Exploring childcare spaces

Young children's exploration of the indoor play space in center-based childcare

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Young children's exploration of the indoor play space in center-based childcare

Ruimten voor kinderopvang exploreren

De exploratie van de binnenspeelruimte in kinderdagverblijven door jonge kinderen

(met een samenvatting in het Nederlands)

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Chapter 1

General Introduction

Introduction

A young child who visits a daycare center for the first time encounters an environment that differs in many ways from his or her home. There are the sounds and movements of other children and adults. There is an unfamiliar space, with rooms that are often bigger than the ones at home. Moreover, the interior design looks different. There is a variety of furniture, play areas and toys that the child has to share with other children. The childcare center is in many respects a distinct social and physical setting that offers the child both new opportunities and challenges: opportunities to interact with peers and to explore a space that is unlike home, and challenges, because the space and its facilities have to be discovered still and shared with others.

A growing number of young children worldwide are enrolled in a child daycare center or preschool in the first years of their lives (OECD, 2014). Ever more children spend an important part of their early years in a childcare setting, and the question whether the quality of childcare settings is satisfactory and contributes to the wellbeing and development of children, has become an urgent one. Most studies into the quality and effects of center-based child care on children's behavior and development focus on the emotional and educational quality of the everyday processes of interaction of children with peers and caregivers in the daycare setting and have addressed how structural characteristics of the childcare setting, pertaining in particular to people, such as adult-child ratio, group size and teacher education, influence process quality (Burchinal, Vandergrift, Pianta & Mashburn, 2010; NICHD Early Child Care Research Network, 2002). Studies examining child behavior and development in relation to the physical environment of daycare centers, however, are scarce. Although the spatial layout, the furnishing and availability of play objects, and the available square meters per child are usually included in global quality assessments (see below), few studies have specifically examined how these characteristics influence children's behavior and development. Yet, in developmental science, the awareness is increasing that the physical environment plays a critical role in children's cognitive and social development. According to the embodied cognition view, for example, knowledge is grounded in real time experiences and knowledge develops through a child's recurrent self-initiated and self-propelled interactions with his or her environment (Smith, 2005), actions which we will refer to as *exploration*. Children gather information and acquire new skills through exploration, that is, through "learning solutions specific to their postures, locations or other particulars of the context" (Thelen & Smith, 1998, p.326). In other words, children use their sensorimotor capacities to perceive and act upon their social and physical environment (Garbarini & Adenzato, 2004). The notion of embodied cognition builds on the ecological psychology theory developed by James and Eleanor Gibson, who introduced the concept of affordances to refer to the idea that objects

and spaces offer opportunities for action relative to what a person can perceive and to the kind of actions a person is able to perform (J.J. Gibson, 1979/1986; E.J. Gibson, 1988). By acting on their environment, children discover correlations between their own sensorimotor behavior and the changes in the environment caused by this behavior, which are essential for developing their cognition and skill (Oudgenoeg-Paz, Leseman & Volman, 2014). They discover, for instance, that a ball can be moved by only a soft push, but that it moves much faster and further away when you roll it down from a slope. Children's exploration is obviously related to their motor development: transitioning from crawling to walking enables children to see more and also new, distal and elevated targets, such as objects and people at a distance, offering new opportunities to explore and act upon in their environment (Kretch, Franchak & Adolph, 2014). Despite an increasing body of research on the relations between exploration, cognition and the physical environment, research in real-life settings such as daycare centers is still very limited.

The current dissertation addresses the relation between spatial characteristics of the indoor play space in center-based child daycare and children's exploratory and social behavior. We investigated how a theoretical framework, based on the theory of embodied cognition and the concept of affordances, can be used to examine how children in a naturalistic setting explore the play space and how this exploration of space is related to their social behavior. With this dissertation we also aim to contribute to the knowledge of childcare professionals regarding children's use of space and spatial components.

The physical environment of daycare centers

While the importance of the physical environment for children's sensorimotor, cognitive and social development is recognized by researchers, remarkably few studies have specifically addressed the relation between child behavior and development and the indoor play space in daycare centers. In contrast, in childcare practice the relation between the furnishing and spatial lay-out of the physical environment and children's behavior and development is widely recognized as an essential component of childcare quality, although mainly based on practical experience and professional intuition. This is, for example, reflected in the pedagogical approach of Reggio Emilia in which a well-designed space is seen as the "third educator" (Gandini, 1994; Musatti & Mayer, 2011). Moreover, prevailing instruments for measuring process and structural quality of child daycare, such as the Infant-Toddler Environment Rating Scale (ITERS-R; (Harms, Cryer, & Clifford, 2003) and the Early Childhood Environment Rating Scale (ECERS-R; Harms, Clifford, & Cryer, 2005), contain 'spaces and furnishings' sections, recognizing its importance as a quality indicator. However, usually the information on this quality indicator is merged with information on other indicators into an overall quality rating. Therefore, little is known about the specific impact spaces and furnishings

as such could have on childcare quality and child outcomes, while the arrangement of the physical layout of indoor play spaces is typically based on intuition and practical considerations rather than well-grounded knowledge (Børve & Børve, 2017).

