errors.

Experimenter's face. From the descriptive graphs (Figures 3.2 to 3.5) the looking times to the experimenter's face suggest that there is some variation. Therefore, to test whether children's looking behaviour at the experimenter's face differed between conditions, proportion looking times per trial were submitted to a 2 x 2 mixed ANOVA, with handling (handling, no handling) as a between-subjects factor and labelling (label, no label) as a within-subjects factor. A main effect of handling (F(1,22) = 5.48, p = .029, η^2 = 20.) showed that looking times were greater in the handling condition (M= .15, SD= .12) than in the no handling condition (M= .07, SD= .05). There was no effect of labelling (F(1,22) = 3.38, p = .08, η^2 = .13), as looking times did not differ for labelled (M= .19, SD= 16.) and non-labelled (M= .25, SD= .21) objects. Finally, we found no interaction between handling and labelling (F(1,22) = .66, p = .07, η^2 = .14).

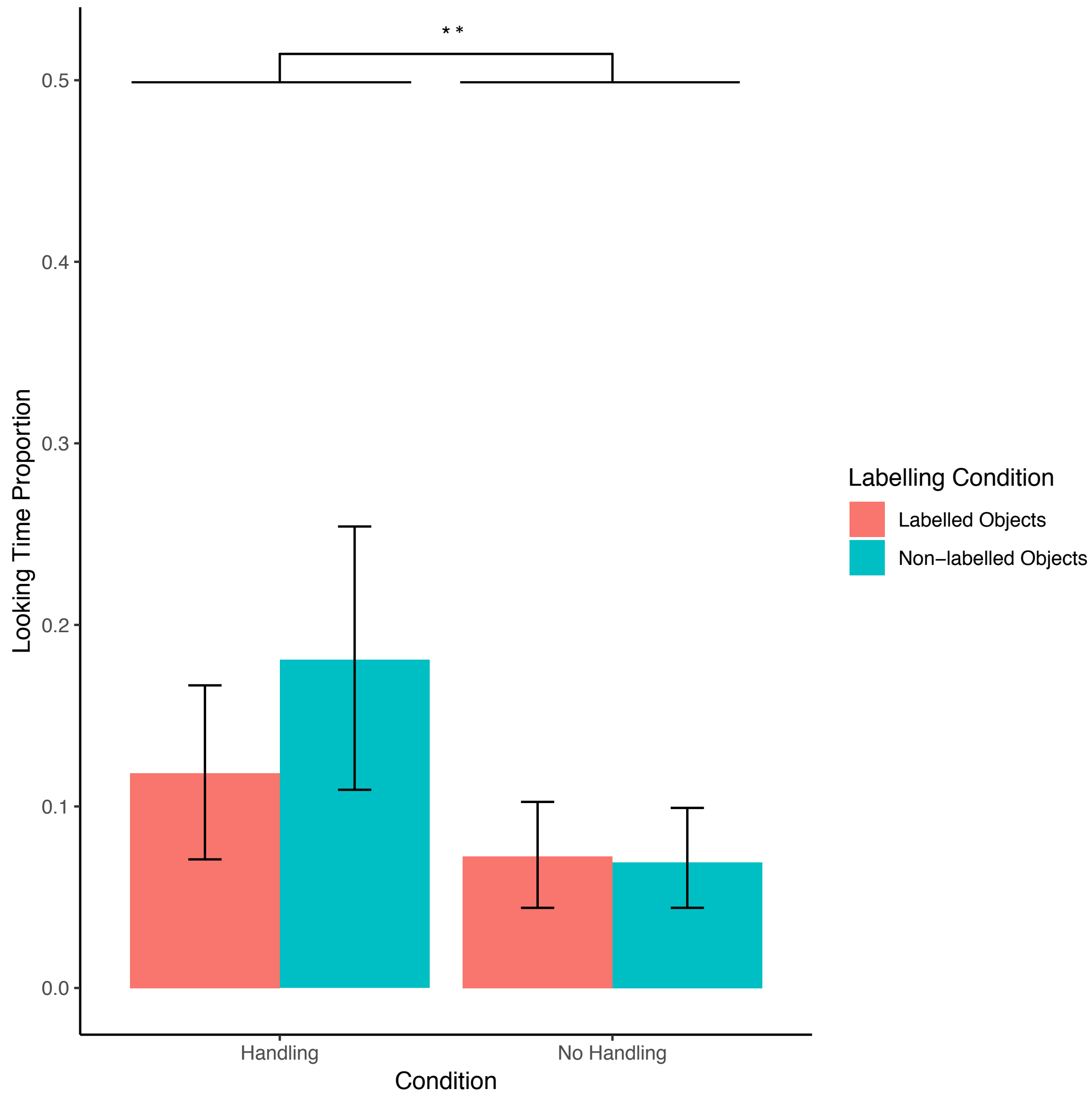

Figure 3.7. Looking times at the experimenter's face between the two conditions (handling, no handling) and within labelling conditions (labelled, non-labelled). Error bars represent +/- 2 standard errors.

Exploratory Analysis

Previous research suggested that children look longer at labelled objects (e.g., Baldwin & Markman, 1989), look at their social partner's face to gather information in a task (e.g., Gogate et al., 2006) and perform more eye-gaze switches (e.g., Matatyaho & Gogate, 2008) when objects have a label; however whether individual differences like vocabulary score predict these have not been tested before. Regression analyses were used to examine whether proportion looking time at the objects and at the experimenter's face, as well as eye-gaze switches between the objects and other areas of interest (e.g. experimenter's face; handling condition: labelled objects: $M = 19$, $SD = 10.56$, range = 15 - 46 switches; non-labelled objects: $M = 32.67$, $SD = 11.01$, range = 17 - 58 switches; no handling condition: labelled objects: $M = 25.83$, $SD = 11.98$, range = 9 - 53 switches, non-labelled objects: $M = 26.17$, $SD = 12.23$, range = 7 – 45 switches) could be predicted by productive vocabulary scores and object labelling condition (labelled = 1, non-labelled = -1). All variables were examined for meeting regression assumptions and variable transformations took place were necessary. Since switches and vocabulary do not have negative scores and their distributions were positively skewed, the square root transformation was used to transform the data to normal. All variables within regression equations with switches and/or vocabulary were also transformed using root square transformation.

Handling condition. To explore whether looking times to the objects were affected by participants' productive vocabulary in addition to labelling condition, proportion object looking times were submitted to a multiple linear regression with labelling condition and productive vocabulary scores as predictors. The model explained 6.9% of variance in looking times at the objects, and did not reach significance ($F(2, 21) = .78$, $p = .47$), suggesting that looking times at the objects were not predicted by these variables. Neither labelling condition ($\beta = .02$; $t(23) = .90$, $p = .38$) nor productive vocabulary ($\beta = -.001$; $t(23) = -.87$, $p = .40$) predicted looking time.

Next, we examined whether looking times to the experimenter's face were affected by participants' productive vocabulary in addition to labelling condition. Proportion looking times to the experimenter's face were submitted to a multiple linear regression with labelling condition and productive vocabulary scores as predictors. The model explained 9.4% of variance in looking times to the experimenter's face, and did not reach significance ($F(2, 21) = 1.09$, $p = .36$), suggesting that looking times at the experimenter's face were not predicted by these variables. Neither labelling condition ($\beta = -.03$; $t(23) = -1.26$, $p = .22$) nor productive vocabulary ($\beta = .001$; $t(23) = .77$, $p = .45$) predicted looking time.

Finally, we explored whether the number of eye-gaze switches between the different areas of interest were affected by participants' productive vocabulary in addition to labelling condition. Total number of switches was submitted to a multiple linear regression with labelling condition and productive vocabulary scores as predictors. The model explained 16.6% of variance in looking times, and did not reach significance ($F(2, 21) = 2.10$, $p = .15$), suggesting that eye-gaze switches were not predicted by these factors. Labelling condition ($\beta = 2.77$; $t(23) = 1.30$, $p = .21$) and productive vocabulary ($\beta = -.05$; $t(23) = -1.59$, $p = .13$) did not predict the number of eye-gaze switches.

No handling condition. To explore whether looking times to the objects were affected by participants' productive vocabulary in addition to labelling condition, proportion of looking times at the objects was submitted to a multiple linear regression with labelling condition and productive vocabulary scores as predictors. The model explained 8.73% of variance in looking times, and did not reach significance ($F(2, 21) = 1.00$, $p = .37$), suggesting that looking times at the objects were not predicted by these variables. Neither labelling condition ($\beta = .01$; $t(23) = .18$, $p = .86$) nor productive vocabulary ($\beta = .001$; $t(23) = -1.40$, $p = .18$) predicted looking time.

Next, we explored whether looking times to the experimenter's face were affected by participants' productive vocabulary in addition to labelling condition. Total looking times to the experimenter's face per trial were submitted to a multiple linear regression with labelling condition and productive vocabulary scores as predictors. The model explained 19.6% of variance in looking times, and did not reach significance ($F(2, 21) = 2.15$, $p = .14$), suggesting that looking times at the experimenter's face were not predicted by these variables. Labelling condition ($\beta = -.001$; $t(23) = -.12$ $p = .91$) did not predict looking time to the experimenter's face. Productive vocabulary ($\beta = .001$; $t(23) = -2.07$ $p = .05$) predicted looking time at the experimenter's face, where children with lower productive vocabulary looked longer at the experimenter's face.

A multiple linear regression was used to explore whether the number of eye-gaze switches between the different areas of interest was affected by participants' productive vocabulary in addition to labelling condition. Total number of eye-gaze switches were submitted to a multiple linear regression with labelling condition and productive vocabulary scores as predictors. The model explained 19.5% of variance in looking times, and did not reach significance ($F(2, 21) = 2.54$, $p = .10$), suggesting that eye-gaze switches were not predicted by these factors. Labelling condition ($\beta = -.17$; $t(23) = -.07$, $p = .94$) did not predict the number of switches. Productive vocabulary ($\beta = -.06$; $t(23)= -2.25$, $p = .04$) predicted eye-gaze switches, where children with lower productive vocabulary switched their eye-gaze more frequently during play.

Retention of Novel Words

Handling condition. The novel labels were not retained by the children above chance (.33), $t(12) = -.39$, $p = .71$ (three out of 12 children successfully retained the labels above chance; 25%). To explore whether label retention was affected by participants' productive vocabulary and number of switches during labelling trials in addition to proportion looking times at labelled objects, novel label retention scores were submitted to a multiple linear regression with proportion looking time at labelled objects, number of eye-gaze switches and productive vocabulary score as predictors. The model explained 23% of variance for participants' successful retention of the novel words, and did not reach significance ($F(3,8) = .80$, $p = .53$), suggesting that label retention was not predicted by these factors. Looking time at labelled objects ($\beta = -.07$; $t(11) = -.10$, $p = .93$), number of switches ($\beta = .01$; $t(11) = 1.13$, $p = .29$) and productive vocabulary ($\beta = -.001$; $t(11) = -.51$, $p = .63$) did not predict label retention.

No Handling Condition. The children did not retain the novel labels above chance (.33), $t(12) = -.89$, $p = .39$ (three out of 12 children successfully retained the labels above chance; 25%). To explore whether participants' productive vocabulary and number of eye-gaze switches in addition to proportion looking times at labelled objects affected label retention scores, label retention scores were submitted to a multiple linear regression with proportion looking time at labelled objects, number of eye-gaze switches and productive vocabulary scores as predictors. The model explained 70.4% of variance for participants' successful retention of the novel words, and did reach significance ($F(3,8) = 6.35$, $p = .02$). Looking time at labelled objects ($\beta = -.68$; $t(11) = -1.77$, $p = .16$) did not predict label retention. However, productive vocabulary ($\beta = -.002$; $t(11) = -3.48$, $p = .01$) did predict label retention: children with lower vocabulary scores were more likely to retain the novel labels. The number of eye-gaze switches ($\beta = -.01$; $t(11) = -3.70$, $p = .01$) also predicted label retention, with children who performed fewer eye-gaze switches more likely to retain the novel labels.

3.4. Discussion

In the current study we explored the effect of labelling and handling on children's visual exploration of objects, aiming to further understand how these environmental settings could influence children's interactions with objects and its relationship to word learning. To achieve this, we provided novel objects to children with or without a novel label within conditions, and between conditions the experimenter either allowed children to handle the objects or presented them at a distance. The descriptive graphs (Figures 3.2. – 3.5.) indicated that children showed substantial individual variability in looking times. These differences might occur for example due to temperamental characteristics or different stages in development.

3.4.1 Children's Looking Behaviours with Objects

Overall, children looked longer at objects during the no handling condition than during the handling condition irrespective of whether the experimenter was providing a label or not. There are a number of possible explanations for this finding. First, the experimenter in the no handling condition was controlling the scene by holding the object; thus, greater looking at the objects in this condition might have been the result of the social partner's actions with the objects while trying to keep them in children's visual field. This is in contrast to the handling condition, where children moved the objects in and out of their visual field when they wanted. Importantly, in the no handling condition the experimenter kept the object in the child's visual field as consistently as possible. Secondly, while presenting the object in either handling condition, the experimenter looked at the objects and either labelled them or talked about them when they did not have a label. Previous studies (e.g. Brooks & Meltzoff, 2002) suggested that children would come to desire the object when an adult holds and looks at it. For example, some authors (e.g., Farroni, Johnson, Brockbank, & Simion, 2000; Brooks & Meltzoff, 2005) argue that when an adult turns to an object with open eyes, this action imparts "desirability" compared to when the eyes are closed. Thus, the acts of looking at and holding something, like a novel object, may take on a referential meaning for children whereby they understand that the adult is shifting his/her attention to something else to communicate (Scaife & Bruner, 1975). Children's understanding of this referential intent could in turn lead to increases in attention. Further, children's sustained attention to the objects is influenced by their social partner's actions during joint play. Specifically, when a social partner holds and looks at objects and shows interest by talking about those objects, then children are more likely to attend more to those objects (Suarez-Rivera, Smith & Yu, 2018). Similarly, Wass et al. (2018) suggest that social partners' attentiveness to the objects influence children to also attend to the objects. Thus, social partners shape children's learning environment by influencing children's responses to the interaction. Even though children were able to look where they wanted influenced by their curiosity, the involvement of the social partner in their object exploration led to a different looking behaviour of the children in which looking at the novel objects was longer compared to when children held the objects alone.

Interestingly, in the current experiment there was no difference in children's looking times when the objects were labelled or non-labelled by the experimenter within both handling conditions. We expected that children would show longer looking times to labelled objects in line with previous work. Baldwin and Markman (1989) suggested that children are more attentive by showing longer looking times to objects when those objects are accompanied with a label compared to objects without a label irrespective as to whether labelled and non-labelled objects were accompanied with ostensive cues: in that case pointing towards the objects. Specifically, in the current study there was only one object visible during each trial and the experimenter was talking about the objects during the trials in both handling conditions whether or not the objects were labelled to engage children in the task and provided about the same amount of spoken words for all objects. This setting might have made the distinction between labelled and non-labelled objects difficult for children, which led to the same amount of looking to all objects. However, a main difference between the current task and Baldwin and Markman (1989) task is how children's looking times were recorded. In our study we recorded children's eye-gaze from their own perspective, whereas Baldwin and Markman used third-view cameras. Recent research suggests that it is highly possible that coding from third-view cameras can be biased by the adults' conceptualization of the structure of the larger image (Yoshida & Smith, 2008) and that what children actually experience is not easily predicted by adult intuitions (Franchak et al., 2011; Fausey, Jayaraman, & Smith, 2016). Therefore, since these results differ, future research is needed if we aim to understand whether the presence or absence of labels influence different looking behaviours for children and consequently affect children's experiences.

3.4.2 Children's Looking Behaviours Towards the Social Partner's Face

Overall, children looked longer at the experimenter's face during the handling condition compared to the no handling condition, whereas the presence or absence of labels did not affect looking times. Recent evidence suggests that children ask for help by looking at their social partner's face when engaged in a task they cannot solve independently (Goupil, Romand-Monnier, & Kouider, 2016), and generally children use their social partner's face during joint play for information (e.g., Gogate et al., 2006). In the current study the social partner was not actively involved in object manipulation during the handling condition, therefore children might have looked at the experimenter's face to establish joint attention (Gogate et al., 2006) and involve the experimenter in the task (e.g., Baldwin et al., 1996). We could also suggest that children looked longer at the experimenter's face with the aim to gather information regarding the names of the labels, as looking at the social partner's face contributes to the onset of lexical development (Byers-Heinlein, & Werker, 2009). As discussed before, in the no handling condition children looked longer at the objects, which might have also affected children's looking times to the experimenter's face. Clearly, then, when social partners are actively involved when children explore objects, they influence what children experience. Further, this finding highlights children's ability to actively maximize their input to learning over and above their social partner's ability to do so.

Additionally, in the handling condition looking times at the experimenter's face were not predicted by labelling condition and productive vocabulary scores. In the no handling condition the regression did not reach significance, however productive vocabulary was a significant predictor: lower productive vocabulary scores predicted longer looking times at the experimenter's face. Therefore, this result needs to be interpreted with caution. However, one possible explanation could be that children with lower productive vocabulary scores in this experiment were looking longer at the experimenter's face to gather more information from their social partner to form object-label associations (Vaish et al., 2011) as the task may have been difficult and they were looking for assistance (Goupil et al., 2016).

3.4.3 Children's Eye-Gaze Switching

In the handling condition, the regression exploratory analyses with labelling condition and productive vocabulary as predictors did not predict the eye-gaze switching of children between the objects and other areas of interest (e.g. experimenter's face and hands). However, in the no handling condition children with lower productive vocabulary were more likely to produce higher frequency of eye-gaze switches. Previous research suggested that more eye-gaze switching (Gogate et al., 2006; Matatyaho & Gogate, 2008) facilitates more successful object-label mappings. For instance, Gogate et al. (2006) suggested that children who made the most frequent eye-gaze switches between a novel object and the face of their social partner during the learning of a label, were more likely to learn the correct object-label relations. Similarly, Oakes and Ribar (2005) suggested that eye-gaze switching reflects comparison between two stimuli and therefore deeper encoding of categories. In the current study, children may have used eye-gaze switching during the experiment as a previously established method to learn new object-label associations. The existing evidence on switching alongside our finding that children with lower productive vocabulary produce more eye-gaze switching raises the possibility that these children used switching to enhance their learning and reach a better level of object-label mapping, as well as the importance of individual differences in children's learning and behaviour. Future research should explore in more detail whether vocabulary level affects looking behaviours of children, and to what extent individual differences, such as vocabulary scores, affect those behaviours.

3.4.4 Retention of Novel Words

Horst and Samuelson (2008) suggested that two-year-old children learn novel object-label mappings under specific circumstances. The children were accurate and quick when they picked a novel object when they heard its associated label. However, after a five minute break, children were unsuccessful in retaining those object-label mappings. Children showed successful retention when learning was associated with ostensive naming of the objects but only for objects whose names were introduced early during the learning session. In line with Horst and Samuelson (2008) we could suggest that given the five minutes break, alongside with the novel objects which were alike (see Figure 3.1.) and the complicated design of the current study, children might have been disadvantaged in both the learning process and retention testing, and therefore were unsuccessful in retaining object-label mappings.

In the no handling condition productive vocabulary predicted retention of the novel labels. Specifically, children with lower vocabularies were more likely to retain novel labels. Samuelson Kucker, and Spencer (2017) suggest that when children become more expert in learning new object-label mappings, they move from novelty-driven associations (novel-*name-nameless-category*; N3C; Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992) to more sophisticated techniques, such as mutual exclusivity (Markman & Wachtel, 1988). In the current study the exploration of only one object at a time from children might have disadvantaged children with higher vocabularies if we assume that they are more expert in label-object associations and use more sophisticated techniques. Conversely, children with lower productive vocabularies in the current experiment were more likely to successfully retain the mappings if we assume that they used novelty-driven associations due to their less developed language techniques. Therefore, 30s for each trial might have not been reasonable for children with higher vocabularies to revert from one mapping technique to another. However, this explanation raises the question as to why children with more advanced vocabulary were not able to revert back to the simplest association technique (N3C). This is currently unknown and future research is needed to understand this phenomenon.

Children were more likely to successfully retain the novel labels when they performed fewer eye-gaze switches while their social partner handled the objects. This might have been a beneficial strategy for children to look longer at the one available object, since less eye-gaze switching promotes more sustained attention (Yu & Smith, 2016) and attention to the target objects have been linked to successful mappings (e.g., Hilton, Twomey, & Westermann, 2019). Further, retention when children handled the objects was not predicted by looking times at the objects, eye-gaze switching or productive vocabulary. Therefore, we could suggest that social partner's actions affected children's retention. Importantly, object handling was a between conditions factor, where age and vocabulary scores did not differ between the children in each condition. However, each individual might behave different under several conditions. Thus, a future study could explore these handling conditions with the same participants to examine whether children's eye-gaze switching behaviour is affected by these handling conditions during object-label learning.

3.4.5 Conclusions

More broadly, the current study provides insights into how different environmental settings can influence the way in which children experience and interact with novel objects. This study adds to the existing literature about how children experience the world and learn new information. We manipulated the presence or absence of labels and whether children handled the objects, or they examined the objects from a distance. The results suggested that children's looking behaviours and learning differ when children play alone compared to when they interact with a social partner, whereas the presence or absence of labels was not found to affect children's looking behaviours and learning. Therefore, children's looking behaviours and learning could be affected by features in the environment and specifically by their social partners' behaviours. Children use their curiosity and intrinsic motivation to learn and explore, but features in the environment, such as object types and the presence of a social partner, influence children's learning and exploration either intentionally or unintentionally. Thus, to fully understand how different environmental features influence what children experience while playing and learning, we not only need to explore children's perspective in more naturalistic settings, but we also need to explore how environmental features affect their social partners' behaviours during joint play events with children in such naturalistic settings closer to an everyday environment, since social partners significantly influence children's experiences and learning input.

Linking Statement for Chapter 4

In Chapter 3 we investigated children's looking behaviours when they explored novel objects. We examined children's looking times when novel labels were present or absent and when those novel objects were manipulated by the children alone (handling condition) or when only manipulated by their social partner and children explored them from a distance (no-handling condition). Taken together, children's looking times were significantly different when they independently manipulated the objects compared to when the experimenter was manipulating the objects, indicating that social partners have an impact on children's experiences while playing.

Since the social partner's actions affected children's looking times and consequently what they experienced when actively involved, this generated questions about what could influence social partners' behaviours, and in turn children's experiences. Previous research (e.g., Danis, 1997) suggested that familiar and novel objects prompt different behaviours from caregivers during joint play with their children. For instance, in the case of prelinguistic children while playing with familiar objects their caregivers used more interactive actions, whereas during play with novel objects their caregivers were less actively involved but provided more verbal information. However, whether object novelty affects caregivers' behaviours when interacting with older children who had developed language is unknown.

Importantly, caregivers do not simply produce actions while playing with their children but also use language to interact with and engage their children in a task. Previous research has explored caregivers' language and voice characteristics, known as infant directed speech (IDS), at different stages of language development of their children (e.g., Tamis-LeMonda, Bornstein, & Baumwell, 2001). For example, pitch range and mean pitch of caregivers' utterances was higher when interacting with children at a prelinguistic stage of 9 months of age compared to caregivers who interacted with 12-month-old children. Caregivers change their IDS characteristics according to their children's needs. It has been suggested that caregivers of prelinguistic children use wider pitch range and higher mean pitch to reinforce children's vocalisation. However, IDS is not the primary cue to vocalization and alertness in older children and thus caregivers narrow their pitch range and lower their mean pitch (Stern et al., 1983). Nevertheless, whether object novelty affects caregivers' IDS characteristics at children's prelinguistic, and verbal stages has not been examined to our knowledge.

Hence, in Chapter 4 we aimed to examine the impact that object novelty may have on caregivers' actions and IDS characteristics (mean pitch, mean pitch range, number of words, first utterance duration) during play with their prelinguistic or speaking stage children. Children's receptive vocabulary and caregivers' educational status were also examined. We took caregivers' educational level into consideration since IDS and gestures have been associated with caregivers' socioeconomic status (e.g., Rowe, 2008; 2012; Rowe & Goldin-Meadow, 2009) and academic achievement (e.g., Augustine, Covanagh, & Crosnoe, 2009; Callahan & Eyberg, 2010). Understanding what affects caregivers' behaviours while playing with their children will enhance our understanding about how social partners, particularly caregivers, structure their children's environment and learning input.

Chapter 4: The Effect of Object Novelty and Children's Age on Caregiver-Child Interactions.

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Abstract

One of the most prevalent ways in which children explore and learn about the world is by interacting with their parents and other social partners in object play. During this play, children's experiences are impacted by their social partner's behaviour. In turn, the social partner's behaviour may be affected by the objects they and their child are exploring. It is therefore important to explore the impact of object features on adults' actions and language during play, as this in-the-moment behaviour influences children's learning and development over time. In this study we investigated how object novelty impacts on caregivers' vocalizations, language and actions when initiating play with their children. Caregivers of nine-month-old (n= 16) and 18-month-old (n = 16) children were presented with eight identical boxes each containing one of three familiar and five novel objects. After caregivers opened each box and retrieved the object to play with their child, their number of words, first utterance's mean pitch, mean pitch range and duration and interactive and non-interactive actions were recorded. Overall, caregivers performed relatively more interactive actions on familiar objects than on novel objects. Exploratory regression analyses including additional measures revealed that caregivers' higher educational level predicted a higher ratio of interactive actions and that children's receptive vocabulary negatively predicted caregivers' pitch range. Caregivers of 18-month-olds produced shorter first utterances with a higher pitch range, especially for novel objects, and more words overall compared to caregivers of nine-month-olds. This research sheds light on how caregivers structure children's experiences at different developmental stages during joint play. Understanding how environmental features shape the behaviour of children's caregivers is important for exploring in more depth children's language and cognitive development in situations closer to their everyday learning environments.

Keywords: interaction, social partner, caregiver, speech, caregivers' responses

The Effect of Object Novelty and Children's Age on Caregiver-Child Interactions.

4.1. Introduction

The idea that social interaction plays a key role in children's development is well-established: decades of research have shown that socio-cognitive development is constructed through social interactions (e.g. Tudge 1992; Vygotsky, 1978, 1980). Given that the parent-child relationship is naturally the first social relationship that is established and that a young child's social interactions come mostly from the person (i.e. usually the mother) that spends most time with him/her, it is not surprising that researchers ascribe a special significance to the input from this adult in early socio-cognitive development (Goldwater-Adler, Wozney, & McGath, 2018; De Rosnay & Hughes, 2006). Previous studies have shown that this interaction in children's learning environments can affect what they experience. For instance, Pereira, Smith and Yu (2014) examined the effect of labels on children's object exploration while they were labelled by the child's social partner. Labelling was successful when the social partner labelled the object while that object was central in the child's view and was blocking the competitor objects. Similarly, Loucaides, Twomey and Westermann (Chapter 3) explored whether children's looking at novel objects was influenced by the presence or absence of labels when the child was either able to handle the objects or when the objects were handled only by the experimenter. Children looked longer at the objects and at the experimenter's face when the objects were handled by the experimenter, while the presence or absence of labels did not affect looking times. Thus, children's learning environments, and therefore their learning input, are influenced by their social partner as well as their own exploration. However, while many studies have explored how children learn, for instance, object-label mappings in relatively constrained settings and how parenting affects this learning, little has been done on the impact that specific factors, such as object novelty, have on social partners' behaviours and consequently the impact that these behaviours have on children's learning environment. Thus, it is important to explore the influence that these factors have on social partners' behaviours, thereby influencing the learning information available to the child.

4.1.2. Caregiver-Child Interaction and Object Exploration

The dyadic caregiver-child interaction which pervades infancy begins early, at around two- to three-months (Aureli, Presaghi, & Garito, 2018). These interactions allow children and caregivers to exchange postural, facial and vocal expressions in a face-to-face context (Aureli et al., 2018; Cohn & Tronick, 1987; Van Egeren, Barrat, & Roach, 2001). Later, at the end of the first year, triadic interactions between two people and an object emerge. In triadic interactions, partners are communicating about something that is external to the interpersonal context (Carpenter, Nagell, Tomasello, Butterworth, & Moore, 1998). These triadic interactions allow children to communicate their interests to their parents through play using object exploration, vocalization, gaze and gestures (Aureli, et al., 2018), while parents respond to these interests with actions and words (Tamis-LeMonda, Kuchirko, & Song, 2014).

Tomasello and Farrar (1986) explored the interaction between caregivers and their children at 15 and 21 months of age through videotaped naturalistic novel object play. Episodes of joint attention, while playing with an object, were identified. During those episodes both the child and the caregiver used more utterances, caregivers used more comments and shorter sentences, and the dyads were involved in longer conversations. Further, maternal references to objects that were in children's attentional focus were positively correlated to children's vocabulary at the age of 21 months and referents that aimed to redirect children's attentional focus were negatively correlated to children's vocabulary. Therefore, joint attention using external referents can elicit more verbal communications between caregivers and children and consequently enhance the verbal input from the caregivers to the children when this verbal input is directed to the children's attentional focus. Thus, triadic interactions between caregivers, children and objects provide more verbal input to children and enhance their vocabulary. when this verbal input is related to their attentional focus.

4.1.2. Object Exploration and Object Novelty

Object exploration at a very young age happens both when the child is playing alone and with a social partner. Playing with objects is considered a foundational ability for the child's later development across domains (e.g., Baumgartner & Oakes, 2013; Needham, 2000). Children who explore with a larger variety of exploratory behaviours and for longer, create more opportunities for gathering information and encoding object characteristics (e.g. weight, shape; Baumgartner & Oakes, 2013). Previous studies have shown the importance of object exploration in enhancing children's understanding that individual objects persist in time and space (Needham, 2000). This understanding is a fundamental achievement that improves language and cognitive development (Oakes & Madole, 2000). Furthermore, object manipulation at the age of six months was associated with children's cognitive and language performance at the age of two (Siegel, 1981), with intellectual functioning at four and 10 years of age and with higher academic achievement at 10 and 14 years (Bornstein, Hahn, & Suwalsky, 2013). Clearly, then, object manipulation is an important ability that supports children's development regarding language and cognition.

Through play, children encounter different types of objects, such as familiar and novel, which elicit different patterns of exploration. In early work, Piaget (1945) suggested that children examine novel objects longer with sustained attention, whereas they play with familiar objects using expected and undirected actions. Similarly, previous studies (Willats, 1983; Ruff, 1986) propose that children look and manipulate novel objects longer compared to familiar objects while playing. Oakes and Tellinghuisen (1994) explored whether sustained attention during children's manual object exploration reflected active processing of information from the novel objects. Looking times showed that seven-month-old children examined objects more compared to 10-month olds. In addition, children examined novel objects more than familiar ones and complex objects more than simple ones. These findings suggest that children's exploration is related to the amount of information they need to process and the type of objects they come across.

While the described studies provide information about how children explore familiar and novel objects, how caregivers interact with familiar and novel objects when playing with their children has not been examined in detail. In line with the previous discussion, that social interaction influences children's experiences, exploring how caregivers respond to familiar and novel objects while playing with their children is important. Through this exploration we could understand in more detail how children's play with their caregivers is influenced by caregivers' responses and in turn affecting children's experiences.

In previous work, Danis (1997) explored how familiar and novel objects influence the structure and the dynamics of an interaction between a child and his/her caregiver. The study included 12 dyads of five- and nine-month-old children and their caregivers. Participants were presented with familiar and novel objects and were asked to play with them. When an object was novel the child was more autonomous and was leading the session. Children spent more time looking at the novel objects compare to the familiar ones. When the objects were novel maternal response was slower, and caregivers allowed children to explore the objects alone. Caregivers decreased their interactive actions and increased their verbalizations to inform children of the properties of the novel objects, which made the exploration serious and didactic. Conversely, with familiar objects caregivers used 'games' that were known to children to gather and maintain their attention. This provided a more playful learning environment where caregivers and children laughed more and eye-gaze switching from children between the caregivers' faces and the objects was more frequent. This study stresses the important role of object novelty in the structuring of children's learning environments by their caregivers.

4.1.3. Language and Infant Directed Speech

As described above, caregivers used linguistic patterns to introduce familiar and novel objects to their children, such as storytelling (Danis, 1997). It is well known that language acquisition is the result of a process of interaction between the child and the social partner that starts early in infancy (Snow, 1977). Caregivers who are verbally responsive to their children's exploratory activities may specifically support advances in children's language by providing labels for events or objects under joint attention (Loy, Masur, & Olson, 2018). Caregivers are especially sensitive towards their children's abilities at different developmental stages (Tamis-LeMonda, Bornstein, & Baumwell, 2001). Indeed, features of maternal speech such as quantity and timing correlate with early language development (Chang, de Barbaro, & Deák, 2016).

Caregivers use infant directed speech (IDS) to communicate with their child, which is preferable to children compared to any other type of speech (e.g. Hayashi, Tamekawa, & Kiritani, 2001; Newman & Hussain, 2006) and enhances word learning (Singh, Nestor, Parikh, & Yull, 2009; Ma, Golinkoff, Houston, & Hirsh-Pasek, 2011). IDS is characterised by overall higher pitch and pitch range (McRoberts & Best, 1997; Papoušek, Papoušek, & Symmes, 1991), higher repetitiveness, lower mean length of utterance (Faragó, Galambos, & Topál, 2017), frequent use of isolated phrases and words, a large number of questions and the frequent use of proper names (Saint-Georges et al., 2013). There is evidence that these features, including number of words, predict early vocabulary development (Hoff, 2003) and play an important role in attracting and maintaining children's attention (Fernald & Kuhl, 1987; Stern, Spieker, Barnett, & MacKain, 1983, Song, Demuth, & Morgan, 2010). IDS is important as it has arousing properties and facilitates associative learning (Kaplan, Goldstein, Huckeby, & Cooper, 1995; Saint-Georges et al., 2013), and serves as an ostensive cue by directing a child's attention to a referent by his/her social partner (Saint-Georges et al., 2013).

Senju and Csibra (2008) suggest that six-months-old children follow an adult's gaze towards an object only when this act is presented after an episode of direct gaze and IDS. However, these features can be influenced by several factors in the environment. For instance, caregivers adjust their speech characteristics to the children's age and cognitive or linguistic competence. Stern et al. (1983) propose that IDS has wider pitch range and higher pitch mean within each caregiver's utterance when the child is at a prelinguistic stage compared to a child that is 12 months old and over whose language comprehension has started to develop. Likewise, Fernald et al. (1989) suggest that caregivers use a wider pitch range when talking to their children between birth to 24 months compared to when talking to adults. Caregivers also use higher mean pitch and pitch range during free play compared to a structured situation, such as reading a story book aloud (Shute & Whezldall, 1995). Taken together, these studies suggest that IDS helps children to develop language and that children's different ages influence caregivers' IDS characteristics (Saint-Georges et al., 2013).

4.1.3.1. Caregivers' educational status and IDS. IDS has been associated with socio-economic status (SES) and with children's language and cognitive development (Arriaga, Fenson, Cronan, & Pethick, 1998; Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002). Children from lower SES backgrounds show slower rates of cognitive and language development than do children from higher SES backgrounds starting from children's second year of life and continuing throughout their school years (Hoff & Tian, 2005). Hoff, Laursen and Tardif, (2002) suggested that low SES caregivers use a smaller range of words, talk less, ask fewer questions and are more directive compared to caregivers with higher SES. Further, the number of words and the mean length of utterance the caregivers use in their IDS predicts their children's vocabulary as toddlers, where children from lower SES backgrounds has slower rates of vocabulary development. Caregivers with higher SES use greater numbers of utterances, words, length of utterance, types of words and topic-continuing replies compared to lower SES caregivers (Hoff, 2003).

For instance, Hoff-Ginsberg (1991) examined whether working-class and upper-middle-class caregivers interact differently regarding speech with their 18- to 29-month-old children at four instances: mealtime, book reading, dressing and toy play. Upper-middle-class caregivers produced speech regarding their children's interests at that moment, for example when the child was attending to an object the caregiver would respond relating to that object and would not try to redirect her child's attention compared to working-class caregivers who more often tried to redirect children's attention. There was no difference of time in joint attention event when both caregivers and children were playing for either working or upper-middle-class dyads. Upper-middle-class caregivers produced significantly more topic-continuing replies to the children's utterances; therefore, the SES of the caregivers did affect their characteristics of IDS.

Importantly, family SES is usually measured through income, occupation and parental education in some combination or individually (Conant, Liebenthal, Desai, & Binder, 2017). Previous studies that examined SES with a combination of these measures (Bradley & Corwyn, 2003; Fluss et al., 2009; Raviv, Kessenich, & Morrison, 2004) suggested that maternal education alone is the optimal measure to predict children's educational attainment, reading and language development. This may occur due to the strong relationship between maternal education and other parenting features (Augustine, Covanagh, & Crosnoe, 2009; Callahan & Eyberg, 2010), such as cognitive stimulation in the environment (Raviv et al., 2004), quality and quantity of IDS and child's development knowledge (Rowe, 2008). For instance, Rowe (2008) examined the relationship between SES and communication of caregiver-child dyads with their 30-month-old children in naturalistic interactions. IDS predicted children's vocabulary skills after one year. The effect of SES and IDS on vocabulary were mediated by maternal knowledge of children's development, which meant that caregivers from different SES had different understanding of their children's development. More educated caregivers talk more to their children, produce smaller proportion of utterances that direct their child's behaviour and use more diverse vocabulary and longer utterances compared to less educated caregivers. Rowe and Goldin-Meadow (2009) suggest that parents from higher SES backgrounds use more gestures than parents from lower SES backgrounds when interacting with their children. In turn, children who experience more of these gestures perform those gestures and show higher vocabulary by the age of 54 months. Overall then, SES and specifically maternal education affect children's development regarding language and cognition since children's learning input is influenced by their caregivers' IDS and gestures.

4.1.4. Current Study

The evidence discussed above provided an overall insight about how caregivers and their responses affect children's learning input. Caregivers' behaviours are different while playing with familiar and novel objects with their prelinguistic children (Danis, 1997). However, exploring caregivers' behaviours at different developmental stages of their children may reveal new information. In particular, since children's motor abilities develop over time (e.g., Libertus & Landa, 2013), any increases in motor ability may affect the amount and type of actions produced by the caregiver. IDS has different characteristics based on children's age and cognitive or linguistic competence (e.g., Stern et al., 1983). However, the impact of object novelty on caregivers' characteristics of IDS, such as number of words and voice mean pitch, while playing with their children at different developmental stages, has not been studied in detail. The current study addresses these gaps. Specifically, we asked whether object novelty affects caregivers' behaviours and characteristics of IDS towards their children while playing, and whether this effect changes with children's age. Based on previous research we expected that caregivers would use more words to describe familiar objects, caregivers' mean pitch and pitch mean range would be higher for younger children, caregivers' first utterance duration would be shorter for older children and caregivers would produce more interactive actions with familiar objects compared to novel objects. Since maternal education is highly associated with children's cognitive and language development, in the current study we collected information only for maternal education level. Therefore, we aimed to examine whether maternal education level was related to caregivers' responses towards object novelty and characteristics of IDS at prelinguistic and speaking stages of children. Further, we included children's receptive vocabulary as a predictor for caregivers' behaviours to explore how these responses were related to children's vocabulary abilities.

4.2. Methods

Participants

Participants were caregiver-child dyads of 16 nine-month-olds (7 females, M = 285.88 days, SD = 11.85 days, range 261 – 299 days) and 16 18-month-olds (10 females, M = 548.50 days, SD = 11.47 days, range 531 – 565 days). Participants were monolingual English-learning, typically developing children. Data from an additional 10 children were excluded due to caregivers' errors in the procedure (5), lack of attention during play by throwing objects or not willing to play with them (4) and equipment error (1).

Stimuli

The stimuli consisted of eight 3D toy objects (approximately 9.5 x 6.5 x 5 cm): three familiar toy objects (banana, boat, fish), three similar novel objects that differed in colour but were similar in shape, and two novel objects with unique textures, shapes and salient features (see Figure 4.1.). Each object was placed in a separate box and all eight boxes were identical.

Parents were asked to complete a communicative development inventory language questionnaire to evaluate their children's receptive vocabulary (UK-CDI; Alcock, Meints, & Rowland, 2018). Participant's receptive vocabulary was significantly different between the two age groups ($t(30) = -4.75$, $p < .001$; 9-month-olds: $M = 70.94$ words, $SD = 72.27$ words, range = 4 - 244 words; 18-month-olds: $M = 209.56$ words, $SD = 91.57$ words, range = 12 - 376 words). Caregivers' education level information was collected and coded into three educational levels: "school education" (including GCSE and A-level education), "university education" and "postgraduate/professional education".

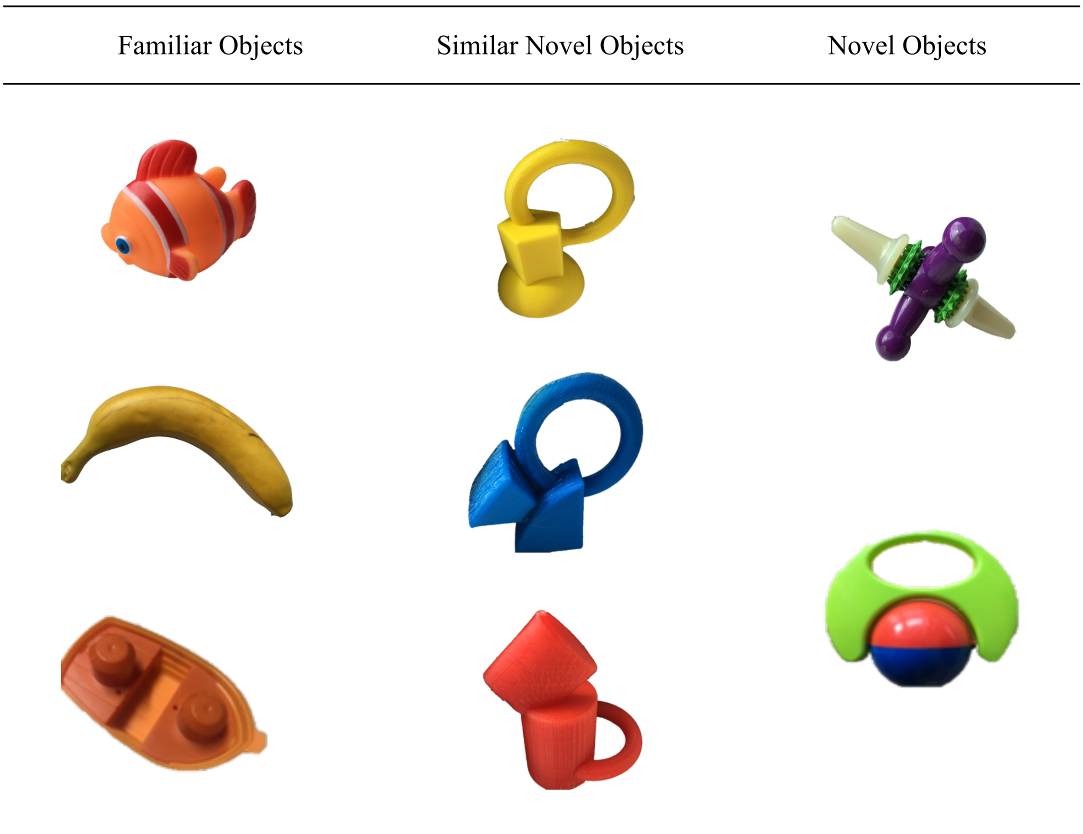

Figure 4.1. 3D Stimuli.

Experimental Room

Children sat on a highchair in front of a small white table (61cm x 91cm x 64cm) and the caregivers sat opposite the children on a low chair such that their eyes were approximately at the same level from the table top as those of the children. The experimenter was not present in the room to increase ecological validity. Three cameras recorded the procedure during play to enable offline coding of caregivers' actions with the objects. The caregiver wore a bug microphone (Movo LV1 Clip-on Omnidirectional Condenser Microphone) with a recorder (Zoom H1) to enable offline coding of caregivers' utterances during play (see Figure 4.2.).

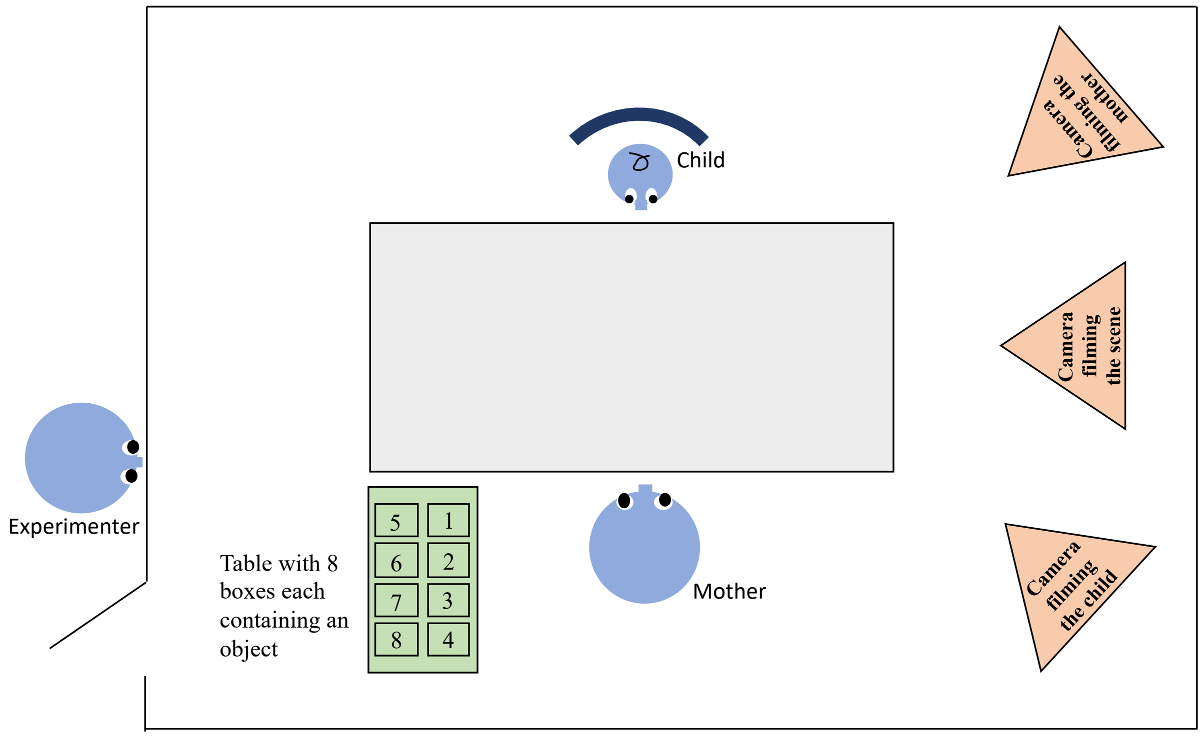

Figure 4.2. Experimental room set up.

Procedure and Design

Caregivers were trained before the session with an identical box that contained an additional object, which differed from those used in the study. The caregivers were given instructions on how long to play with each object and how to retrieve each object from the boxes. Apart from these instructions, the caregivers were asked to play with the children as they would normally do.

After this training phase, the eight numbered boxes were placed on a table next to the caregiver. The caregiver presented each object to the child for 30 seconds. The experimenter was outside the room and knocked on the door to indicate when to open the first box, retrieve the object and remove the empty box from the big table. The caregiver then engaged in joint play with their child using the retrieved object. Then, after 30 seconds the experimenter knocked on the door to notify the caregivers to put away the object and present the next box with the next object. This technique was chosen as a knocking sound is familiar and is unlikely to elicit any novelty response.

Objects were presented in four blocks: two familiar objects were always presented first, followed by the three similar novel objects, followed by the two novel objects, and finally a third familiar object. Order of presentation was Latin square counterbalanced within all object groups: familiar objects, similar novel objects, novel objects.

Coding

We derived five dependent variables from the videoed play sessions: caregiver's number of words (i.e. raw frequency of all word tokens), mean pitch of first utterance, mean pitch range of first utterance, mean first utterance duration and action type.

Number of words. Audio recordings from the bug microphone were coded word by word using PRAAT (6.0.29; Boersma, & Weenink, 2018). For each caregiver we calculated the mean number of words used for familiar and novel objects over the duration of a 30 s play event per trial. We included the mean scores of the raw frequency of the words used by the caregivers since we were interested in the number of words used instead of the lexical diversity of the caregivers' talk (i.e. how many different words the caregivers used during the experiment).

Mean pitch, mean pitch range and mean first utterance duration. For each object the caregiver's first vocal reaction (first utterance; duration: 0.6s to 2s) at the moment she opened the box and looked inside was analysed. For each first utterance for each of the eight trials we calculated first utterance mean pitch in hertz, first utterance mean pitch range in hertz, and first utterance duration in seconds. The mean pitch for each object type was calculated by adding mean pitch and dividing by the number of trials for that object type (familiar trials: 3, novel trials: 5). Mean pitch range (pitch floor: 70Hz-800Hz; Song et al., 2010) for familiar and novel objects was calculated by subtracting high pitch from low pitch and again dividing by the number of trials. Mean utterance duration was calculated by adding the duration of the utterances and again dividing by the number of trials.

Action type. Videos from the cameras were coded using ELAN software (5.2; Lausberg, & Sloetjes, 2009). A coder coded caregivers' actions on all objects as either interactive (e.g. demonstrating the function of the object to the child, making eye contact with the child while manipulating the object) or non-interactive (e.g. holding the object without speech or eye contact). For each trial the action coding started when the experimenter knocked on the door to indicate the start of the trial. The starting point of each action was the moment that the previous action finished. For instance, the caregiver was holding the object without speech or eye contact with the child (non-interactive action) and the next action was to pass the object to the child (interactive action). The moment (.01s) just before moving her hand towards the child was coded as the end of the previous action and the beginning of the next action. We analysed the number of actions instead of action duration since we were interested in whether the caregivers perform more interactive or non-interactive actions when playing with familiar or novel objects and when playing with nine or 18-month-old children. We were interested in quantity of actions in this experiment instead of duration.

A second coder, naive to the experimental hypothesis, scored a subset (20%) of the data. Coders' level of agreement was tested for reliability; interrater reliability was high (k = .78, 81.55%).

4.3. Results

Words

The words that the caregivers used during play time were counted for the nine-month-old (familiar: M = 45.67, SD = 14.34, range 17 – 66.33; novel: M = 42.04, SD = 11.65, range 25.60 – 64.80) and the 18-month-old (familiar: M = 51.74, SD = 14.62, range 28.67 - 77; novel: M = 50.36, SD = 14.49, range 30.40 - 71) groups (see Figure 4.3.).

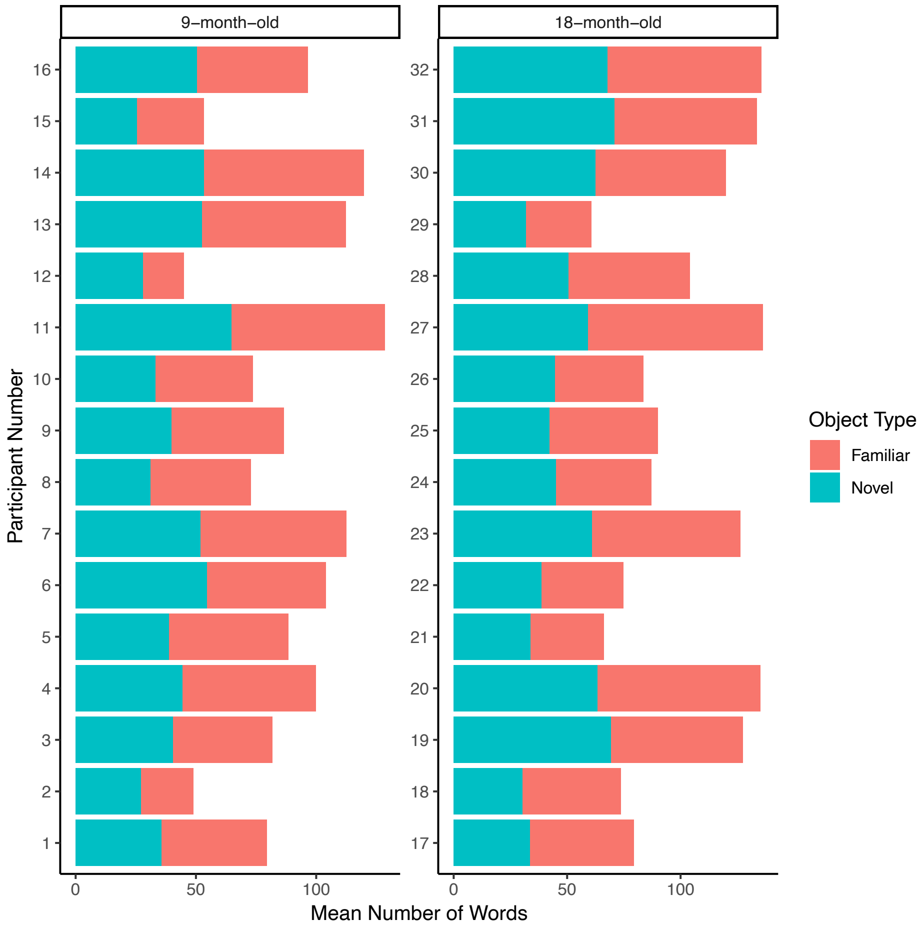

Figure 4.3. Mean number of words used per participant between the two conditions (9-months-old, 18-months-old) and within object type (familiar, novel).

We were interested in whether the number of words the caregivers used for familiar objects were higher compared to novel objects and whether they differed between children's ages. To test this possibility, we first calculated caregivers' mean words for each object type. We then submitted this variable to a 2 x 2 mixed Anova, with age (9-month-olds, 18-month-olds) as a between-subjects factor and object type (familiar, novel) as a within-subjects factor. Children's age did not affect the number of words the caregivers used (9-month-olds: $M = 43.85$, $SD = 13$; 18-month-olds: $M = 51.05$, $SD = 14.56$; $F(1,30) = 2.35$, $p = .14$, $\eta^2 = .07$). Further, caregivers used the same amount of words for each object type (familiar: $M = 48.70$, $SD = 14.58$; novel: $M = 46.20$, $SD = 13.61$; $F(1,30) = 3.34$, $p = .08$, $\eta^2 = .10$). There was no interaction between age and object type ($F(1,30) = .68$, $p = .42$, $\eta^2 = .02$; see Figure 4.4.). Overall, we did not find differences between the amount of words the caregivers used for familiar and novel objects or the amount of words between children's ages.

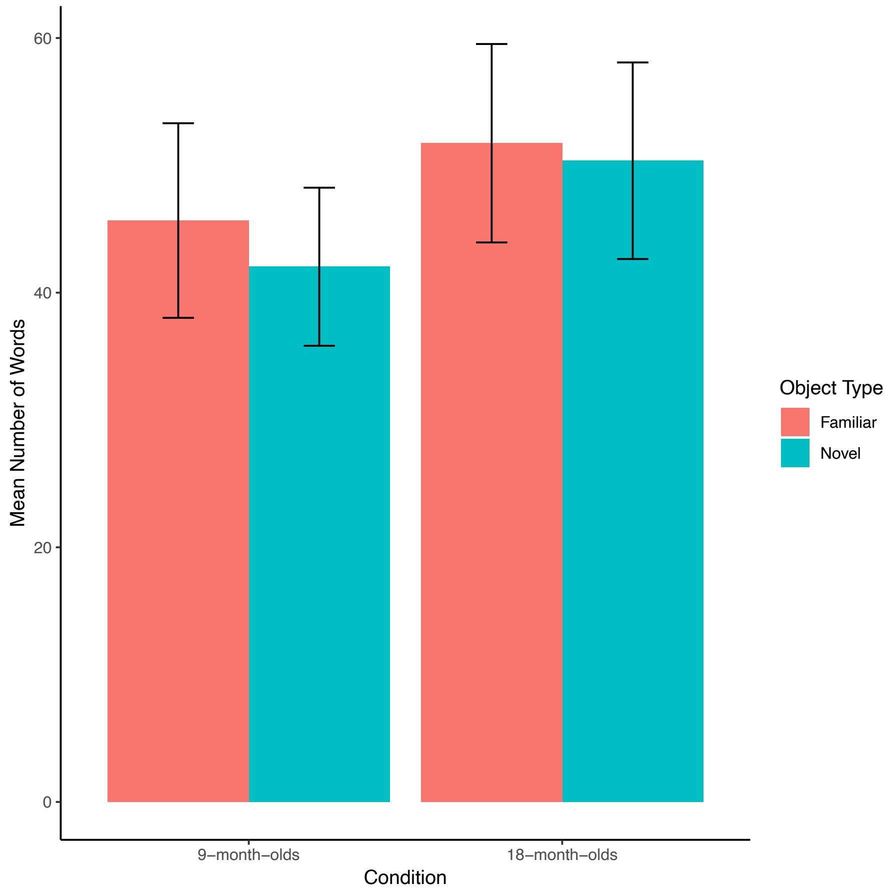

Figure 4.4. Mean number of words used between the age groups (9-months-old, 18-months-old) and within object type (familiar, novel). Error bars represent +/- 2 standard errors.

Mean Pitch

The mean pitch of the caregivers' first utterance for each trial during play was calculated for the nine-month-old (familiar: $M = 282.38$, $SD = 64.40$, range 189.77 – 433.21; novel: M

= 287.76, *SD* = 92.98, range 164.67 – 574.51) and the 18-month-old (familiar: *M* = 339.51, *SD* = 96.56, range 194.08 – 491.47; novel: *M* = 296.67, *SD* = 68.30, range 192.40 – 441.64) groups (see Figure 4.5.).

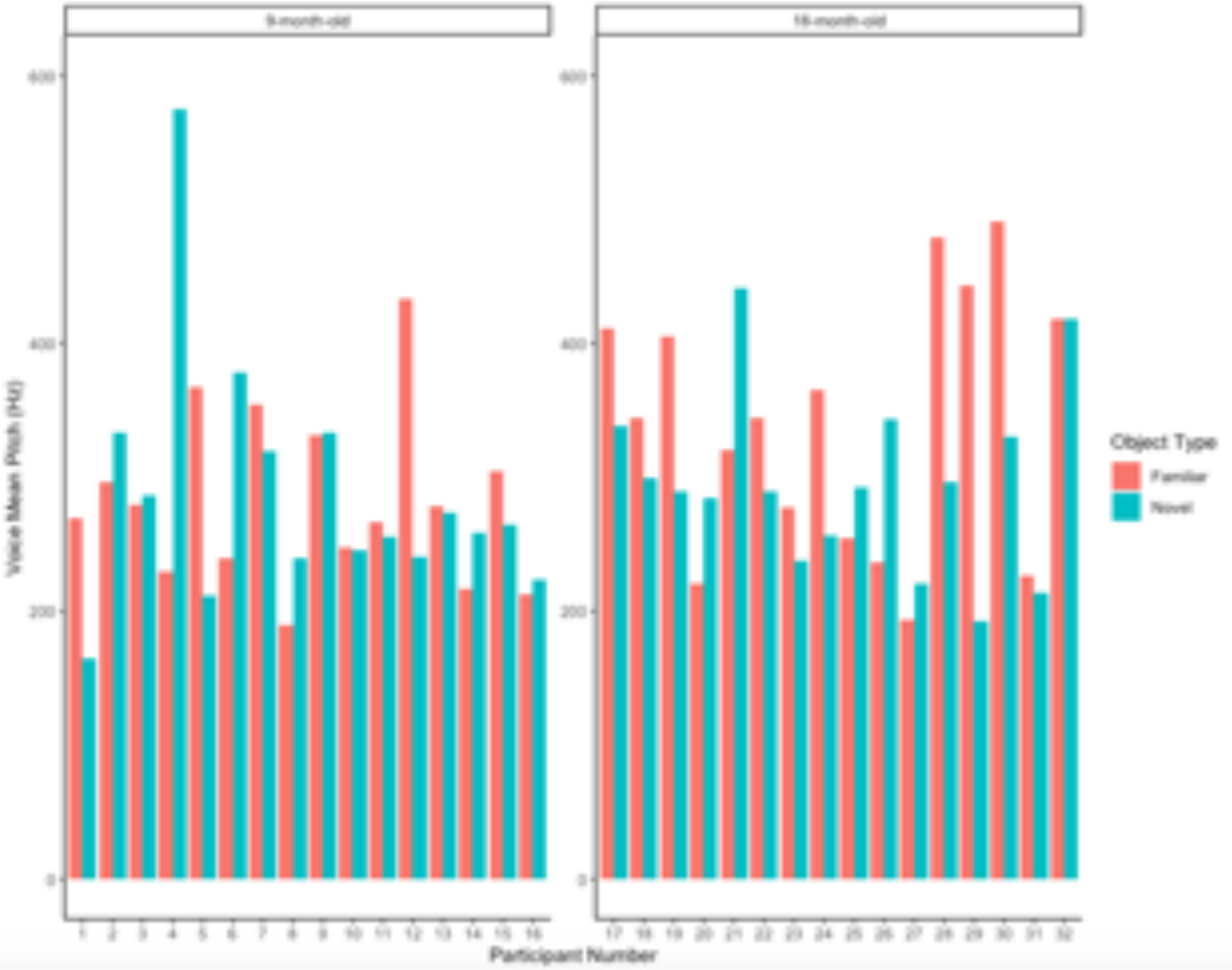

Figure 4.5. Mean pitch per participant between the two conditions (9-months-old, 18-months-old) and within object type (familiar, novel).

We were interested in whether mean pitch differed between age groups and when objects were novel or familiar. We submitted mean pitch in Hz to a 2 x 2 mixed Anova, with age (9-month-olds, 18-month-olds) as a between-subjects factor and object type (familiar, novel) as a within-subjects factor. Caregivers' voice mean pitch was not significantly different between the age groups (9-month-olds: *M* = 273.35, *SD* = 88.99; 18-months-olds: *M* = 318.09, *SD* = 82.43; $F(1,30) = 3.71$, $p = .06$, $\eta^2 = .11$) or between familiar nor novel objects (familiar: *M* = 310.95, *SD* = 85.79; novel: *M* = 280.49, *SD* = 93.64; $F(1,30) = 2.16$, $p = .15$, $\eta^2 = .07$). There was no interaction between age and object type ($F(1,30) = .36$, $p = .56$, $\eta^2 = .01$; see Figure 4.6.). We hypothesized that caregivers would use higher mean pitch for younger children, however this hypothesis was not confirmed.[1]

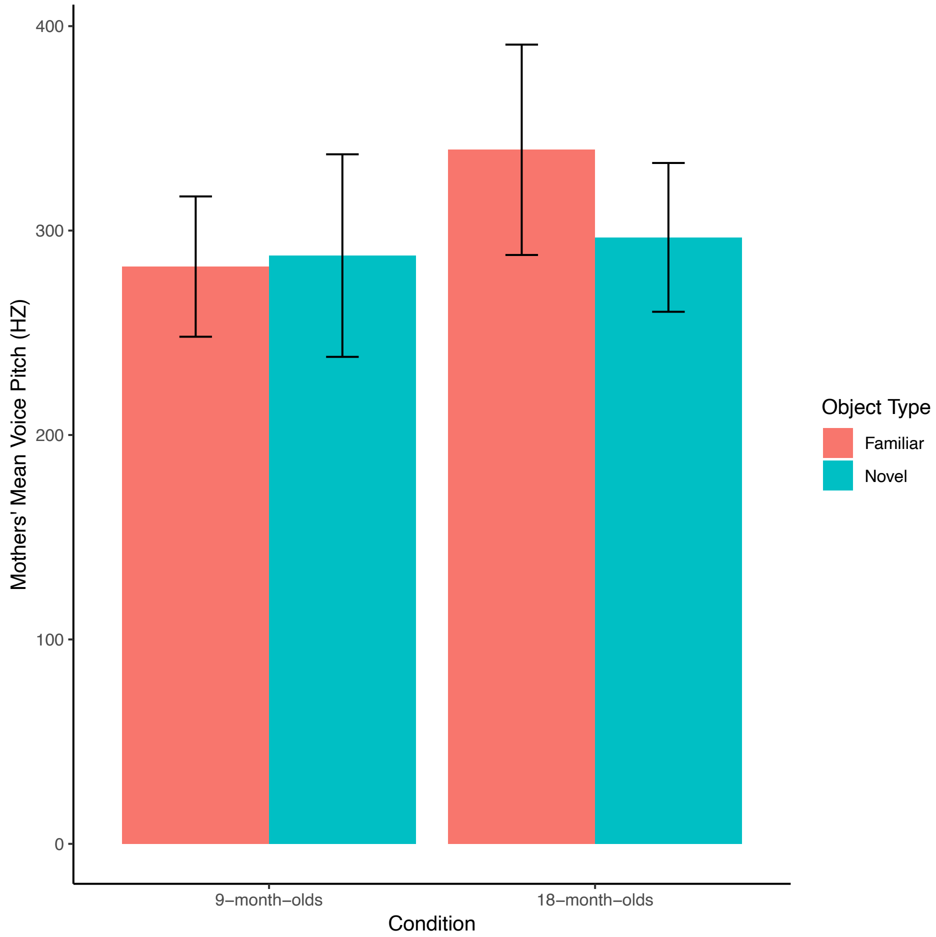

Figure 4.6. Mean pitch of first utterance between age groups (9-months-old, 18-months-old) and within object type (familiar, novel). Error bars represent +/- 2 standard errors.

Mean Pitch Range

Then, we were interested to explore caregivers' pitch range as there is no baseline, therefore caregivers' individual differences in their mean pitch baseline could have masked changes in their voice mean pitch in relation to object novelty and children's age group. The

[1] From the graph (Figure 4.5.) we see that there are some outliers. Therefore, we ran the mixed Anova excluding those outliers. The results were the same when including and excluding the outliers. Hence, we included the analysis with the outliers.

mean pitch range of the caregivers' first utterance for each trial during play was calculated for the nine-month-old (familiar: M = 149.16, SD = 86.03, range 31.46 – 338.99; novel: M = 172.15, SD = 87.54, range 42.11 – 380.40) and the 18-month-old (familiar: M = 168.71, SD = 92.78, range 30.77 – 315.98; novel: M = 178.14, SD = 80.59, range 50.12 – 439.38) groups (see Figure 5.7.).

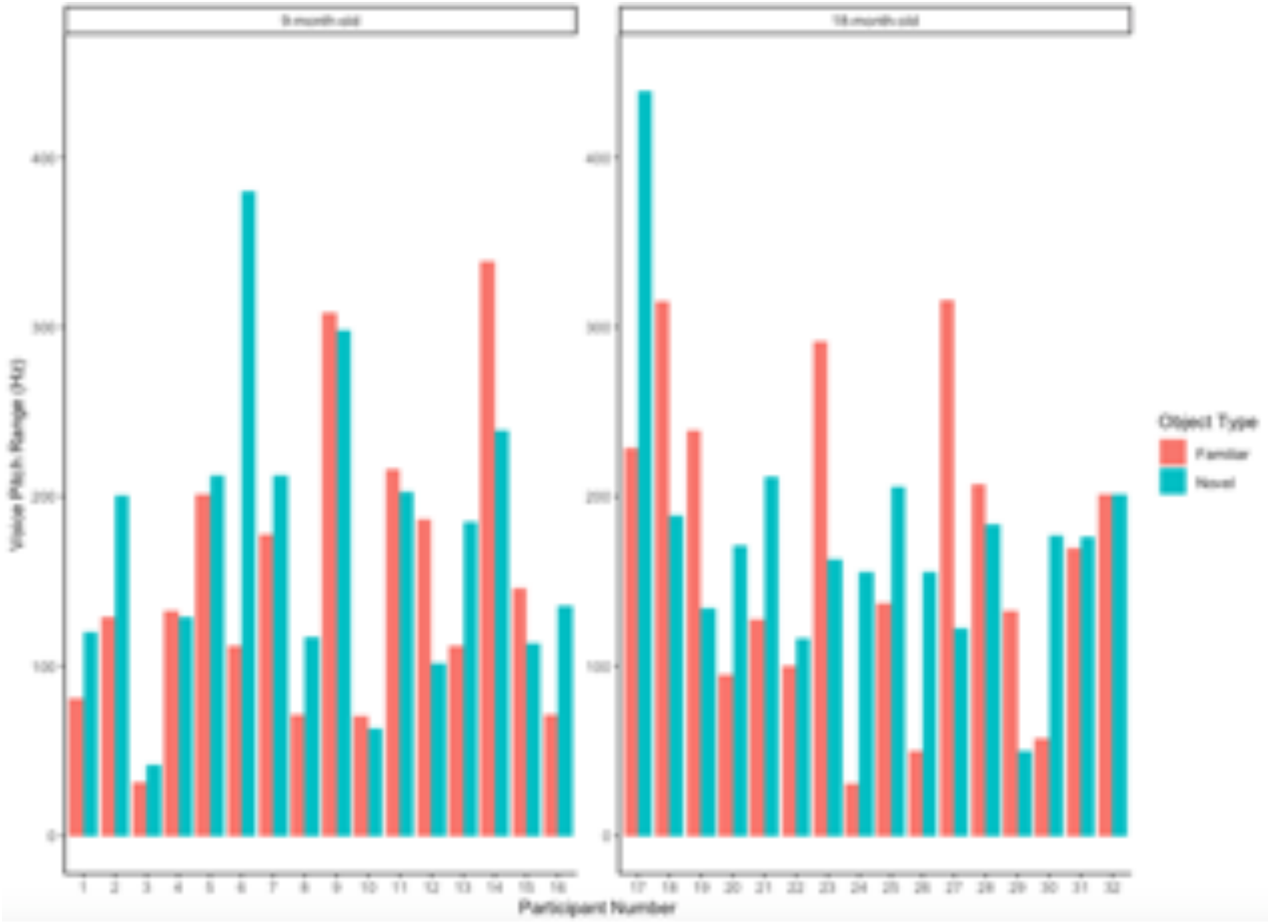

Figure 4. 7. Mean pitch range per participant between the two conditions (9-months-old, 18-months-old) and within object type (familiar, novel).

To test whether mean pitch range differed between conditions and object types, we submitted pitch range to a 2 x 2 mixed Anova, with age (9-month-olds, 18-month-olds) as a between-subjects factor and object type (familiar, novel) as a within-subjects factor. We found no difference in pitch range between children's ages (9-month-olds: M = 273.35, SD = 88.99; 18-month-olds: M = 318.09, SD = 82.43; $F(1,30) = .26$, $p = .62$, $\eta^2 = .01$) or object types (familiar: M = 158.94, SD = 88.57; novel: M = 175.14, SD = 82.83; $F(1,30) = .86$, p =

.36, $\eta^2 = .03$). No interaction between age and object type ($F(1,30) = .15$, $p = .70$, $\eta^2 = .01$; see Figure 5.8.) was found. We expected that caregivers would have wider pitch range when playing with younger children, however. Again, this hypothesis was not confirmed.[2]

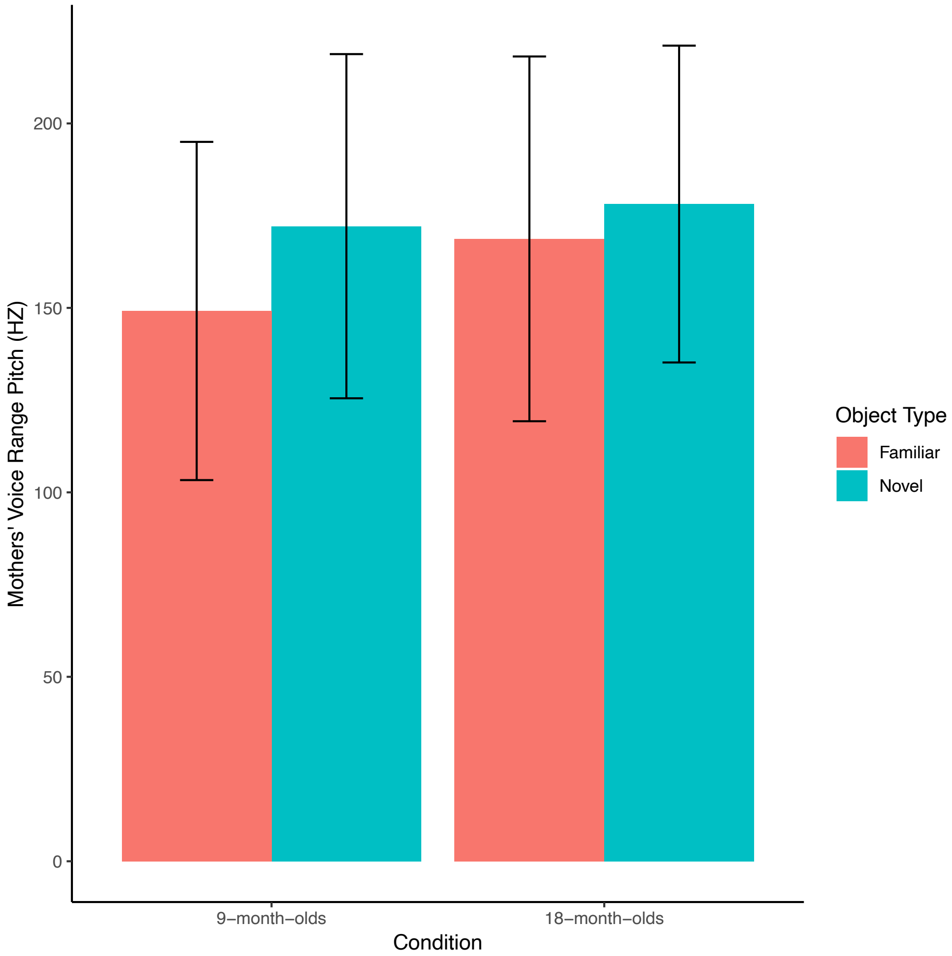

Figure 4.8. Mean pitch range of first utterance between age groups (9-months-old, 18-months-old) and within object type (familiar, novel). Error bars represent +/- 2 standard errors.

[2] From the graph (Figure 4.7.) we see that there are some outliers. Therefore, we ran the mixed Anova excluding those outliers. The results were the same when including and excluding the outliers. Hence, we included the analysis with the outliers.

Mean Utterance Duration

Caregivers' mean first utterance duration was calculated for the nine-month-old (familiar: M = 1.07, SD = .34, range .62 – 1.69; novel: M = 1.00, SD = .21, range .69 – 1.52) and the 18-month-old (familiar: M = .82, SD = .15, range .53 – 1.18; novel: M = .87, SD = .21, range .49 – 1.15) groups (see Figure 4.9.).

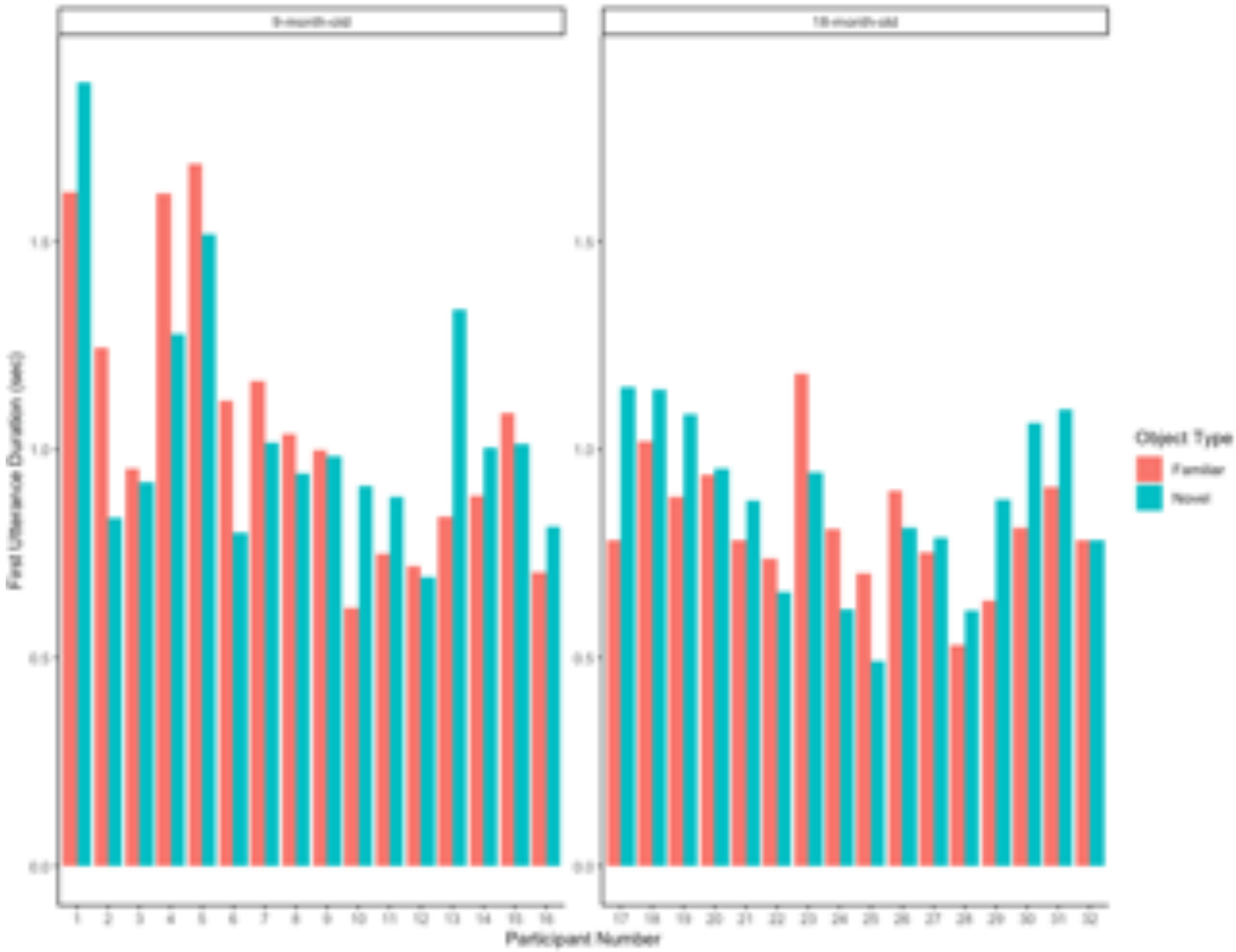

Figure 4.9. Mean utterance duration per participant between the two conditions (9-months-old, 18-months-old) and within object type (familiar, novel).

To test whether mean utterance duration of the caregivers' first utterance differed between conditions and object types, we submitted mean utterance duration to a 2 x 2 mixed Anova, with age (9-month-olds, 18-month-olds) as a between-subjects factor and object type (familiar, novel) as a within-subjects factor. We found no difference in duration for caregivers of older or younger children (9-month-olds: M = 1.03, SD = .26; 18-month-olds: M = .86, SD = .37; $F(1,30) = 3.14$, $p = .09$, $\eta^2 = .10$). Further, caregivers did not show a significant difference in duration for either familiar nor novel objects (familiar: M = .96, SD = .34; novel: M = .94, SD = .32; $F(1,30) = .10$, $p = .75$, $\eta^2 = .01$); There was no interaction between age and object type ($F(1,30) = .63$, $p = .43$, $\eta^2 = .02$; see Figure 4.10.). Overall, we found that utterance length of the caregivers did not differ between age groups or object types, in contrast with our hypothesis that caregivers' utterance length would be longer for younger children.

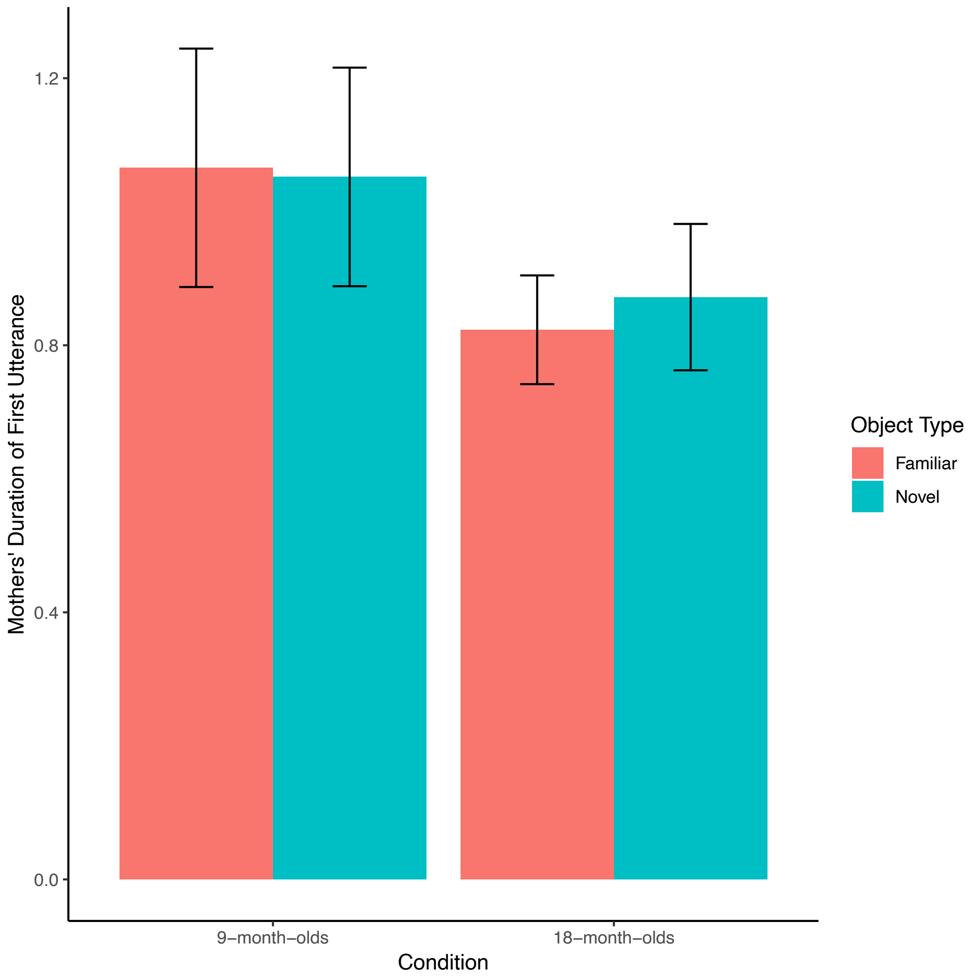

Figure 4.10. Mean duration of first utterance between age group (9-months-old, 18-months-old) and within object type (familiar, novel). Error bars represent +/- 2 standard errors.

Action Type

Next we calculated the mean interactive and mean non-interactive actions of the caregivers for the nine-month-old (familiar interactive: *M* = 8.71, *SD* = 1.78, range 6.33 – 11.67, familiar non-interactive: *M* = 2.69, *SD* = .56, range 2.00 – 4.33; novel interactive: *M* = 4.85, *SD* = 2.01, range 1.60 – 10.20, novel non-interactive: *M* = 2.74, *SD* = .63 range 1.80 – 3.80) and the 18-month-old (familiar interactive: *M*= 10.31, *SD*= 2.44, range 6 – 13.67, familiar non-interactive: *M* = 2.08, *SD* = .66 range 1.00 – 3.33; novel interactive: *M* = 4.19, *SD* = 1.43, range 1.60 – 6.20, novel non-interactive: *M* = 2.15, *SD* = .98, range .60 – 4.20) group (see Figure 4.11.).

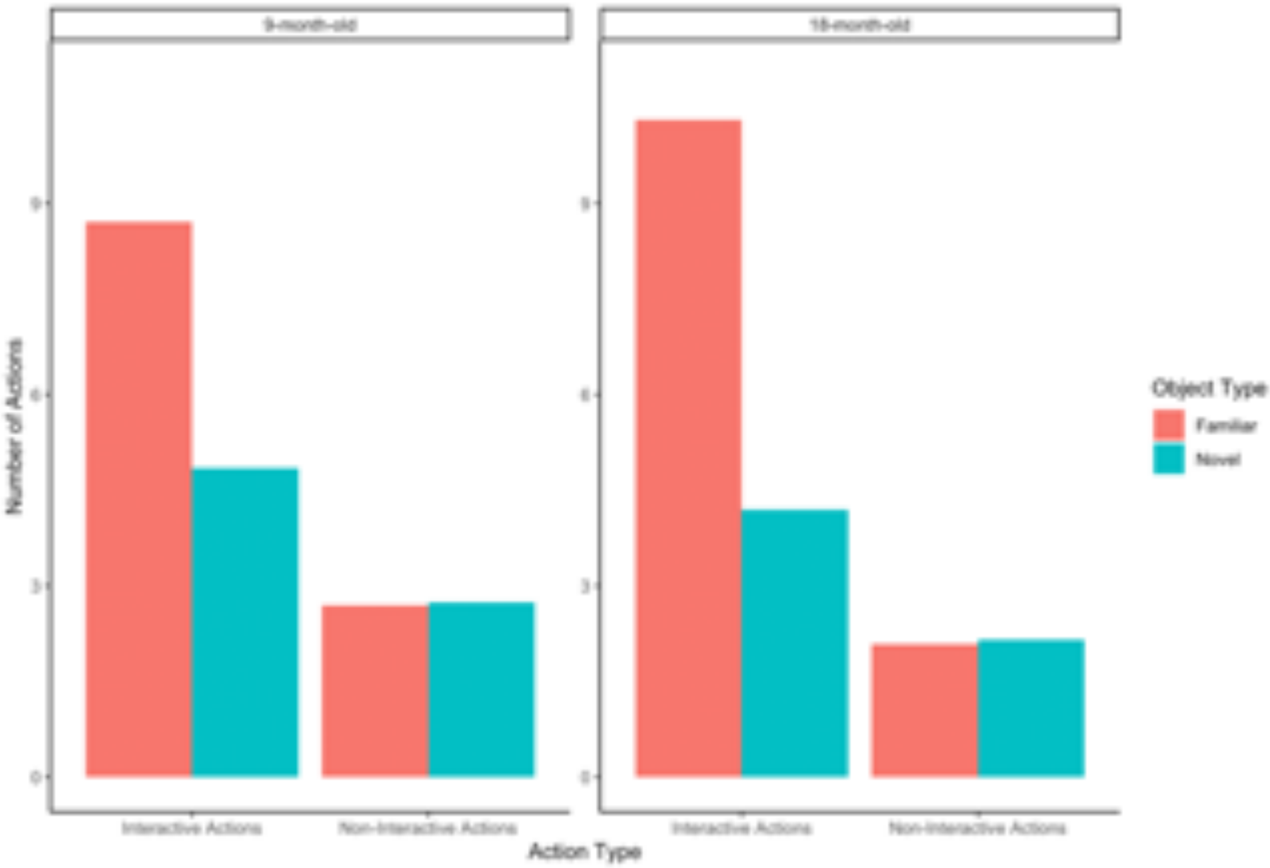

Figure 4.11. Mean number of interactive and non-interactive actions between the two conditions (9-months-old, 18-months-old) and within object type (familiar, novel).

Next, we were interested in whether the type of action performed differed when objects were novel or familiar. To test this possibility, we first calculated the ratio of interactive to non-interactive actions performed by caregivers during interaction with the objects. We then submitted this variable to a 2 x 2 mixed Anova, with age (9-month-olds, 18-month-olds) as a between-subjects factor and object type (familiar, novel) as a within-subjects factor. Caregivers of older children performed relatively more interactive actions (main effect of age; 9-month-olds: $M = 3.15$, $SD = .87$; 18-months-olds: $M = 4.97$, $SD = 2.66$; $F(1,30) = 8.80$, $p = .01$, $\eta^2 = .23$). Further, caregivers performed relatively more interactive actions with familiar than with novel objects (main effect of object type; familiar: $M = 4.46$, $SD = 2.29$; novel: $M = 3.65$, $SD = 2.03$; $F(1,30) = 5.90$, $p = .02$, $\eta^2 = .16$); however there was no interaction between age and object type ($F(1,30) = 1.43$, $p = .24$, $\eta^2 = .05$; see Figure 4.12.). In line with our hypothesis and previous studies, caregivers produced more interactive actions towards familiar than novel objects, and more interactive actions when playing with older than younger children.

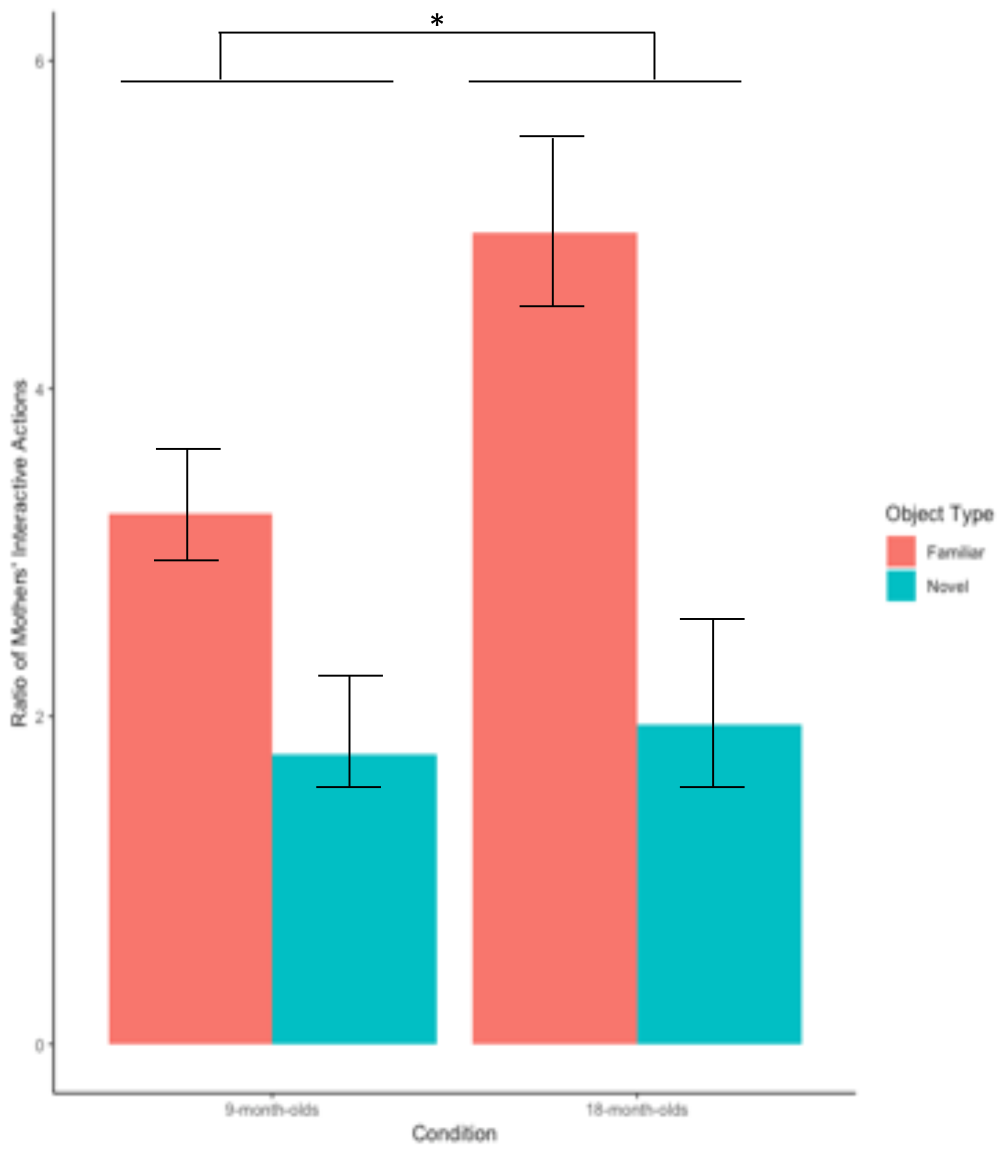

Figure 4.12. Ratio of interactive and non-interactive actions between age groups (9-months-old, 18-months-old) and within object type (familiar, novel). Error bars represent +/- 2 standard errors.

Exploratory Regression Analysis

To explore whether children's age and receptive vocabulary, object familiarity (familiar = 1, novel = 2), maternal education level (low = 1, medium = 2, high = 3; *M* = 2.10, *SD* = .76), presentation order of the objects and transitions between objects (first object = 0, familiar to novel = 1, novel to familiar = 2, familiar to familiar = 3, novel to novel = 4) were related to number of words, mean pitch, mean pitch range, mean utterance duration and action type we used multiple linear regression. All the variables were coded in the same way for all regressions and were checked for normality and homogeneity before conducting analysis.

Words. We were interested in the relationship between these same predictor variables and the number of words caregivers used. A multiple linear regression on number of words with these variables as predictors explained 8.1% of variance ($F(6, 249) = 3.64$, $p = .002$). Caregivers of older children used more words ($\beta = .33$; $t(248) = 4.07$, $p = .001$), while caregivers with children with higher receptive vocabulary scores ($\beta = -.03$; $t(248) = -2.12$, $p = .035$) used fewer words. Object type ($\beta = .03$; $t(248) = .26$, $p = .80$), maternal education level ($\beta = .05$; $t(248) = .26$, $p = .39$), presentation order ($\beta = -.06$; $t(248) = -.48$, $p = .63$) and object transitions ($\beta = -.98$; $t(248) = -.09$, $p = .27$) did not predict the number of words.

However, caregivers of older children used more words, but at the same time caregivers of children with higher receptive vocabularies used fewer. This is unexpected, as we know that older children had higher vocabularies (see 4.2. Methods). Therefore, we examined the values that each participant provided regarding vocabulary and number of words. Two participants were at the extreme ends of vocabulary and number of words used (one participant had the higher vocabulary, and the fewer use of words and another participant had the lowest vocabulary and the higher use of words), one from each age group, without being statistical outliers.

Thus, we ran again the same analysis after excluding these two extreme values to understand if these were influencing these conflicting results. The new model explained 5.1% of variance in the number of words used within each trial, and did not reach significance ($F(6, 233) = 2.08$, $p = .06$). However, in this equation the only variable that predicted number of words was children's age, where caregivers of older children used more words ($\beta = .26$;

t(232) = 2.54, *p* = .01). Thus, we concluded that these extreme values influenced the results in the previous analysis.

Mean pitch. We were interested in exploring how the mean pitch of caregivers' voice was related to the same predictors. Thus, we ran a multiple linear regression and the model explained 2.2% of variance in the mean pitch of caregivers' voice, and did not reach significance ($F(6, 249) = .95$, $p = .46$)[3].

Mean pitch range. Next, we examined mean pitch range using the same predictor variables. The multiple linear regression model explained 6.7% of variance in the mean pitch range, and reached significance ($F(6, 249) = 2.96$, $p = .01$). Caregivers with older children had wider pitch range ($\beta = 71.86$; $t(255) = 1.40$, $p = .002$) and caregivers with children with higher receptive vocabulary scores had narrower pitch range ($\beta = -.33$; $t(248) = -2.99$, $p = .002$). Caregivers' pitch range was wider for novel objects ($\beta = .28$; $t(248) = 2.43$, $p = .02$) and pitch range was narrower as the presentation of the objects progressed ($\beta = -.28$; $t(248) = -2.34$, $p = .02$). Maternal education level ($\beta = -.04$; $t(248) = -.59$, $p = .56$) and object transitions ($\beta = .02$; $t(248) = .21$, $p = .83$) did not predict pitch range.

However, the result that caregivers of older children had wider pitch range, while caregivers of children with higher receptive vocabularies had narrower pitch range is again contradictory, as we know that older children had higher vocabularies (see 4.2. Methods). We again excluded the same two participants with the extreme values of vocabulary (one participant had the higher vocabulary score and the wider caregiver's pitch range, and another participant had the lowest vocabulary score and wide caregiver's pitch range). The new model explained 5.1% of variance in the pitch range used by the caregivers, and showed significance ($F(6, 233) = 2.10$, $p = .05$). We found the same contradictory results, where

[3] From the graph (Figure 4.5.) we see that there are some outliers. Therefore, we ran the regression excluding those outliers. The results were the same when including and excluding the outliers. Hence, we included the analysis with the outliers.

caregivers with older children had wider pitch range (β = .24; t(232) = 2.34, p = .02) and caregivers with children with higher receptive vocabulary scores had narrower pitch range (β = -.25; t(232) = -2.38, p = .02). In line with the previous analysis, caregivers' pitch range was wider for novel objects (β = .30; t(232) = 2.47, p = .01) and pitch range was narrower as the presentation order of the objects (β = -.24; t(232) = -1.94, p= .05) continued. Maternal education level (β = .00; t(232) = .01, p = .99) and object transitions (β = -.02; t(232) = -.22, p = .83) did not predict pitch range[4].

Mean utterance duration. Further, we explored how mean utterance duration was related to the same predictors. The multiple linear regression model explained 7.6% of variance in the mean utterance duration, and reached significance (F(6, 249) = 3.42, p = .003). Utterance duration for caregivers with older children was shorter (β = -.26; t(248) = -3.17, p = .002). Receptive vocabulary (β = .02; t(248) = .22, p = .82), object novelty (β = .07; t(248) = .57, p = .57), maternal education level (β = -.08; t(248) = -1.35, p = .18), presentation order of the objects (β = -.10; t(248) = -.88, p= .38) and object transitions (β = .10; t(248) = 1.25, p = .21) did not predict mean utterance duration.

Action type. Next, we ran a multiple linear regression with children's receptive vocabulary, whether the object was familiar or novel, maternal education level, the presentation order of the objects and object transitions as predictors for action type. The model explained 14.9% of variance in action type, and reached significance (F(6, 249) = 7.28, p = .001). In line with the Anova analysis, caregivers with older children produced more actions (β = .21; t(248) = 2.72, p = .01) and more interactive actions were produced towards the familiar objects (β = -.22; t(248) = -2.00, p = .047). Caregivers with higher education level produced relatively more actions (β = .16; t(248) = 2.73, p = .01) during play

[4] From the graph (Figure 4.7.) we see that there are some outliers. Therefore, we ran the regressions excluding those outliers. The results were the same when including and excluding the outliers. Hence, we included the analysis with the outliers.

time. Receptive vocabulary (β = .13; t(248) = 1.66, p = .10), the presentation order of the objects (β = .06; t(248) = .52, p = .61) and object transitions (β = .01; t(248) = 16, p = .87) did not predict action type.

4.4. Discussion

Previous studies (e.g., Danis, 1997; Tamis-LeMonda et al., 2014) explored caregivers' responses when playing with their children in relatively naturalistic environments with familiar and/or novel objects, however, this has not been studied in detail. The current study aimed to explore caregivers' responses while playing with familiar and novel objects with their nine- or 18-month-old children to understand how object novelty influenced caregivers' actions and language characteristics at prelinguistic and speaking stages of children. To achieve this, we provided caregivers with familiar and novel objects and asked them to play with their children as they would normally do. We recorded caregivers' actions during play and caregivers' vocalizations to examine differences in number of words used, mean pitch, mean pitch range, utterance duration and interactive/non-interactive actions between age groups and within object types.

Generally, most of the Anova analyses did not show significant differences between the age groups and between different object types with an exception to action type, whereas most of the regression analyses did. This difference between the results could be explained as in regression analyses the equations included more predictors compared to the Anova analyses where we explored the differences between age groups and object types. Importantly, all regression equations were not a good fit to the data as the variance explanation for all was relatively low. Therefore, the results need to be considered with caution.

The descriptive graphs (see Figures 4.3., 4.5., 4.7., 4.9., 4.11.) suggest that for each outcome variable individual differences between participants were present. Caregivers' actions and language characteristics show individual differences where for instance, some caregivers overall used more words when playing with their children and others fewer words, or some caregivers produced higher mean pitch while playing with either familiar or novel objects. Individual differences are important since each person has its own behavioural and biological characteristics (Piazza, Iordan, & Lew-Williams, 2017). Some caregivers might have been shyer or more anxious than others during the experiment and thus either talked less or produced fewer actions. Previous research suggests that caregivers' levels of shyness and anxiety influence their actions towards their children (e.g., Root, Hastings, & Rubin, 2016). Therefore, considering that each person has his/her own characteristics that affect their behaviour we controlled these differences by exploring the mean and ratio values of the outcome variables.

4.4.1. Number of Words Used by The Caregivers

Anova analysis showed no differences between the amount of words used by the caregivers regarding object novelty and age group. However, the regression analyses revealed that caregivers with older children used more words. Previous studies (Tamis-LeMonda et al., 2001; Loy et al., 2018) suggest that caregivers are sensitive towards their children's abilities. Caregivers can monitor their child's development and provide the right information at the right time (Chang et al., 2016). They also change their behaviour according to their children's needs, which has been strongly linked to language development (Snow, 1977). Further, caregivers' IDS is characterized by the frequent use of the same words and phrases (Saint-Georges et al., 2013) and the use of IDS is strongly associated to children's vocabulary development (Loy et al., 2018).Therefore, caregivers' sensitivity to their children's abilities might have elicited caregivers to provide more words to enhance their older children's vocabulary learning who were at a speaking stage, since exposure to more words facilitates the expansion of vocabulary (e.g., Hoff, 2003).

4.4.2. Pitch and Pitch Range of Caregivers' Voices

Pitch and mean pitch range of caregivers' first utterances did not differ between the two age groups or between familiar and novel objects from the mixed Anova. While caregivers' voice mean pitch was not predicted by any of the predictors, caregivers' mean pitch range was predicted by age, object type, vocabulary score and objects presentation order.

4.4.2.1. Children's age and caregivers' pitch range. Caregivers of older children were more likely to show wider pitch range. A previous study (Fernald et al., 1989) with a broader age range of 0-to-24-month-old children, suggests that caregivers use a wider pitch range while interacting with children within this age group compared to pitch range when interacting with an adult. Further, Stern et al. (1983) propose that IDS has greater expansion of pitch range when interacting with prelinguistic children compared to speaking stage children. Importantly, the auditory system firstly matures for high frequencies and later for lower (Schneider & Trehub, 1992). Therefore, children are better at listening higher pitched and pitched range voices compared to lower pitched voices, and in turn this prompts adults to use higher pitch and wider pitch range to gather infants' attention (Trainor & Desjardins, 2002). Therefore, caregivers may use wider pitch range as an attention gatherer to further enhance their children's language development since wider pitch range is a characteristic of IDS (e.g., McRoberts & Best, 1997; Papoušek et al., 1991) and IDS helps in the development of language (e.g., Loy et al., 2018; Ma et al., 2011; Newman & Hussain, 2006; Singh et al., 2009). The current results provided information about caregivers' voice characteristics at specific speaking stages of their children which conflict with previous suggestions (Stern et al., 1983). Therefore, further research as to why there is a difference of caregivers' pitch range between nine- and 18-month-old children is important in order to understand the role of pitch range changes in children's development.

4.4.2.2. Object types and caregivers' pitch range. Caregivers produced wider pitch range for novel objects compared to the familiar objects. This might have occurred as an attention reinforcer by the caregivers to direct the child's attention to the novel objects (Trainor & Desjardins, 2002). It is known that exploring and playing with novel objects can enhance children's language and cognitive development and a larger variety of longer and exploratory behaviours can generate opportunities to collect more information about object characteristics (Baumgartner & Oakes, 2013; Needham, 2000; Oakes & Madole, 2000). Caregivers are sensitive to their children's abilities and learning behaviours (Vygotsky, 1978) and by using wider pitch range for novel objects they might aimed to prompt children's exploration towards the new information that was available.

4.4.2.3. Vocabulary and caregivers' pitch range. Caregivers of children with higher receptive vocabulary produced narrower pitch range. Narrower pitch range was previously associated with the development of language and comprehension (Stern et al., 1983). Thus, the caregivers might have been using narrower pitch range when communicating with children with more developed vocabularies. However, this is a conflicting result with our finding of wider pitch range for older children. We expected that caregivers of older children and children with higher receptive vocabulary would show the same pattern since older children had significantly higher vocabularies compared to younger children. The vocabulary size range for both age groups as indicated by the caregivers' completion of the UK-CDI (Alcock et al., 2018) was rather broad with standard deviations within each group more than 70 words. It is well known that children's vocabulary sizes differ within age groups as each child has its own vocabulary developmental speed (Kidd, Donnelly, & Christiansen, 2018) and variance within vocabulary sizes grows with age (Bates, Dale, & Thal, 1995). Therefore, these variances between vocabulary within groups might have affected these results. Thus, future research is needed to shed more light on how caregivers use their pitch range in relation to their children's age and vocabulary abilities.

4.4.2.4. Object presentation and pitch range. Pitch range of the caregivers' first utterance was narrower as the presentation of the objects continued throughout the experiment, which could be a sign of caregivers habituating in this study and losing interest as the experiment proceeds. Another explanation for pitch range becoming narrowed over time could be the order that object types were presented as the last object was always familiar and children had more knowledge about its characteristics (e.g., Trainor & Desjardins, 2002), since we found that pitch range for novel objects was wider.

4.4.3. Caregivers' First Utterance Duration

The mean duration of the first utterance the caregivers produced did not differ between the two age groups or between object types. However, the regression analyses showed that the duration of the first utterance was shorter for older children compared to younger children. Previous studies (Penman, Cross, Milgrom-Friedman, & Meares, 1983) suggest that caregivers use utterances to provide information for objects, which is increased during the prelinguistic stages of language development and decreased as the language ability of the children develops (Sherrod, Crawley, Petersen, & Bennett, 1978). Therefore, shorter utterances were used by the caregivers for older children as their receptive vocabularies were significantly higher. Further, we could suggest that when children's language acquisition is more developed, caregivers talk faster to older children as they are better to extract information from utterances (e.g., Liu, Kuhl, & Tsao, 2003; Sherrod, Crawley, Petersen, & Bennett, 1978). Further, as children grow and their language abilities develop, they are able to communicate and structure a dialogue with their caregivers (Stern et al., 1983). When a child is able to speak that may reinforce caregivers to decrease their speaking time to allow children to communicate as caregivers adjust their behaviours to their children's abilities (e.g., Tamis-LeMonda et al., 2001).

4.4.4. Caregivers' Interactive and Non-Interactive Actions

The Anova analyses showed that the ratio of the interactive actions the caregivers produced during play were relatively more than non-interactive actions for 18-months-old children compared to nine-month-olds and more interactive actions were produced towards familiar compared to novel objects. Similarly, the regression analyses showed that caregivers of older children produced relatively more interactive actions compared to caregivers of younger children and higher maternal education predicted relatively more interactive actions.

4.4.4.1. Caregivers' actions and children's age. Caregivers of older children were found to produce relatively more interactive actions while playing with their children. Children's developing motor system provides different ways of engagement and exploration (Libertus & Landa, 2013; Bushnell & Boudreau, 1993). When children's motor abilities are not well developed, the interaction between the child and the social partner may include fewer interactive actions. A social partner like a caregiver adjusts to her child's needs (e.g., Vygotsky, 1980) and produce more interactive actions as the child's motor abilities develop to enhance the child's learning. Therefore, playing can be more interactive where the two partners share the objects easier and more frequently, which creates a more active and interactive environment (Libertus & Needham, 2011). Further, previous studies (Sherrod et al., 1978) suggested that caregivers of younger children provide more verbal information when exploring objects compared to caregivers of older children who provide more active play.

4.4.4.2. Caregivers' actions and object types. Caregivers produced more interactive actions towards familiar objects than towards novel objects. Danis (1997) suggests that caregivers increase their verbalizations and decrease their interactive actions when their children are attending to a novel object to allow time for exploration by providing guidance using language. This creates a more didactic and serious learning experience (Danis, 1997; Piaget, 1945). Conversely, caregivers refer to previously established "games" or life experiences children had when a familiar object is presented, which produces more interactive and fun play (Danis, 1997; Piaget, 1945). Similarly, children tend to look and manipulate novel objects longer by themselves to explore and learn new information (Pêcheux, Findji, & Ruel, 1992; Oakes & Tellinghuisen, 1994; Willats, 1983), which suggests that caregivers produced fewer interactive actions towards the novels objects to allow this learning exploration by the children. Therefore, we argue that caregivers, due to their sensitivity they adjust their actions during play in favour for their children's playing preferences. That is; caregivers decrease their interactive actions when a novel object is available to allow more independent exploration from the child and increase their interactive actions while playing with a familiar object. which generates a more joyful environment.

4.4.4.3. Caregivers' actions and maternal education. Caregivers' education predicted caregivers' interactive actions during play: caregivers with higher education produced relatively more interactive actions compared to caregivers with lower education. To our knowledge, interactive and non-interactive actions relationship to maternal education has not been studied before. However, previous studies have shown that caregivers' education level affects IDS and consequently children's language and cognitive development (Huttenlocher et al., 2002). Lower maternal education has also been associated with slower language and cognitive development of the children from the second year of life continuing into their school years (Hoff & Tian, 2005). Similarly, some behaviours of the caregivers are associated with lower educational level, such as the use of smaller vocabulary, less talking to the children and asking fewer questions (Hoff et al., 2002). Taken together, from the results of the previous studies and in line with our finding, we could suggest that different educational levels of the caregivers reinforce different styles of parenting, such as different amounts of interactive actions during play. This might occur as caregivers with higher education have better knowledge of children's development (Rowe, 2008; Rowe & Goldin-Meadow 2009) and understand that parenting features such as cognitive stimulation (Raviv et al., 2004) through interactive actions while playing are beneficial for children's development, such as vocabulary learning (Rowe & Goldin-Meadow 2009).

4.4.5. Conclusions

To fully understand children's development, we not only need to experience and explore it through the children's perspective, but also explore how their social partners shape this environment and influence their learning. The current study provides insight into how different environmental features can influence caregivers' responses. This study adds to the limited literature on caregivers' responses towards object novelty at children's different language stages and the influence of these responses on their children's learning environment. Overall, we suggest that caregivers are sensitive to their children's development and adjust their behaviours and vocalisations to create the best playing and learning environment for their children.

This is a study with 32 different dyads carrying their individual differences during the experiment, thus investigating caregivers' responses in a longitudinal study and how these change over time could be introduced for future work. Future research is needed to gain more knowledge in this area and replicate the current results, since our regression models were not the optimal fit to the data. Exploring how these changes in responses influence children's development is important for understanding the degree to which a caregiver affects children's development in general. While a growing literature supports that children learn independently (e.g. Oudeyer & Kaplan, 2009; Twomey & Westermann, 2018), adults nonetheless play a substantial role in children's learning (e.g. Goldwater-Adler et al., 2018; De Rosnay &

Hughes, 2006). The current research provides new information on how maternal responses differ based on several features of the environment and gives a new insight on how these responses could influence children's experiences and therefore, children's development.

Linking Statement for Chapter 5

Chapter 4 examined whether object novelty affected caregivers' behaviours and infant directed speech (IDS) characteristics while playing with their children at two different developmental stages, prelinguistic and speaking stages. Overall, caregivers performed more interactive actions while playing with familiar objects compared to novel objects. Similarly, caregivers of older children produced more interactive actions during play compared to caregivers of younger children and caregivers' higher educational level predicted more interactive actions during play. Children's receptive vocabulary negatively predicted caregivers' pitch range. Caregivers of older children produced shorter first utterances, with more words and a wider pitch range, especially for novel objects. Thus, these findings suggested that environmental features, such as object novelty, children's developmental stages, children's vocabulary and caregivers' educational status could influence caregivers' actions and IDS while playing. Both Chapters 3 and 4 indicated that social partners play an important role in structuring children's learning environments. These findings raised the question of whether caregivers structure the environment systematically, and if they do, whether they structure the environment in response to their children's behaviour.

Recent research suggests that children systematically prefer intermediate novelty/complexity when leaning new information (e.g., Kidd, Piantadosi, & Aslin 2012; 2014). Whether children's caregivers can systematically generate this type of novelty/complexity for their children has not yet been examined. We would expect that caregivers' sensitivity towards their children's behaviours and abilities (e.g., Donovan et al., 2007) would prompt similar behaviours from caregivers as those of children. For instance, caregivers are able to recognize when they need to provide instructions and guidance to their children when a task is difficult for children to solve alone (Vygotsky, 1978). Further, children's individual differences, such as shyness (e.g., Dixon & Hull Smith, 2003) and attachment (e.g., Grusec & Goodnow, 1994), are also known to affect caregivers' behaviours while interacting with their children (e.g., Fagot & Gauvain, 1997; Gauvain, 1995).

Thus, in Chapter 5 we aimed to investigate whether the structure of children's learning information from their caregivers is systematic and carried out in response to children's behaviour. That is, we examined whether caregivers were sensitive to their children's object preferences. Specifically, we measured the number of instances that caregivers chose the object their child was looking at longer. Children's shyness and attachment levels were also examined as individual characteristics that could influence caregivers' behaviours regarding sensitivity. Overall, Chapter 5 aimed to provide evidence on new themes that to our knowledge have not been examined before, that is, whether caregivers generate object sequences of specific level of novelty/complexity for their children, and whether caregivers are sensitive to their children's object preferences and individual characteristics during joint play.

Chapter 5: Caregivers Shaping Children's Learning Environments: Agreement, Systematicity and Children's Individual Differences

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Abstract

When engaged in independent exploration, children show a preference to stimulus that is not too novel nor too familiar, but of intermediate novelty. Additionally, previous research suggests that children's object exploration is influenced by their social partners. Therefore, in the current study we explored whether caregivers would systematically generate a specific level of object novelty during a task for their children, and whether they would generate this level of novelty in relation to their children's object preferences. Twenty-four caregivers and their two-year-old children were presented with novel object categories. Caregivers were asked to choose category exemplars to play with, and children's gaze direction was recorded using a head-mounted eye-tracker as an index of their object preference. Caregivers completed shyness (ECBQ) and attachment (AQS) questionnaires. Object choice agreement scores between caregivers' choices and children's preferences were low, indicating that caregivers were not sensitive to their children's object preferences, however agreement scores were higher when children were less securely attached to their caregivers. Caregivers showed a tendency to generate higher to intermediate levels of novelty for object sequences for their children; while overall this pattern did not differ from chance, caregivers of shyer children generated sequences of higher novelty. This research helps to enhance our understanding of how caregivers structure children's learning environments by suggesting that caregivers showed lack of sensitivity towards their children's behaviours and did not structure the learning environment systematically under these settings. Further, we demonstrated the importance of children's individual characteristics and their effect on their caregivers' behaviours during play.

Keywords: caregiver, sequence novelty/complexity, agreement, attachment, shyness

Caregivers Shaping Children's Learning Environments: Agreement, Systematicity and Children's Individual Differences

5.1. Introduction

Substantial research has demonstrated that features in the environment, such as object novelty and the involvement of social partners, affect children's experiences (Danis, 1997) since children are sensitive to changes in their environment regarding learning (Younger & Fearing, 1998). Social interactions and environmental features have an important role in children's learning environment, especially in parent-child interactions (e.g., Goldwater-Adler, Wozney, & McGath, 2018; De Rosnay & Hughes, 2006, Pereira, Smith, & Yu, 2014). Caregivers are sensitive to their children's cues, such as pointing (e.g., Southgate, van Maanen, & Csibra, 2007), holdouts (Boundy, Cameron-Faulkner, & Theakston, 2018) and eye-gaze direction (e.g., Senju & Csibra, 2008) as well as to children's learning abilities (e.g., Tamils-LeMonda & Bornstein, 1991). This sensitivity influences caregivers' responses to children's cues and affect the structure of children's experiences (Donovan, Leavitt, Taylor, & Broder, 2007). Previous research suggests that children's individual characteristics, such as attachment (Grusec & Goodnow, 1994) and shyness (Dixon & Hull Smith, 2003) affect children's behaviours and caregivers' responses. Therefore, caregivers also show sensitivity to their children's individual differences. However, while many studies have investigated caregivers' sensitivity towards their children's cues and learning abilities, little has been done regarding object selection. Whether caregivers choose the objects their children prefer and whether they do so in relation to children's individual characteristics has not been studied. Further, whether caregivers structure their children's learning environments systematically is currently unknown.

5.1.1 The Learning Environment Influenced by The Social Partner

Previous research provided evidence that the active involvement of a social partner affects children's experiences while playing. For instance, Loucaides, Twomey and Westermann (Chapter 3), examined how two-year-old children's looking behaviours changed when children were able to handle or examine objects from a distance while their social partner handled them. Children's looking was longer at the objects and at the experimenter's face when the social partner handled the objects compared to when the children handled them, suggesting that children's social partners influence children's experiences. Importantly, features of the environment such as object novelty can also shape the behaviour of children's social partners and in turn children's experiences. Danis (1997) examined interactions between caregivers and five- to nine-month-old children when they played with familiar and novel objects. Object novelty influenced the structure and dynamics of the interactions between caregivers and their children. For instance, caregivers allowed children to play for longer times alone when exploring a novel than a familiar object, while familiar objects were introduced by the caregivers using known games and stories creating a more enjoyable environment. During play with novel objects caregivers used language for information about object characteristics, which generated a more serious and didactic environment.

Similarly, Loucaides, Twomey and Westermann (Chapter 4) examined caregivers' behaviours and language when playing with familiar and novel objects with their nine-month and 18-month-old children. Caregivers produced a higher ratio of interactive actions when playing with familiar objects and older children, while caregivers with higher education levels produced a higher ratio of interactive actions. Caregivers also varied their language depending on the children's age. These studies suggest that children's input is shaped not only by features of the learning environment but also by their social partner's behaviours.

5.1.1.1. Social partner's sensitivity. When playing with adults, children's learning environment is influenced by those adults as they engage in ways that children can observe and learn from, provide support and encourage play (Bornstein, Venuti, & Hahn, 2002). When children explore objects with their caregiver, her sensitivity towards them affects their learning (Donovan et al., 2007). This sensitivity can be seen in scaffolding behaviours that aim to guide the child to overcome a difficulty. A more skilled social partner encourages and guides a child to overcome this difficulty using scaffolding behaviours to enhance learning. This difficulty is the difference between what a child can do without help and what a child could do after help and guidance and is known as *zone of proximal development* (Vygotsky, 1978). Caregivers, as advanced social partners, structure interactions to reduce task's cognitive demands by providing cognitive support, through more detailed instructions to help their children overcome their difficulties (Neitzel & Stright, 2004). Therefore, caregivers adjust their behaviours during play according to their children's abilities with the aim of enhancing their learning (e.g., Belsky, Goode, & Most, 1980; Tamils-LeMonda & Bornstein, 1991).

For instance, Damast, Tamis-LeMonda, and Bornstein (1996) investigated how caregivers responded to their 21-month-old children while playing naturally in their home environment. Caregivers' responses to their children showed scaffolding behaviours, where caregivers followed children's cues (e.g., objects focus, actions) to adjust their responses at either children's level of play or higher. For instance, if a child was manipulating a phone toy, the caregiver encouraged the child to "talk on the phone". Further, caregivers who were more knowledgeable about children's early play development (measured with a questionnaire completed by the caregivers; see Tamis-LeMonda, Damast, & Bornstein, 1994) provided higher levels of play. Therefore, caregivers promote their children's development through play, and caregivers with more knowledge about their children's play development provide more challenging play interactions at the appropriate level of difficulty.

While playing with a social partner, children use behaviours such as pointing (e.g., Cameron-Faulkner, Theakston, Lieven, & Tomasello, 2015; Lucca & Wilbourn, 2018; Southgate et al., 2007), language and vocalizations (e.g., Bates, Camaioni & Volterra, 1975; Camaioni, 2017; Harding & Golinkoff, 1979) and eye-gaze (e.g., Csibra, 2010; Senju & Csibra, 2008) to communicate. In order to successfully communicate, children need to establish joint attention with their caregiver. Joint attention occurs when a social partner and a child coordinate their attentional focus to the same information (e.g., Yu, Smith, Shen, Pereira, & Smith, 2009). Mundy and Newell (2007; see also Mundy et al., 2007) suggested that children's joint-attention behaviours can be divided into two categories: spontaneous initiations from children and responses from children to their social partner cues. Spontaneous initiations from children take place when children use cues such as gestures and eye-gaze to direct their social partner to their focus of attention. Conversely, responses from children to their social partners' cues shows children's ability to attend to a common reference following their social partners' gestures and eye-gaze direction. Previous studies showed that caregivers are sensitive to these cues from their children and respond to them (e.g., Bornstein & Tamis-LeMonda, 1989; Tamis-LeMonda, Kuchirko, & Tafuro, 2013).

These responsive behaviours from caregivers show sensitivity that entails the accurate perception of cues and appropriate timely response (e.g., Bell & Ainsworth, 1972). For instance, Tamis-LeMonda et al. (2013) examined how caregivers responded to their 14-month-old children while playing with objects. Maternal responsive behaviours were reduced when children were off task but when children were active, maternal behaviours included object exploration and referential language that was didactic and multimodal as a response to their children's object exploration. For instance, when a child was exploring an object the caregiver was also showing exploratory behaviours. If the child was off task, that is stopped exploring that object and stop communicating with the caregiver, this influenced the caregiver to also be off task at the same time. Thus, caregivers are sensitive to children's social cues and respond to children's behaviours during joint play events, highlighting the important role that caregivers have in children's experiences.

5.1.1.2. Object agreement between children and caregivers. Since caregivers are responsive to their children's cues, we would expect than when they play together, caregivers would provide to children the objects for which they show a preference. Corter and Jamieson (1977) examined whether caregivers were able to guess which object their child would choose to play with before children showed their preference. Participants were 20 caregiver-child dyads. Eighteen out of 20 caregivers predicted that their child would choose to play longer with the most complex object. However, only nine children played longer with the most complex object, eight with the intermediate complex object and only three with the simple object. When caregivers were presented with novel and familiar objects, 13 predicted that their child would choose the novel, five the intermediate novel and two the familiar object. However, all but one child chose the novel object. Thus, children prefer novel and complex objects over familiar and simple. Caregivers were not accurate on their predictions about children's preferences regarding their object choices.

However, this study was not a joint play study and caregivers were only guessing their children's selections as caregivers were not able to follow their children's cues. To our knowledge, exploring whether caregivers would choose the same objects with their children in a joint play setting has not been examined. This exploration can provide new information about caregivers' responses to their children's cues in relation to object selection in a joint play event. Further, it is important to investigate whether caregivers choose the objects that their children show preference, since this affects children's experiences and learning environment. For example, if a child wants to play with a doll but the caregiver provides the train toy instead, then the child's experiences will be different compared to the child's experiences if he/she is able to choose the object, in this case the doll, alone. Exploring whether caregivers provide the objects to their children following children's preferences will further enhance our understanding of caregivers' role and influence in children's environments and learning.

5.1.2. Stimulus Novelty/Complexity and Sequences

Children's environments contain information of different content and novelty. Dember and Earl (1957) proposed that people prefer to choose information that contains an ideal level of novelty/complexity based on their own preferred level of novelty/complexity (see also Yerkes & Dodson, 1908). Evidence for this view was found by Kidd, Piantadosi and Aslin (2012; see also Kidd, Piantadosi, & Aslin, 2014) who examined whether children's attention towards stimuli could be affected by the content. The experiment included seven-to-eight-month-old children and measured their looking times. Children systematically looked away when the events were highly uninformative or highly informative. Thus, children preferred events of intermediate rates of information/novelty. This might have occurred as children tried to avoid committing cognitive resources to either overly surprising or predictable events. In line with the "Goldilocks" effect, children are surrounded by significant amounts of information and stimuli of different novelty levels, but learning is optimal when stimuli are of intermediate predictability. Further, a behavioural study (Ke, Malem, Twomey, & Westermann, 2018) examined 12-month-old children where children touched objects. Each child was primed with an object and then was given the remaining objects from the same 3D novel objects sequence. Children systematically chose the object that was most different/most novel, i.e., the object with the highest perceptual distance from the prime, while children's sequential touching to the objects systematically generated sequences of intermediate novelty/complexity.

Taken together, recent empirical (Kidd et al., 2012, 2014) and computational (Twomey & Westermann, 2018) research suggests that children show some systematicity regarding information novelty/complexity while structuring their learning of new information and this systematicity might be of intermediate novelty/complexity. We know that caregivers are sensitive to their children's learning behaviours. However, whether caregivers show sensitivity to this novelty preference of children and whether caregivers systematically structure children's environment in relation to information novelty is currently unknown.

5.1.3. Attachment and its Role in Children's Development

The previous discussion framed the importance of different environmental features, and especially caregivers' role in children's environment. Importantly, however, a substantial body of work has demonstrated individual differences in caregiver-child relationships. Specifically, caregivers and children form an attachment relationship which influences caregiver-child interactions, and therefore the learning environment. Attachment is seen as an internal working model developed by the child, which affects his/her behaviour and understanding of events (Bowlby, 1969). Children's level of attachment has a number of developmental implications. In relation with a sensitive parenting style, children's emotional and moral growth is significantly enhanced by secure attachment (Kochanska, Aksan, Knaack, & Rhines, 2004). Securely attached children show more willingness to cooperate (Grusec & Goodnow, 1994), follow the requests of their caregivers (Van der Mark, Bakermans-Kranenburg, & Van Ijzendoorn, 2002) and show higher levels of visual self-recognition (Schneider-Rosen & Cicchetti, 1984) compared to insecurely attached children. Similarly, insecure children during problem-solving tasks indicate less positive involvement (Ainsworth, Blehar, Waters, & Wall, 2015) compared to securely attached children. Critically, children's exploratory behaviour is linked to attachment: a child who feels securely attached with his/her caregiver shares more information while exploring and uses the caregiver as a secure base, and a source of comfort and security to explore the world, while insecurely attached children explore without sharing with their caregiver or show little exploration (Donovan et al., 2007). The significance of attachment to child development raises the possibility that attachment could be related to caregivers' sensitivity to their children's object preferences; in the current study attachment status was therefore measured as a potential predictor of caregivers' sensitivity to children's object preferences and children's preferred rates of information complexity.

5.1.4. Shyness as a Characteristic

In line with attachment, temperamental characteristics also influence children's learning and maternal behaviours towards children. Shyness has been associated with internalizing difficulties and lack of socialisation and withdrawal from social events (Asendorpf & Meier, 1993; Coplan, Bowker, & Cooper, 2003). Higher shyness levels have been negatively linked with productive and receptive vocabulary development (e.g., Hilton & Westermann, 2017) and also negatively associated to productive vocabulary size (e.g., Swith Watts et al., 2014). Children's temperamental characteristics also affect the learning input from their social partners' behaviours while playing. Fagot and Gauvain, (1997; see also Gauvain, 1995) suggested that children with difficult temperaments prompt their caregivers to provide extensive levels of cognitive assistance when solving a cognitive task, while caregivers give children limited opportunities to develop their own problem-solving techniques. Dixon and Hull Smith (2003) investigated how children's cognitive and temperamental characteristics could influence their caregivers' play behaviours. They followed 40 caregiver-child dyads between the child's age from 5 to-20 months using temperament measures and behavioural data from free play sessions. Children's temperament predicted maternal play styles longitudinally. Caregivers with children of higher negative temperament characteristics show greater efforts to appease the children, present a larger selection of objects and provide higher levels of play. These results were explained as caregivers' effort to maintain children's attention in the task and caregivers' efforts to do anything possible to satisfy their children.

To our knowledge research exploring specific temperament characteristics of the children and how these characteristics affect maternal play behaviour is limited. Intrinsic characteristics are crucial contributors to children's development as they significantly influence children's learning during individual play or by affecting maternal behaviours during joint play. This generated the question whether shyness is related to caregivers' sensitivity towards their child's object preferences. Thus, in the current study shyness was measured as a possible predictor of the information complexity that caregivers would generate for their children and of caregiver-child agreement for object selection.

5.1.5. Current Study

Previous literature suggests that caregivers influence children's experiences while they show sensitivity to children's cues. However, whether caregivers show sensitivity towards their children's cues during object selection is currently unknown. In the current study we investigated this and expected that caregivers would choose their children's preferred objects. Further, recent research suggests that children may systematically prefer information of intermediate complexity. Thus, we examined the information complexity of object sequences generated by caregivers while actively playing with their children, and whether these sequences showed any systematicity. We expected that caregivers would generate intermediate complexity sequences, due to their sensitivity towards their children's learning abilities. Attachment and shyness significantly affect children's and caregivers' behaviours. Therefore, we were interested in whether attachment and shyness could affect caregivers' sensitivity to their children's object preferences and caregivers' object sequences. We expected that caregivers of insecurely attached children would choose the same objects with their children in order to involve them in the task. Caregivers of shyer children were expected to generate sequences of higher complexity to provide higher levels of play to maintain children's attention in the task.

5.2 Methods

Participants

Participants were 24 caregiver-child dyads. Children were 24 months old (11 females, *M* = 728.71 days, *SD* = 8.19 days, range = 718 – 745 days), typically developing, monolingual English learners. Data from an additional 22 children were excluded due to caregivers' errors in the procedure (7), refusal to wear the headgear (7), poor calibration (6; the linear fit of 15 calibration looking points had to be greater than $r = .75$) and children's lack of engagement as indexed by not attending to the stimuli and looking away during the experiment (2).

Stimuli

Stimuli consisted of three sets of five 3D objects (see Ke et al., 2018; size: approximately 9.5 x 6.5 x 5 cm). The five objects formed a category in which each object lay along a continuum where each object differed systematically from the next. Specifically, object edges changed from corners to rounded edges (e.g., a square pyramid to a cone; see Figure 5.1). Each set was produced in red, yellow and blue to allow for counterbalancing of set colour between participants; thus, each child saw one red, one yellow and one blue set.

	Set		
Sequence order	Cube	Cylinder	Pyramid
1			
2			
3			
4			
5			

Figure 5.1. 3D Stimuli.

Procedure and Design

Children sat on a highchair suitable for toddlers in front of a small table (61cm x 91cm x 64cm) and the caregivers sat opposite the children on a low chair with their eyes at approximately the same level from the table top as those of the children. Two video cameras recorded the caregivers and the entire scene to allow offline coding of caregivers’ object choices. Before the study began, the experimenter explained to the caregivers that they should keep the tray with the objects away from the children and close to themselves, as caregivers were expected to choose which toy to play with the children and in which order.

There were no instructions on how to play with the objects or which order objects should be selected in.

Next, the experimenter asked the child to wear a head-mounted eye-tracking gear. The headgear was equipped with two miniature cameras. The first was an infrared eye-camera that records the movements of the participant's right eye and the second was a scene-camera that was mounted above the right eye facing outwards to record the child's view of the world (field of view: 54.4 degrees horizontal and 42.2 degrees vertical; http://www.positivescience.com/hardware/). Both cameras were mounted on a padded, flexible band that was placed slightly above the eyebrows of the child. The headgear was attached to a flexible spandex hat with velcro tabs, which secured the headgear when infants were moving. Software (PSLive Capture**,** v. 1.8.3) designed for head-mounted eye-tracking tracked both the pupil and the corneal reflection simultaneously. The experimenter calibrated the eye-tracking camera by moving an interesting object around the table and asking the children to look at it. At least 15 points of calibration were collected for each participant.

After calibration, the experimenter provided one of the three trays to the caregiver. The three sets of objects were placed equidistantly on three identical light wood colour trays (50cm x 30cm x 6cm) and covered with a cloth. Objects' horizontal location was pseudorandomized. The three sets were presented in a randomized order across participants.

The experimenter was present in the room sitting behind the child and outside of his/her visual field to avoid any interaction. The experimenter's role was to adjust the head-mounted eye-tracking camera if the child moved it during the experiment, to time trials and indicate when to change the objects and to provide the caregiver with the trays containing the object sets.

Next, the experimenter knocked on the table to indicate the start of the first trial and the caregiver was asked to remove the cloth and reveal the objects. The same knocking noise was used every time the caregivers had to change object. Each trial commenced with a 5 s pause to allow the child to show their preference by looking at their preferred object. During this time the caregiver was asked to keep her hands on her laps and avoid talking to the child. After 5 s had elapsed, the experimenter knocked on the table to prompt the caregiver to select an object and play with it with her child. After 20 s, the experimenter again knocked on the table to indicate the end of the trial. After playing with an object the caregiver placed it in a box out of the child's field of view. The next tray was given to the caregiver after caregiver and child had played with all five available objects. Playing with each set lasted for two minutes and five seconds.

After the experiment the caregivers were asked to complete the section about shyness from a personality questionnaire (The Early Childhood Behaviour Questionnaire, ECBQ; Putnam, Gartstein, & Rothbart, 2006) for their child and an attachment questionnaire (Vaughn & Waters, 1990).

Coding Procedure

Caregivers' choices and sequence distances. Caregivers' object choices (5) per set were coded post hoc from video captured from one of the cameras. We coded caregivers' choices as 1 to 5 based on the position of the object in the continuum for that set (see Figure 5.1). Distance between choices were coded 1 to 4, again based on objects' position on the continuum. For instance, if the caregiver chose object 1 followed by object 5 then the distance between those choices was 4 (see Figure 5.1).

Children's preferences. Video from the head and eye-tracking cameras were analysed using Yarbus (v. 2.2.9) and GazeTag (v. 0.940) software. This software maps a person's eye position (eye-tracking camera) to a reference scene video (head-camera) using simple calibration and image processing. This eye-gaze analysis shows precisely where children look when examining an object based on fixation-by-fixation segments (100 milliseconds for each fixation). The fixation segments are defined as the time intervals between successive saccades and are composed of several scene frames (approx. 30 frames/second). Children's preferred object was coded using looking fixations during the 5 s break. The object that the children looked at for longest in the 5 s break between playing trials was assumed to be the preferred one. We coded children's preferences 1 to 5 based on the position of the object in the continuum for that set (see Figure 5.1).

Attachment questionnaire. We used an attachment questionnaire to assess the attachment relationship between the child and the caregiver with the aim to examine whether different levels of attachment could influence caregivers' object choices during play and in turn the object complexity sequences. The Attachment Q-Sort Questionnaire (AQS) includes 12 items that were standardized by Vaughn and Waters (1990). Observations of caregivers and children in the Ainsworth Strange Situation (Vaughn & Waters, 1990) were used to differentiate among secure and insecure groups based on attachment and were used to develop these Likert scale measures (this test has been previously used for children up to 36 months of age, see Cassibba, Van Ijzendourn, & D'Odorico, 2010). Caregivers in this experiment were asked to rate their children's behaviour on a nine-point Likert scale (1 = *very unlike my child*, 9 = *very like my child*). The scale included questions such as, "If I move very far, my child follows along and continues his/her play in the area I have moved to" and "If given a choice, my child would rather play with toys than adults." Parents were asked to report their child's typical behaviour. Standardized Cronbach's alpha for the attachment measure was .52. For each dyad we calculated a mean attachment score (M = 6.54, SD = 1.09, range = 2.08 – 7.75). Greater scores indicated maternal reports of more secure child behaviours.

ECBQ questionnaire. We used the ECBQ (Putnam, et a., 2006) to assess individual differences in children's shyness and to examine whether the children's shyness level was associated with caregivers' object choices and object sequence complexity. The ECBQ asks parents to rate on a scale from one to seven how often their child has demonstrated specific behaviours during the previous two weeks (1 = *never*, 7 = *all the time*), in order to assess the child in 18 fine-grained subdimensions of temperament. These subdimensions include areas such as activity level, high- or low-intensity pleasure and attention focusing. Caregivers completed the ECBQ, however in the current study we only focused in the shyness subdimension for the analysis. The shyness section included 12 items that assessed how children react in situations that elicit shy behaviour. For instance, "In situations where s/he is meeting new people, how often did your child become quiet?" and "While visiting relatives or adult family friends s/he sees infrequently, how often did your child stay back and avoid eye contact?" Standardized Cronbach's alpha for the shyness measure was .76. Each child was scored from one to seven by averaging their parent's responses to the twelve questions relating to shyness while correcting for the reverse coded questions. A score of seven was considered the shyest, and a score of one the least shy (M = 3.58, SD = .81, range = 1.92 - 5).

A second coder, naive to the experimental analysis of this study, scored a subset (20%) of caregivers' choices (i.e. using the third camera videos) and children's preferences (i.e. using the head-mounted eye-tracker videos). Then their level of agreement was tested for reliability and validity. Interrater variability was high (k = .85, 88%).

5.3 Results

Children's First Preference and Caregivers' First Choice

Caregivers' object choices and children's object preferences for the first trial, on which all objects were available for selection, are depicted in Figure 5.2. First, we performed chi-square goodness-of-fit tests to establish whether caregivers and children systematically preferred specific objects in each set. The tests showed that caregivers' choices for the cylinder set (X^2 (4, N = 24) = 5.58, p = .23) and pyramid set (X^2 (4, N = 24) = 2.67, p = .62) were not systematic. However, for the cube set (X^2 (4, N = 24) = 23.08, p < .001) caregivers showed a systematic choice towards object 5, which was a ball. Similar results were found for children: for the cylinder (X^2 (4, N = 24) = 2.67, p = .62) and pyramid set (X^2 (4, N = 24) = 3.08, p = .54) children showed no preference. However, for the cube set (X^2 (4, N = 24) = 20.58, p < .001), in line with caregivers, children preferred the ball (see Figure 5.2.).

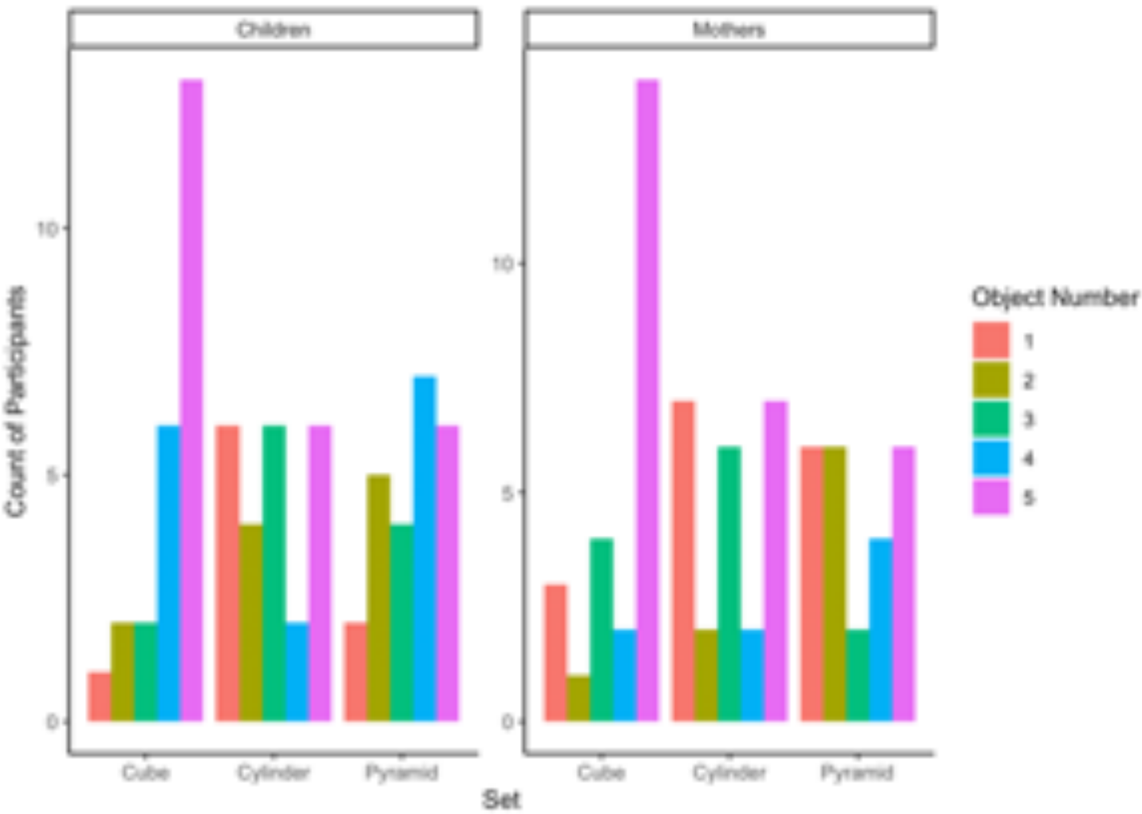

Figure 5.2. Children's first preference and caregivers' first choice per set on the first trial.

Agreement Between the Caregiver's Choices and Child's Preferences

Next, we were interested in whether caregivers' choices and children's preferences were the same across trials. Because objects were not replaced as the experiment proceeded, the probability of a match occurring by chance was different on each trial (trial 1: .20, trial 2: .25, trial 3: .33, trial 4: .50). To test this possibility, we performed a Cohen's kappa inter-rater reliability test for each trial. We chose this method as kappa is a robust measure to test agreement between two categorical variables and takes into account the possibility of agreement occurring by chance. Interpretation of the Cohen's kappa is based on Landis and Koch's (1977) scale. On trial one agreement was slight (k = .01, 25%). On trials two and three, agreement was fair (trial 2: k = .28, 44.44%; trial 3: k = .25, 43.10%) and on trial four agreement was moderate (k = .57, 66.67%). Since caregivers and children were found to systematically prefer the ball from the cube set on trial one, the slight agreement on trial one was explored further as we would expect agreement to be higher. Caregivers and children who preferred the ball did not agree (i.e., the caregiver chose the ball and the child preferred another object from the cube set) as frequently as we expected (N = 7, see Figure 5.3) based on the number of the caregivers (N = 14; see Figure 5.2) and children (N = 14; see Figure 5.2) who chose the ball from the cube set in trial 1.

Importantly, the systematic preference for the ball in the cube set could have influenced the rest of the choices within that set. Specifically, choosing the ball systematically in the first trial by the caregivers could change the selection of the objects in the following trials as the ball would not be available to be selected later since objects were not replaced. Due to this extreme preference we removed the cube set from the analysis and reran the Cohen's kappa for each trial. On trial one agreement was poor (k = -.02, 20.83%). On trial two and three, agreement was fair (trial 2: k = .33, 50%; trial 3: k = .23, 39.58%). On trial four agreement was moderate (k = .60, 68.75%).

Removing the cube set from the analysis, increased the agreement on trial 2 and 4 with a slight decrease in trial 3. For trial one the agreement was close to chance (.20). The above results suggest that caregivers and children preferred different objects throughout the experiment, however, their agreement increased as the experiment proceeded since the number of the objects on the tray that were available to be selected decreased.

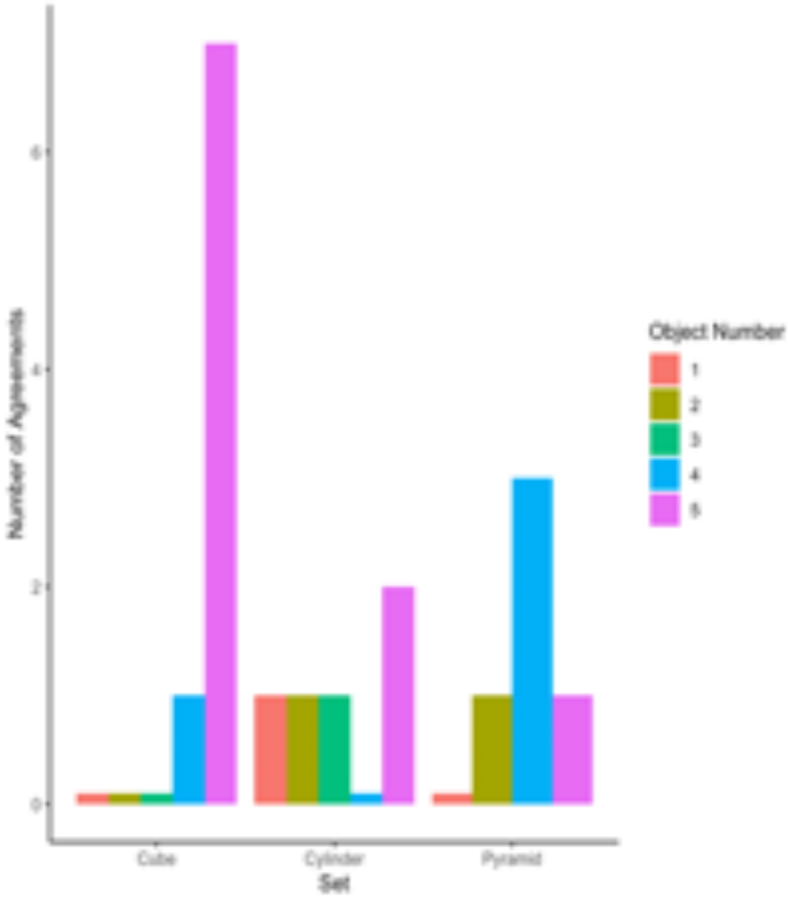

Figure 5.3. Participant object choice agreement for trial 1.

Next, we investigated whether total agreement scores were related to children's attachment and shyness scores. Checks on regression assumptions revealed an extreme outlier in the attachment scores. Therefore, the analysis was run excluding the outlier as it was influential for the analysis outcome (for justification see Appendix A). We ran two linear regression models. In the first model we used children's attachment to predict total agreement scores and in the second model we used children's attachment and shyness scores to predict total agreement scores (see Table 5.1). Model 2 including both predictors was better to explain the variance of total agreement scores. The model explained 25% of the variance in agreement between the caregiver and the child, but did not reach significance ($F(2, 20) = 3.28$, $p = .06$). Agreement scores were higher when attachment scores were lower, thus caregivers of less securely attached children were more likely to choose the object their child preferred. Shyness scores did not predict the total agreement scores.

Table 5.1. Regression model 1 and 2 for total agreement scores excluding the outlier.

	R^2	B	SE B	β	p
Model 1	.20				
Constant		17.33	3.89		<.001*
Attachment Mean Score		-1.33	.58	-.45	.03*
Model 2	.25				
Constant		16.39	3.98		<.001*
Attachment Mean Score		-1.41	.58	-.48	.02*
Shyness Mean Score		.41	.38	.21	.30

* Statistically significant at $p < 0.05$.

Sequence Analysis

We were also interested in the object sequences the caregivers generated while playing with their child and the level of complexity of those sequences. It was possible to generate 120 unique sequences in this task; caregivers generated 53 unique sequences of the 72 total sequences produced. It is important to consider that objects were not replaced during the experiment, which reduced the degrees of freedom as the experiment proceeded.

To examine the novelty/complexity levels of the sequences, we calculated the mean novelty/complexity score for all 120 possible sequences. Each sequence gave rise to four novelty/complexity values. For example, if caregivers' first choice was object 5, and second was object 3, then the difference in novelty would be 2 (see Figure 5.1) and this would be one of the four novelty values in a novelty/complexity sequence. For each sequence we calculated the mean novelty score. The 120 sequences provided eight unique mean novelty values. Table 5.2. shows the frequency with which each level of novelty/complexity was generated (higher rank = greater novelty/complexity). The frequency of the rankings suggested that most of the caregivers generated intermediate to higher novelty/complexity sequences.

Table 5.2. Mean sequence rankings frequency including the square set.

Rank mean	**Frequency/72**
1/8	8
2/8	11
3/8	14
4/8	11
5/8	14
6/8	9
7/8	4
8/8	1

Next, we decided to exclude the cube set from the sequences as we previously found that caregivers systematically chose the ball (see Figure 5.2) on the first trial. This tendency could have affected the sequences generated. When we excluded the cube set, the total number of sequences generated was 48 of which 41 were unique. Table 5.3 shows the rankings for the sequences (higher rank = greater novelty/complexity). Again, the frequency of the rankings suggests that caregivers generated intermediate to higher novelty sequences, suggesting that irrespective of whether caregivers systematically chose the ball from the cube set during the first trial, caregivers systematically preferred to generate sequences of intermediate to higher novelty/complexity.

Table 5.3. Mean sequence rankings frequency excluding the cube set.

Rank mean	**Frequency/48**
1/7	6
2/7	9
3/7	11
4/7	7
5/7	9
6/7	3
7/7	3

Next, we examined whether the distributions of sequence novelty generated by the caregivers were the same as the distribution of the 120 possible sequences; that is, we were interested in whether the distributions generated by the caregivers had occurred by chance or systematically. The Kolmogorov-Smirnov test is used to decide if a sample comes from a population with a specific distribution (Chakravarti, Laha, & Roy, 1967). This test was applied to our sequence data and indicated that the distributions of caregivers' sequences were not significantly different from the possible sequences distribution (all sequences: $D(72) = .08$, $p = .93$; sequences excluding cube set: $D(48) = .13$, $p = .62$). Therefore, whether or not the cube set was included, the distribution of caregivers' sequences did not differ from the distribution of 120 possible sequences (see Figure 5.4). This means that caregivers were choosing objects and creating sequences at chance levels without any systematicity.

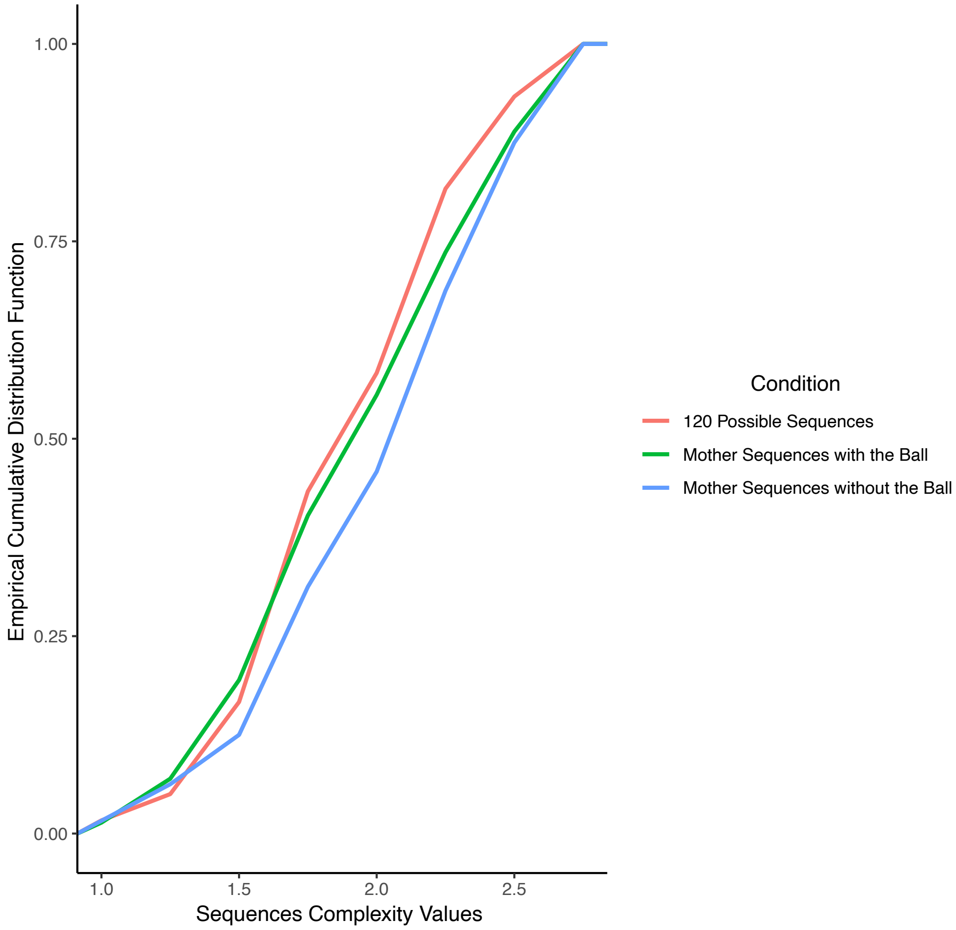

Figure 5.4. The distribution of the 120 possible sequences. The empirical cumulative distribution function is a probability model for the empirical data.

Finally, we investigated whether mean sequence distance/novelty was related to children's attachment and shyness scores. Checks on regression assumptions revealed an extreme outlier in the attachment mean scores variable. However, the analysis was run including the outlier as it was not influential for the analysis outcome (for justification see Appendix B). We ran two linear regression models. In the first model we used children's attachment to predict mean sequence distance/novelty and in the second model we used children's attachment and shyness scores to predict mean sequence distance/novelty (see Table 5.4). Model 2 including both predictors was better to explain the variance of mean sequence distance/novelty. The model explained 25% of variance in the mean sequence distance/novelty and was significant ($F(2, 21) = 3.55$, $p = .05$). Caregivers of shyer children generated sequences of higher novelty/complexity, whereas attachment scores did not predict mean sequence distance/novelty.

Table 5.4. Regression model 1 and 2 for mean sequence distance including the outlier.

	R^2	B	SE B	β	*p*
Model 1	.09				
Constant		2.45	.31		<.001
Attachment Mean Score		-.07	.05	-.30	.16
Model 2	.25				
Constant		2.06	.34		<.001*
Attachment Mean Score		-.08	.04	-.48	.09
Shyness Mean Score		.12	.06	.21	.047*

* Statistically significant at $p < 0.05$.

5.5. Discussion

Previous research (e.g., Damast et al., 1996; Neitzel & Stright, 2004) suggests that caregivers affect their children's learning environment and experiences and show sensitivity to their children's individual characteristics (e.g., Donovan et al., 2007; Dixon & Hull Smith, 2003). In the current study we investigated how caregivers interact with sequences of exemplars from object categories while playing with their children. Specifically, we were interested in whether caregivers were sensitive to children's object preferences and what level of information complexity the caregivers generated for their children while playing. We also considered the relationship between attachment and shyness on the agreement between the caregivers and the children on object choice, and on the information complexity.

Firstly, we investigated whether the caregivers and their children showed systematicity on the first object they chose from each object sequence. Within the cube set both caregivers and children systematically chose the rounded object first, which was a ball. This might have occurred since balls are objects known to caregivers and children and are used on an everyday basis as toys. Therefore, this choice might have been driven by familiarity. However, the majority of children who showed preference to the ball were not given the ball by their caregivers, whereas the majority of caregivers who chose the ball had children who preferred a different object. We ran all further analyses including and excluding the cube set due to the systematic selection of the ball, which could have influenced object selection and caregivers' object sequences in the following trials since objects were not replaced. However, the conclusions of the results were the same when the cube set was included or excluded, therefore in the discussion we will focus on the results including the cube set.

Subsequently, the analysis revealed that caregivers did not show sensitivity towards their children's preferences regarding object selection, since caregivers' object choices were different to children's preferences. Children's attachment to their caregivers suggested that caregivers with less securely attached children were more likely to choose the objects their children showed preference to, whereas shyness of children was not a predictor for caregiver-child object agreement. Further, caregivers had a tendency to generate intermediate to high levels of novelty/complexity object sequences for their children, however this was not different from chance. While attachment did not predict those sequences, shyness of children predicted that children with higher shyness were more likely to experience sequences of higher levels of novelty/complexity from their caregivers.

5.5.1. Caregivers' Object Choice and Children's Object Preference

Corter and Jamieson (1977) examined whether caregivers guessed with which object their child was to play with longer based on object complexity and novelty. Caregivers did not accurately guess which object their child was to choose as children were making different choices. Corter and Jamieson's study to our knowledge is the only published study examining object agreement, however it was not a joint-play study. Therefore, in our experiment we aimed to investigate object agreement within a joint-play event. Analysis of whether caregivers and children chose the same objects throughout the experiment showed low agreement in the first three out of the four trials. In the first trial caregivers could choose from five objects, in the second from four objects and so on, as the objects were not replaced. In the fourth trial there were only two objects to choose from and the agreement was moderate, however the chance to agree was high as the options were limited to only two. Thus, caregivers and children did not choose the same objects throughout the experiment.

Given that previous research suggests that caregivers are sensitive to their children's cues, such as eye-gaze direction (e.g., Csibra, 2010; Senju & Csibra, 2008) and pointing (e.g., Cameron-Faulkner et al., 2015; Lucca & Wilbourn, 2018; Southgate et al., 2007), the result that caregivers did not show sensitivity to their children's cues in the current study was unexpected. We would expect that caregivers would have followed children's eye-gaze using joint-attention (e.g., Mundy & Newell, 2007; Yu et al., 2009) and provided to children the object they looked at longer. The current study's results do not suggest that caregivers and children did not form joint-attention while playing or that caregivers perceived children's cues inaccurately, but rather suggests that caregivers did not show sensitivity to their children's cues under these settings or that caregivers just did not choose the objects their children showed preference and chose the objects they preferred. Recent research (Wass et al., 2018) suggest that during joint play children's attention to the objects did not affect caregivers' attention at the objects. Therefore, we could also suggest that caregivers were aware about their children's attention, but they just chose they objects they preferred. Research on whether caregivers and children show agreement on object selection while playing together is limited. Future research should examine this in more detail. For instance, whether children's ages or different environmental features, such as object novelty, could influence object selection agreement between caregivers and their children. This will shed more light on how children's environments are shaped by their social partners.

5.5.1.1. Object agreement and children's individual characteristics. We were also interested in whether agreement between caregivers and children was influenced by children's attachment and shyness. Shyness did not predict agreement, but attachment was lower when agreement scores were higher. It is well known that caregivers are sensitive towards their children's individual characteristics and abilities (e.g., Donovan et al., 2007), thus these behaviours could be interpreted as caregivers' sensitivity towards children's attachment. Previous studies suggested that children with higher attachment to their caregivers are more cooperative (Grusec & Goodnow, 1994) and follow their caregivers' requests (Van der Mark et al., 2002), whereas less securely attached children show less involvement during problem-solving tasks (Ainsworth et al., 2015). Thus, in the current study caregivers with less securely attached children may have provided children with the objects they preferred to enhance their children's cooperation and involvement in the task.

Further, securely attached children use their caregiver as a base of security and comfort while exploring the environment and sharing information with their caregivers. In contrast, children who are less securely attached share less with their caregivers when exploring their surroundings and get frustrated during separation events (Donovan et al., 2007). Therefore, caregivers might be aware that their less securely attached children could be frustrated if they do not receive their preferred object, whereas caregivers with more securely attached children might be more confident in providing different objects as their children feel more secure and are less likely to get frustrated. Taken together, caregivers' actions while playing with their children are affected by children's individual characteristics and in turn influences what children experience in these joint-play events. Additionally, this result highlights the importance that these characteristics have when examining children's experiences and learning.

5.5.2. Sequences of Object Novelty/Complexity Levels

Next, we calculated the novelty/complexity levels of the sequences the caregivers generated. To our knowledge, this is the first study to quantify the novelty/complexity level of the learning environment generated by caregivers for their children. We aimed to investigate this since social partners' behaviours influence children's experiences (e.g., Chapter 3; Chapter 4; Danis, 1997, Pereira et al., 2014) and existing research suggests that children prefer to learn from information that is of intermediate novelty/complexity levels. Kidd and colleagues (2012, 2014) showed that children prefer events that provide intermediate amount of information regarding their current knowledge level compared to lower or higher amounts of information. Earlier research (Dember & Earl, 1957; Yerkes & Donson, 1908) suggested that learners allocate their attention to stimuli that have the amount of novelty/complexity which is appropriate for their current knowledge.

We also know that caregivers show sensitivity to their children's learning abilities (e.g., Tamis-LeMonda & Bornstein, 1991), sophistication of their play activities (Damast et al., 1996) and provide support when children need to overcome a state of difficulty (Vygotsky, 1978). Therefore, we expected that caregivers would generate sequences of objects with intermediate levels of novelty/complexity in line with what children were found to do in recent studies. While caregivers had a tendency to generate sequences of high to intermediate levels of novelty/complexity, when examining the relationship between the distribution of all possible sequences that could have been generated by the caregivers and the distribution of the sequences they generated, we found no difference. Therefore, the sequences generated by the caregivers were not systematic but random and by chance.

This might have occurred because caregivers are not aware of these systematic learning techniques of their children, therefore they did not show sensitivity while generating these sequences for their children. Another possible explanation could be children's own structured learning environment. Recent research suggests that children are active, intrinsically motivated learners and structure their own learning environment (Smith, Yu, & Pereira, 2011), based on their curiosity (Twomey & Westermann, 2018). The everyday visual world offers many potential opportunities to explore, and their self-generated learning environment is highly different from an adult's environment, as the child's interests, activities and body size are profoundly different from those of an adult and as such influence children's experiences (Smith et al., 2011). Therefore, caregivers' lack of sensitivity regarding children's intermediate information novelty preference could also be driven by children's ability to structure their own experiences alone, as well as children's ability to maximise their learning input over and above their social partner's ability to do so (e.g., Smith et al., 2011; Yoshida & Smith, 2008). Additionally, the large differences between adults' and children's experiences within the same settings might have driven this result (Yu, Smith, Shen, Pereira, & Smith, 2009). However, the design of the current study might have not been sensitive enough in relation to data point numbers since each caregiver only generated three sequences. There were only five stimuli per set (three sets available, one each time) and when selected by the caregivers they were not replaced, which reduced the degrees of freedom as the experiment proceeded. A different task where objects are replaced and therefore provide the generation of longer novelty sequences might have shown different results. Future research with bigger sample sizes and more data points is needed to gain more detailed knowledge about whether caregivers are sensitive to the level of novelty/complexity of learning their children prefer.

5.5.2.1. Novelty/Complexity sequences and children's individual characteristics. Finally, we investigated if the novelty/complexity sequences of the objects the caregivers generated were influenced by children's attachment and shyness. We found that attachment did not predict sequence's level of novelty/complexity, but shyness was higher when the sequence's novelty/complexity level was higher. Previous studies on shyness suggest that shy children have reduced verbal interactions (Asendorpf & Meier, 1993) and less developed productive and receptive vocabularies (e.g., Hilton & Westermann, 2017; Smith Watts et al., 2014). Further, difficult temperament of children has been associated with their caregivers' behaviours. Previous research suggests that caregivers with children with higher negative temperament characteristics do not provide children with enough opportunities to solve problems alone (Fagot & Gauvain, 1997), but provide higher levels of play, show higher efforts to appease children and provide children with a larger selection of objects (Dixon & Hull Smith, 2003). Therefore, caregivers of shyer children might have produced sequences of higher novelty/complexity levels as a way to maintain their children's attention and keep children satisfied throughout the experiment. In particular, larger novelty differences between the objects may have made the whole procedure more interesting for those children. The differences in novelty/complexity of the sequences in the current study provided different learning inputs to the children by their caregivers, which highlights the importance of specific temperamental characteristics of children and the influence that those characteristics have on their caregivers' behaviours. The effect that temperamental characteristics have on caregivers' behaviours towards their children could also be interpreted as caregivers' sensitivity towards their children (e.g., Donovan et al., 2007), where caregivers respond and adjust their behaviours following their children's individual characteristics. This result adds to the limited research on how specific temperamental characteristics, affect caregivers' behaviour towards children and strengthens the important role that these characteristics have when investigating children's development.

5.5.3. Conclusions

To our knowledge these results add to the limited research about how caregivers structure their children's learning environment based on object choice agreement and sequences of objects based on levels of novelty/complexity alongside their children's individual characteristics of attachment and shyness. At such, they should be considered cautiously as future research is needed for replication and to explore these results in more detail. Exploring these types of interactions between caregivers and children including children's individual characteristics would provide further insights about how caregivers structure their children's environment while playing together in relation to caregivers' sensitivity towards their children's abilities, needs and cues. This type of research would provide new information about the importance of a caregiver's behaviours in a child's learning environment and would help us understand child's cognitive development through their everyday interactions.

Chapter 6: Discussion: The Role of Children, Social Partners and Objects in a Triad for Children's Learning Environments

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Discussion: The Role of Children, Social Partners and Objects in a Triad for Children's Learning Environments

6.1. Summary

The current thesis aimed to explore how objects, social partners and children themselves structure and influence the child's learning environment in relatively unconstrained settings closer to children's everyday environments. Overall, this work highlights the complexity of a triad which constructs the environment and learning experiences of children through their development, alongside individual characteristics of children and individual characteristics of social partners. Current research has not studied in detail whether social partners' actions and language characteristics are influenced by object characteristics and children's developmental stages and whether social partners structure this environment systematically. This thesis provides evidence that social partners' actions can affect children's environments, while social partners' actions and language characteristics are affected by object novelty, children's developmental stages and children's individual characteristics and thus in turn, structure a learning environment for children, which is not systematic.

6.2. The Triad: Child, Social Partner and Objects

Generally, this thesis provided evidence and new insights that the features of this triad constitute children's experiences, environments and learning input. Each element in the triad affects all other elements and therefore influences children's environments and children's cognitive development. To achieve this, we used children's eye-tracking and/or behavioural measures of the social partner from joint play events. Since we know that children's own perspective scenes regarding scene properties systematically differ from adult-perspective scenes (Smith, Yu, & Pereira, 2011) and from third-person perspective scenes (Yoshida & Smith, 2008; Yurovsky, Smith, & Yu, 2013), and are not easily predicted by adult intuitions (Franchak, Kretch, Soska, & Adolph, 2011; Fausey et al., 2016), we used head-mounted eye-tracking to examine children's looking behaviours from their own perspective (Chapter 3, 5). The following discussion brings together the results from Chapters 3, 4 and 5 along with implications and limitations and future directions in the context of each chapter, followed by general limitations and general future directions.

6.2.1. Playing Alone or With a Social Partner

In Chapter 3 we investigated whether children's looking times were affected when children's social partner (the experimenter) was actively involved in the manipulation of objects compared to when objects were manipulated by children alone. We were also interested in whether the presence or absence of labels can influence children's looking times, however we found no differences between children's looking times under these two conditions.

6.2.1.1. Effect of handling on children's looking times. Children looked longer at the objects when only the social partner handled them suggesting that social partner's active involvement in object manipulation affects children's experiences. Children's sustained attention to the objects might have been influenced by their social partner's actions during joint play. When a social partner attends to objects (Wass et al., 2018), that is, showing interest to the objects by holding and looking at them, children are more likely to attend more to those objects (Suarez-Rivera, Smith & Yu, 2018). In line with attention, since children were not able to actively manipulate the objects, their desire to get the objects (e.g. Brooks & Meltzoff, 2002) might have also increased their looking times.

Additionally, when the experimenter handled the objects, children with lower vocabulary scores looked longer at the experimenter's face. This increase in looking times might be due to children's attempts to gather sociopragmatic information to form object-label mappings (Baldwin, 1991, 1993; Vaish, Demir, & Baldwin, 2011) and/or seek assistance during the task (Goupil, Romand-Monnier, & Kouider, 2016). Samuelson, Kucker and

Spencer (2017) suggested that when children increase their knowledge in the initial mappings, children then shift from novelty-driven associations (N3C; Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992) to more sophisticated processes, such as mutual exclusivity (Markman & Wachtel, 1988). In our study children with lower productive vocabulary were more likely to retain object-label mappings. In the exploration task only one novel object was available each time, which may have disadvantaged children with higher vocabulary who are more expert and use more sophisticated techniques, for example mutual exclusivity (Samuelson et al., 2017). Better retention of the novel words was also predicted when children performed fewer eye-gaze switches when the social partner handled the objects. This can be explained as a beneficial strategy from children to look longer at the one available object, since fewer eye-gaze switches promote more sustained attention (Yu & Smith, 2016) to the target object, which has been linked to more successful object-label retention (e.g., Hilton, Twomey, & Westermann, 2019).

Further, when the objects were handled by children alone, children looked longer at the experimenter's face. Children might have done this to involve the experimenter in the task (e.g., Baldwin et al., 1996) and establish joint attention during play (Gogate, Bolzani, & Betancourt, 2006). Another explanation could be that children might have looked longer at the experimenter's face to gather information (Goupil, Romand-Monnier, & Kouider, 2016) regarding the labels provided, as looking at the social partner's face significantly contributes to lexical development (Byers-Heinlein, & Werker, 2009). Therefore, this finding proposes children's ability to actively maximize their learning input above their social partner's ability to do so.

6.2.1.2. Vocabulary and eye-gaze switching. Children with lower productive vocabularies performed more eye-gaze switches between the objects and other areas of interest (e.g. experimenter's face and hands) in the no handling condtition. Previous research suggests that increased eye-gaze switching (Gogate et al., 2006; Matalyaho & Gogate, 2011; Silvén, 2001) during object-label association learning enhances children's retention of those associations.

6.2.1.3. Limitations. The objects in Chapter 3 had similar shapes, which might have disadvantaged children to learning the labels as the distinction between them was ambitious. While the main question of the study was not children's retention, we examined whether they learned the labels since we provided labels to half of the novel objects. The five minutes break between the exploration task and retention (see Horst & Samuelson, 2008), alongside alike novel objects, the small amount of time for exploration (30s) and the complicated design of the study, might have disadvantaged children to learn object-label mappings.

Additionally, the two handling conditions were between participants. Therefore, different children might show dissimilar behaviours under different circumstances. We followed this design as we expected that starting with active manipulation of the objects by children and then moving to active manipulation only by the experimenter would have frustrated children.

6.2.1.4. Implications. Generally, these results suggest that social partners' active involvement during object manipulation, affects children's looking behaviours and object-label retention. This evidence adds to current literature about children's and social partners' role in the structure of children's experiences and learning input (e.g., Pereira, Smith, & Yu, 2014) and stresses the importance of social partners' active involvement in children's play. Based on the triad we suggest in the current thesis, these findings show a strong link between the active involvement of the adult when the child is manipulating novel objects, as well as, affecting language learning during this exploration. Therefore, since social partners were found to influence what children experience, a further question emerged of whether social partners' behaviours are affected by other environmental features, such as object novelty and in turn influencing children's experiences.

6.2.2. Caregivers as Social Partners, Object Novelty and Developmental Stages

In Chapter 4 we explored whether object novelty affected caregivers' verbal and action responses in a relatively unconstrained caregiver-child interaction. Caregivers' actions and characteristics of infant directed speech (IDS) were affected by object novelty and children's developmental stages, as this study included both a prelinguistic and a speaking stage group.

6.2.2.1. Caregivers' interactive actions. In line with Danis (1997), Chapter 4 suggests that caregivers' actions are affected by object novelty. Specifically, caregivers produce more interactive actions when they play with familiar compared to novel objects. Children show higher sensitivity to novel objects through longer manipulation and longer looking times (Willats, 1983; Oakes & Tellinghuisen, 1994). Piaget (1945) proposed that children explore familiar and novel objects differently. When children play with familiar objects, they use undirected expected actions, whereas when they interact with novel objects they show longer and sustained attention. Therefore, caregivers' reduction of interactive actions during the presence of novel objects, can be explained as caregivers' adjustment to children's manipulation preferences (e.g., Donovan, Leavitt, Taylor, & Broder, 2007; Vygotsky, 1978, 1980).

Additionally, children's developmental stages affect caregivers' actions: caregivers of older children produced more interactive actions compared to caregivers of younger children during play. In terms of motor development, older children interact more with their physical environment and social partners and engage more frequently in joint play as they can give and take objects, which creates a more interactive environment (Libertus & Landa, 2013; Bushnell & Boudreau, 1993). In line with previous research, Chapter 4 suggests that caregivers adjust their interactive actions based on their children's manipulation preferences (Danis, 1997) and developmental abilities (e.g., Libertus & Landa, 2013) due to caregivers' sensitivity to their children (e.g., Donovan et al., 2007).

6.2.2.1.1. Effect of maternal educational level on caregivers' interactive actions. Caregivers' actions were predicted by maternal educational level: caregivers from higher educational backgrounds provided more interactive actions while playing compared to caregivers of lower educational backgrounds. Therefore, caregivers from higher educational backgrounds might have produced more interactive actions due to their enhanced knowledge about their children's developmental needs (Rowe, 2008; Rowe & Goldin-Meadow, 2009), such as greater awareness of cognitive stimulation (Raviv, Kessenich, & Morrison, 2004). Conversely, reduced active interaction from caregivers during play might disadvantage children since extended interaction with an adult enhances development and especially language development (Dave, Mastergeorge, & Olswang, 2018; Rowe, 2008). Therefore, future research needs to explore this effect in more detail to determine whether this lack of interaction during play can affect children's cognitive development and to what extent early intervention can limit this disadvantage.

6.2.2.2. Caregivers' infant directed speech. The current work is the first to provide evidence (to the author's knowledge) as to whether object novelty affected caregivers' characteristics of IDS. Caregivers of older children produced shorter first utterances with wider pitch range, especially for novel objects and overall used more words throughout the experiment. Caregivers' wider pitch range could have been used as an attention gatherer and director of their children's attention (Trainor & Desjardins, 2002) to the novel objects. Exploring objects and extracting information from their features enhances children's cognitive development (Baumgartner & Oakes, 2013; Needham, 2000; Oakes & Madole, 2000). Therefore, caregivers adjust their IDS in favour of their children's learning (e.g., Liu, Tsao, & Kuhl, 2009; Tamis-LeMonda, Bornstein, & Baumwell, 2001; Loy, Masur, & Olson, 2018; Pêcheux, Findji, & Ruel, 1992), as attention to novel information is important to acquire new knowledge. Further, caregivers of younger children expand the duration of pronouncing words to make them perceptually distinct between one another (Kuhl et al., 1997; Liu Kuhl, & Tsao, 2003), which may be beneficial for younger children (Kuhl et al., 1997). Therefore, caregivers of younger children might have used less words as they expanded the duration of pronouncing each word, whereas caregivers of older children may have pronounced words faster. This explains the use of more words and shorter utterances by caregivers of older children, since the use of long utterances decreases as children acquire language (Sherrod, Crawley, Petersen, & Bennett, 1978).

Caregivers produced narrowed pitch range for children with higher receptive vocabularies, while caregivers of older children provided wider pitch range. These two results are contradictory, since older children had higher vocabularies. Thus, we expected that caregivers of both children with higher vocabularies and older children would show the same patterns regarding pitch range. Narrowed pitch range has been associated with the development of language comprehension (Liu et al., 2009; Stern, Spieker, Barnett, & MacKain, 1983). In this context, caregivers of older children with higher vocabularies should have shown narrowed pitch range. An explanation could be children's individual differences in language development, since each child develops at its own pace (Bates, Dale, & Thal, 1995; Kidd, Donnelly, & Christiansen, 2018) and caregivers adjust their behaviours based on their children's needs (Snow, 1977; Vygotsky, 1978). Therefore, each caregiver might have been adjusting her pitch-range in relation to her understanding about her own child's language development.

6.2.2.3. Limitations. In sum, the results regarding pitch range are conflicting and need to be interpreted with caution in line with the fairly low variance explanation from all the regression equations in Chapter 4. The regression equations were not a good fit to the data. This might have been the result of not including all relevant predictors to explain the outcome variables. Other predictors could have been caregivers age, as well as caregivers' emotional status before and after the experiment, which might have affected their pitch values. Future research is needed in order to make stronger conclusions regarding object novelty and children's developmental stages with respect to their influence on caregivers' characteristics of IDS and interactive/non-interactive actions.

6.2.2.4. Implications. Caregivers' sensitivity towards their children's developmental stages (Chapter 4; Vygotsky, 1978) and children's exploratory behaviours with familiar and novel objects (Chapter 4; Danis, 1997) prompted caregivers to adjust their behaviours regarding their children's own abilities and behaviours (e.g., Donovan et al., 2007). Based on the triad that exists in children's environments, these findings provide evidence that the link between the caregiver and the child is affected by both the child's and caregiver's individual characteristics, whereas the link between the caregiver and the objects can be affected by objects' characteristics. All these influences between the features of the triad suggest that small changes of each feature (e.g., for children their age can be seen as a change) can affect children's experiences and consequently their learning. These results stress the importance of investigating what could affect social partner's behaviours and in turn how these behaviours influence children's learning input. Chapters 3 and 4 suggest that social partners' actions affect children's experiences when actively involved during play, while caregivers are sensitive to children's abilities and adjust their actions and vocal characteristics in favour of their children's learning. Therefore, the question of whether social partners, and specifically caregivers, structure children's environment systematically, and if they do, whether they structure this environment in response to their children's behaviour was developed.

6.2.3. Caregivers Structuring the Learning Environment

Chapter 5 investigated whether children's learning environments are systematically structured by their caregivers, in response to children's behaviour and individual characteristics.

6.2.3.1. Do caregivers show sensitivity to children's object preferences? Caregivers' sensitivity towards children's object preferences was investigated, in relation to whether caregivers chose the objects their children showed preference. However, caregivers did not choose the objects their children preferred, as indicated from children's looking times, suggesting that caregivers did not show sensitivity to children's preferences (see Corter & Jamienson, 1977). Caregivers are sensitive to their children's cues, such as eye-gaze direction (e.g., Csibra, 2010; Senju & Csibra, 2008) and pointing (e.g., Cameron-Faulkner, Theakston, Lieven, & Tomasello, 2015; Lucca & Wilbourn, 2018; Southgate, Van Maanen, & Csibra, 2007), and caregivers' actions are mainly child-directed and initiated (Aslin, 2012; Eshel, Daelmans, Mello, & Martines, 2006). Caregivers observe those cues and accurately interpret them to meet children's needs (Heinicke et al., 1999). Therefore, within this context, we could suggest that caregivers might not always be sensitively responsive to their children.

An explanation could be children's age. In Chapter 5, children were two years of age, whereas the majority of the studies exploring caregivers' sensitivity towards their children include younger children (e.g., Heinicke et al., 1999; Donovan et al., 2007). Therefore, caregivers' sensitivity towards children's cues may change over time. A different explanation could be task differences. While many previous studies were designed to be "free play" where social partners explored together (e.g., Danis, 1997), in the current experiment the caregiver was expected to choose the objects her child was to play with. Hence, it is possible that caregivers were concentrated on object selections and did not successfully attend to the cues from their children.

6.2.3.2. Learning input structured by the caregiver. In Chapter 5 we examined whether caregivers structure their children's learning input to a specific level of complexity. Caregivers did not systematically generate levels of complexity for their children to learn from, whereas recent empirical research suggests that children are more likely to systematically choose intermediate novelty/complexity (e.g., Kidd, Piantadosi, & Aslin, 2012, 2014). We expected that caregivers might have been aware of children's preferences regarding learning novelty/complexity due to caregivers' sensitivity to their children's learning abilities (e.g., Tamis-LeMonda & Bornstein, 1991) and sophistication of play activities (Damast, Tamis-LeMonda, & Bornstein 1996). Nevertheless, this is the first study to examine what levels of novelty/complexity are found in object sequences generated by caregivers for their children. Future work could use 3D stimuli sequences (see Chapter 5) and ask caregivers to create sequences of objects alone and with their children and examine whether the complexities of these sequences differ. This will provide information about how caregivers structure sequences of complexity and then compare them to the sequences generated while playing together with their children.

6.2.3.3. Children's individual characteristics. Chapter 5 provides evidence suggesting that children's differences in their attachment and shyness levels could influence caregivers' behaviours, suggesting that children may indirectly structure their own experiences. Specifically, caregivers of less securely attached children were more likely to choose the objects their children preferred. This suggest that caregivers are aware that their less securely attached children could be frustrated if they do not receive their preferred object (Donovan et al., 2017). Conversely, caregivers with securely attached children are more confident in providing different objects as they know that their children are more cooperative (Grusec & Goodnow, 1994) and willing to follow their requests (Van der Mark, Bakermans-Kranenburg, & Van Ijzendoorn, 2002).

Additionally, caregivers generated sequences of higher complexity for shyer children. This result, in line with previous research, suggests that caregivers of shyer children generated object sequences of higher complexity to keep children satisfied and maintain their attention in the task using higher levels of play: more perceptually complex sequences are more interesting as the differences between the objects each time are perceptually greater (e.g., Dixon & Hull Smith, 2003; Fagot & Gauvain, 1997; Gauvain, 1995).

Arguably, therefore, children's intrinsic characteristics influence caregivers' behaviours during joint play, and consequently affect what children experience. Thus, to understand in detail why caregivers behave in certain ways during joint play, and why children show different behaviours within the same settings, children's individual characteristics have to be considered. Including more information about such characteristics will provide a deeper understanding for children's development, and specifically children's differences within cognitive development, as well as caregivers' differences when structuring the learning environment for their children.

6.2.3.4. Limitations. In Chapter 5 we used children's longer looking times as a cue to indicate their preference to objects. When children look longer at a stimulus over another when presented at the same time, this indicates preference for the stimulus with the longer looking times (Aslin, 2012). Nevertheless, we need to consider that looking times are constitute by two types of looks: looks where information is processed and looks that are considered as blank stares (Aslin, 2007). This suggests that the children might have been looking at the objects, but we cannot be sure whether their looks included processing of the objects' information or whether their looks were blank stares at the objects. However, this is a limitation for all studies that examine looking behaviours if they do not include a cognitive task at the end to examine if the information was processed by the participant. In the current study we did not include a cognitive task as it was not relevant to our questions.

Children also use other cues to communicate their preferences, such as pointing. Children point to share their attentional focus with a social partner and/or ask their social partner to do something for them from around nine months old (Bates et al., 1975). Specifically, two-year-old children use pointing to share attention with their social partner and redirect their social partner's attention (Moore & D'Entremont, 2001). In Chapter 5, children were two years old, therefore, we could have used children's pointing to determine object preferences or a combination of looking times and pointing. However, we did not ask children to point, to not actively involve the experimenter, since we aimed to create an environment close to children's everyday experiences; that is, playing with their caregivers.

Similarly, we did not request caregivers to ask their children to point at their preferred object as this would have clearly indicate children's preferred object and we would not be able to examine caregiver-child object agreement through caregivers' sensitivity to their children's cues, particularly eye-gaze at the objects since this was our measure. Caregivers are sensitive towards their children's cues therefore we expected that following their children's eye-gaze during joint play was clear to understand children's preferred objects. Nevertheless, object agreement between caregivers and children during joint attention has not been studied before (to the author's knowledge). Future work should explore caregiver-child agreement using different cues of children or a combination of them. For instance, studies could investigate whether children's developmental stages affect caregiver-child object agreement to shed light on whether caregivers' sensitivity to children's cues changes depending on children's age.

6.2.3.5. Implications. Overall, Chapter 5 suggests caregivers' lack of sensitivity under these circumstances towards their children's object and learning preferences, whereas in Chapter 4 caregivers showed sensitivity to their children's developmental stages and object manipulation preferences. Therefore, it is important to explore in which instances caregivers show lack of sensitivity and whether these affect caregiver-child interactions and/or children's learning. A possible explanation regarding the structure of the environment not being systematic by the caregivers could be that children structure their own learning environments. We know that children are active, intrinsically motivated learners and structure their own learning environment (Smith et al., 2011). Chapter 3 alongside other research (e.g., Pereira et al., 2014; Smith et al., 2011) provided evidence which suggests that children's visual environments are highly different when they play alone compared to when they play with their social partner. Therefore, caregivers not structuring the environment systematically following children's preferred information complexity (e.g., Kidd et al., 2012, 2014) and preferred objects could also have been driven by children's ability to structure their own different experiences. These could also be supported by the large differences between adults' and children's experiences within the same settings (Smith et al., 2011). Based on the triad we introduced in the current thesis that constitutes children's environments for a significant amount of time, these results suggest that all three main features of the triad can affect each other. Specifically, children's individual characteristics can affect caregivers' behaviours during joint play, caregivers choose different objects than the ones that children show preference and caregivers do not structure children's environments systematically.

6.3. Bringing the Triad Together in a Dynamic System

To summarise, the current work examines children's learning environments and their structure through a triad formed by children, social partners and objects. Specifically, children directly impose structure on their learning environments by selectively choosing where to attend driven by their own motivation (Chapter 3). When social partners are actively involved, they can affect this selection (Chapter 3). Social partners, and especially caregivers directly structure children's environments by providing particular toys to children to play with, but not systematically (Chapter 5). Children's intrinsic characteristics, such as shyness and attachment levels, indirectly affect their caregivers' behaviours towards them, therefore children's environment is also shaped by their own intrinsic characteristics. (Chapter 5). Children's vocabulary level affects language learning (Chapter 3), as well as it affects their caregivers' vocal responses while playing together (Chapter 4). Generally, environmental factors, such as types of objects and children's developmental stages, influence caregivers' actions when interacting with their children and again influencing children's learning (Chapter 4). Interestingly, caregivers are sensitive to their children's manipulation preferences and developmental stages (Chapter 4) but show lack of sensitivity regarding children's object preferences and children's preferred level of complexity during learning (Chapter 5).

According to the dynamic systems interaction theory (Thelen & Smith, 1994, 2007; Smith & Thelen, 2003), learning is a dynamic system with several parts which are interconnected and change with time (Lunkenheimer, 2018). Therefore, development is a complex dynamic system open to environmental changes, while information exchange between the system and the environment is continuous (Thelen & Smith, 2007). The components within a dynamic system are mutually interactive and linked between the environment and the individual and within the individual alone. The processes in this system are cumulative and seamless in time, where physical and mental development are always in the "history" of the system and set the stage for the next piece of information to be learnt (Thelen & Smith, 1994, 2007; Smith & Thelen, 2003). Hence, in the context of the current thesis, social partners, children and objects are interconnected and constitute a dynamically complex learning environment for children, where each component interacts with the other components either directly or indirectly. In other words, children's learning environments are affected by several features, while they are also open to environmental changes.

The results of this thesis strongly support the dynamic systems theory. The evidence provided earlier in this chapter suggests that the triad of child, adult and objects as a system is dynamic since each feature affects the others and environmental or other changes of these features affect the dynamics of this system. For example, Chapter 5 suggested that children's shyness and attachment levels affect caregivers' object selection, while in Chapter 4 object novelty and children's age were able to influence caregiver's actions and speech characteristics. In Chapter 3, the active involvement of the social partner when children were playing with novel objects affected children's looking behaviours and novel label retention. The results of the current work demonstrate that the triad is a dynamic system open to changes as well as influenced by changes. At the same time the development within the triad exists in the "history" of the triad's system. For instance, when new information is learnt it belongs to the "history" of the system and sets the background for new information to be learnt. An example from the current thesis could be caregivers' adjustments (e.g., speech, actions, object selection) according to their children's age and exploratory behaviours. That is, allowing children to play longer with novel objects to promote learning, whereas caregivers are more interactive when playing with familiar objects where the background is already set since the object is known. Another example could be children's shyness. This characteristic is known by the caregiver and it is placed in the "history" of the triad, therefore it influences the interaction between the caregiver and the child, specifically influences the caregiver's object selection. The current work suggests that there are many factors that affect the dynamic system of the triad, from different types of objects to children's temperamental characteristics. Therefore, if we aim to fully understand children's learning and cognitive development, we need to understand how environmental features that could influence this development interact with each other in a dynamic environment (see Figure 6.1.).

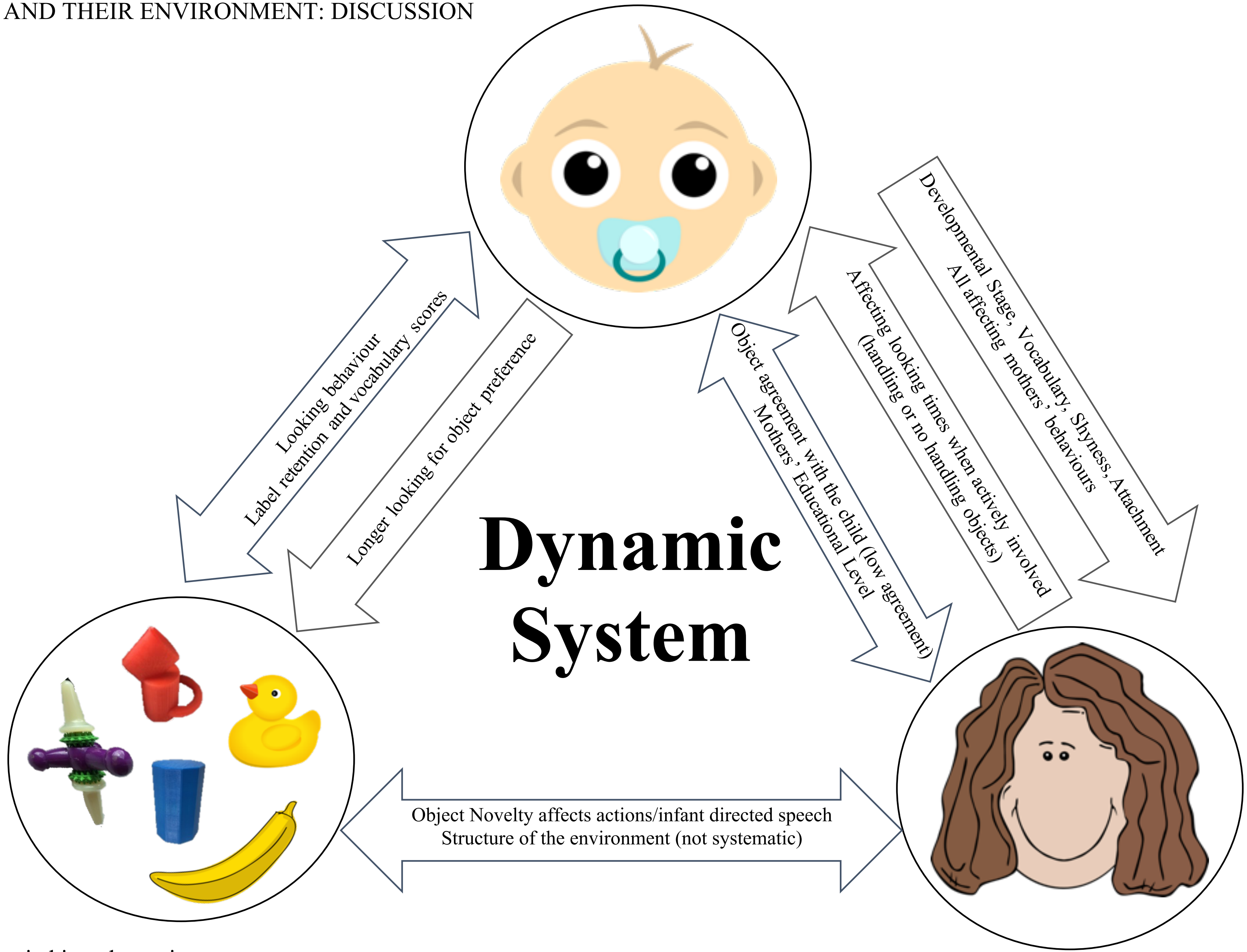

Figure 6.1. The triad in a dynamic system.

6.4. General Limitations of The Current Work

In the current thesis each study was developed to allow children and/or caregivers to actively explore, play with and manipulate objects in relatively unconstrained settings. Both Chapter 3 and 5 measured children's eye-gaze using head-mounted eye-tracking. While this equipment allows the collection of gaze data in more naturalistic environments that typically offered by remote eye-trackers, data loss is unavoidable. During testing children tend to look at other available information, which is not part of the experiment. While this is true for remote eye-tracking, the data from head-mounted eye-trackers are noisier. Further, this equipment leads to high dropout of participants due to children's aversion to wearing the head gear. Additionally, children's calibration check takes place offline after data collection, therefore not being able to check calibration quality before the experimental task could also lead to participant dropout. We know that the more time we need for a good calibration, the less likely children will cooperate at the main experimental goal of the eye-tracking task (see Aslin & McMurray, 2004). Thus, in the current work we decided to check calibration offline, in order to avoid children's frustration.

In Chapters 4 and 5, the social partners for children were their caregivers (specifically their mothers) as we aimed to investigate their behaviours while playing with their children. While caregivers were not informed about the actual aims of each study, the possibility that some caregivers were not spontaneous has to be considered. Caregivers may have been anxious to perform their best during the task, which might have affected their behaviours. For instance, caregivers might have been overacting during the tasks as they knew they were recorded, which might have affected the scores within variables (e.g., actions, pitch). Conversely, some caregivers might not have been interested in the task and therefore performed by chance. That is, caregivers may have not behaved as they would normally do.

However, in order to control these possibilities, we used mean scores and proportions and tested for outliers and transformed variables where possible.

The experiments in the current work took place within the lab and the tasks were designed to be relatively unconstrained to provide an environment closer to caregivers and children's everyday experiences. However, we need to consider that caregivers and children may behave differently if they are in their own environment (see Salomo & Liszkowski, 2012). Nevertheless, the current thesis investigates new themes in a dynamic triad, which is part of children's everyday experiences. Future work needs to examine these themes in more detail within caregivers and children's own environments.

6.5. Future Directions

The current thesis suggests that all features in the triad of children, social partners and objects dynamically affect each other. Given that this triad constitutes children's everyday environment, or at least a large proportion of it, children's learning is inevitably influenced by the interaction of all these factors. Therefore, if we aim to fully understand how children's environments are structured and how children's learning input may differ, we need to investigate this dynamic triad in detail. While future research has been proposed within the context of each study, here we suggest general future directions that could shed light on the interactions between the features of this triad.

Future research could examine the same participants in a longitudinal study to investigate how caregivers' behaviours and characteristics of IDS change over time while playing with familiar and novel objects. This will enhance our understanding about how caregivers' behaviours change over time in relation to children's developmental stages and whether such changes enhance children's learning. Additionally, future research could also investigate how fathers' behaviours change under these conditions and compare their behaviours with mothers. While the majority of research explored mothers' behaviours with children, investigating how fathers interact with their children under several circumstances (e.g., play with familiar and novel objects) will provide a bigger picture about children's everyday experiences, since fathers also spend a significant amount of time with their children.

We know that caregivers' behaviours highly differ between cultures (e.g., Bronstein, 1984; Gogate, Maganti, & Bahrick, 2015). Therefore, future research could examine whether children's looking behaviours differ during playing, whether object novelty affects caregivers' characteristics of IDS and actions, whether caregivers systematically structure their children's environments and whether caregivers choose the same objects with their children across different cultures. Such research will provide information about how children's experiences are formed between cultures and further understand cultural differences regarding children's learning, development and their interactions with their parents/caregivers.

6.6. Conclusion

While children learn when they interact independently with their environment, the importance of social partners and objects in this learning environment should not be neglected. During children's everyday experiences social partners and objects are present for a significant amount of time, affecting children's learning and experiences. Therefore, children, social partners and objects form a dynamic triad, in which all elements interact with and affect each other. To illustrate, different kinds of objects elicit different actions and language characteristics from the social partners. Children's developmental stages and individual characteristics such as shyness also influence social partners' behaviours during play. Social partners' actions affect children's looking times and therefore children's exploration of objects.

In summary, the current thesis should stand as a demonstration that understanding how children, their social partners and objects interact can offer key insights into children's cognitive development. Through this exploration our knowledge about children's development and learning input, as well as why children show different developmental patterns could be explained. When exploring children’s learning world, including social partners and objects alongside individual differences could provide a more detailed explanation of how and why children learn the way they do.

Appendix A for Chapter 5

Agreement Regression

Checks on regression assumptions revealed an extreme outlier in the attachment mean score predictor. Table 5.1 and 5.5 demonstrate the regression models excluding and including the extreme outlier respectively. The model that was selected from both tables was Model 2 as in both cases the model was able to explain a bigger proportion of the variance of the outcome variable of total agreement scores. After choosing the best models for the regression including and excluding the outlier, we compared the parameters of the two regression models to decide which model would be best (see Table 5.6). If an outlier is not influential in the outcome then this difference should be zero (see Predicted Y at Table 5.6), therefore we expect that this difference should be as small as possible. As seen in the difference column for the predicted Y (see Table 5.6) for the outlier (Case 19), when the outlier is included and when the outlier is excluded is a lot higher (4.52) than zero indicating that the outlier affects the results of the model when included. We used Model 2 excluding the outlier from the attachment mean scores as showed in Table 5.1 (see Field, Miles, & Field, 2012).

Table 5.5. Regression model 1 and 2 for total agreement scores including the outlier.

	R^2	B	SE B	β	*p*
Model 1	.09				
Constant		11.16	1.96		<.001
Attachment Mean Score		-.43	.30	-.29	.16
Model 2	.12				
Constant		10.09	2.34		<.001
Attachment Mean Score		-.45	.30	-.31	.15
Shyness Mean Score		.34	.40	.18	.40

Table 5.6. Comparing the parameters for the regression model when the extreme outlier was included and excluded.

Parameter (b)	Case 19 included (Model 2)	Case 19 excluded (Model 2)	Difference
Constant	10.09	16.39	6.30
Predictor X_1 (Attachment Mean Score)	-.45	-1.41	.96
Predictor X_2 (Shyness Mean Score)	.34	.41	.07
Model	$Y = (-.45)X_1+(.34)X_2 +10.09$	$Y = (-1.41)X_1+(.41)X_2 +16.39$	
Predicted Y	10.31	14.85	4.52

Note. X is the value for case 19 for each independent variable.

Appendix B for Chapter 5

Novelty/Complexity Sequences Regression

Checks on regression assumptions revealed an extreme outlier in the attachment mean score predictor. Table 5.4 and 5.7 demonstrate the regression models including and excluding the extreme outlier respectively. The model that was selected from both tables was Model 2 as in both cases it was able to explain a bigger proportion of the variance of the outcome variable, mean sequence distance. Therefore, after choosing the best fitted models for the regression including and excluding the outlier, we compared the parameters of the regression models to establish the extent of the influence of the outlier (see Table 5.8). If an outlier is not influential in the outcome then this difference should be zero, therefore we expect that this difference should be as small as possible As seen in the difference column for the predicted Y of the outlier (see Table 5.8), when the outlier is included and when the outlier is excluded the difference is small and close to zero (.10) indicating that the outlier does not affect the results. We therefore included the outlier in the attachment mean scores predictor and use Model 2 as shown in Table 5.4 (see Field, Miles, & Field, 2012).

Table 5. 7. Regression model 1 and 2 for mean sequence distance excluding the outlier.

	R^2	B	SE B	β	p
Model 1	.01				
Constant		2.33	.66		.002
Attachment Mean Score		-.05	.10	-.11	.61
Model 2	.20				
Constant		2.04	.63		.004
Attachment Mean Score		-.07	.09	-.16	.43
Shyness Mean Score		.12	.06	.42	.05*

* Significant at $p \leq 0.05$.

Table 5.8. Comparing the parameters for the regression model when the extreme outlier was included and excluded.

Parameter (b)	Case 19 included (Model 2)	Case 19 excluded (Model 2)	Difference
Constant	2.45	2.33	.12
Predictor X_1 (Attachment Mean Score)	-.08	-.07	-.01
Predictor X_2 (Shyness Mean Score)	.12	.12	0
Model	$Y = (-.08)X_1+(.12)X_2 +2.45$	$Y = (-.07)X_1+(.12)X_2 +2.33$	
Predicted Y	2.69	2.59	.10

Note. X is the value for case 19 for each independent variable.

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