The relation between children's behavior and development and the social and physical environment was first recognized by Kurt Lewin (1931), who postulated that there is a dynamic relation between the environment and the individual, and, thus, that all aspects of a child's behavior are co-determined by his or her current environment. Roger Barker (Barker, 1968) elaborated on Lewin's work by developing the concept of *behavior settings*, which opened the way to studying behavior in the natural settings in which this behavior normally occurs. James Gibson further developed the principles of what became to be known as *ecological psychology*, building on his previous work on perception-action couplings as the building stones of human cognition (J.J. Gibson, 1979/1986). Both Barker and Gibson argued that researchers investigating person-environment relations need to take into account characteristics of the environment, of the person and of the person's actions (Heft, 1988). These theoretical perspectives have been applied in a number of empirical studies relating spatial features of early childhood education and care settings to children's behavior (e.g., Legendre, 1999; Moore, 1986; Prescott & David, 1976; Smith & Connolly, 1980). Different aspects such as density (number of children per square meter), total available square meters, noise level, and spatial layout were studied and related to various aspects of child behavior, such as social interactions, aggressive behavior and cognitive development. However, the number of studies is limited, and both the aspects that were studied and the methodological designs of the studies diverge vastly. In 2002, Moore (2002) summarized the state-of-the-art in this field in a narrative review of empirical studies on the relation between the physical environment and young children's behavior and development in early childhood education and care settings conducted until 1987. Since then it has been rather silent. To the best of our knowledge, no new reviews, meta-analyses or other summaries of studies on the relation between the indoor physical environment and children's behavior and development have been published.

Exploration

Exploration plays a key role in the development of children. Having opportunities to discover the environment and to practice skills in acting upon the environment, opens the door to identify new action possibilities and to develop more complex skills by acting upon these new possibilities (Oudgenoeg-Paz et al., 2014). Through exploration children learn to solve context-dependent problems (Thelen, 2000) and to discover causal relations between actions and outcomes (Legare, 2014). The development of exploratory skills, together with increasing competence in self-locomotion due to neuro-muscular maturation, also offers the child a growing range of opportunities for interaction with

others. Watching another person's actions, going to that person's location and taking the other person's perspective, or imitating his or her actions, leads to more engagement with others and promotes the development of perspective taking skills (Creem-Regehr, Gagnon, Geuss & Stefanucci, 2013; Karasik, Tamis-Lemonda & Adolph, 2011; Moll, Meltzoff, Merzsch & Tomasello, 2013).

Exploration has often been defined as a goal-directed activity, the general goal being to acquire information about an object or a situation (Rusher, Cross & Ware, 1995; Weisler & McCall, 1976). Studies involving young children indicate that exploration frequently starts with a spontaneous, not always goal-directed movement, which causes an effect, for instance a noise or a displacement of an object (Koziol, Budding & Chidekel, 2012; Smith & Gasser, 2005). The child who accidentally causes an effect can use this experience in a next step to intentionally repeat the action, reproducing the effect, and elaborating on it. Children learn about the properties of the object and the effect their action has, which leads to a new stage, in which movement and cognition are coordinated in a new skill (Koziol et al., 2012). Hence, exploration becomes goal-oriented behavior. According to Adolph and colleagues (Adolph, Eppler, Marin, Weise & Clearfield, 2000; see also: Gibson, 1988) exploration is *movement* that produces information and allows the child to gather information that is relevant for planning future actions.

Various studies show that young children learn effectively by active, self-induced exploration of the environment (Bonawitz et al., 2011; Kushnir, Wellman & Gelman, 2009). Once children start to self-locomote, first by crawling or a similar way of moving, and subsequently by walking, they become able to perceive the environment in different ways. They can move to distal objects, go from one place to another, and they can manipulate the spatial arrangement of their environment (Karasik et al., 2011). Self-locomotion and spatial cognition, therefore, are closely related: a child who moves on his or her own, will pay more attention to distal targets than a child who is not yet able to move around, and will be more focused in his or her attention to the spatial features of the larger space (Campos et al., 2000). Other studies have shown a connection between the way children explore their environment and the environments' physical characteristics (Smith, 2005; Campos et al., 2000). A study testing young children's walking on uneven floors demonstrated that subtle variations in floor height led children to adjust their steps to stay upright, indicating the coupling of perception and action in real-time (Gill, Adolph & Vereyken, 2009). Put differently, different structures and objects in the environment encourage children to use their abilities in different ways, and, thereby, to gather knowledge about both the environment and their own skills at the same time. However, most studies investigating exploratory behavior in young children have focused on children's use of play materials (e.g., Caruso, 1993; Kahrs & Lockman, 2014; Oudgenoeg-Paz, 2014). The few studies on children's exploration of space, moreover, mostly pertained to home (Campos et al., 2000; Oudgenoeg-Paz,

Boom, Volman & Leseman, 2016) or lab situations (Gill et al., 2009). Little is known as yet about the ways in which children explore the indoor play space in child daycare centers.

The concept of affordances

Relating exploration behavior to physical characteristics of the environment requires a coherent theoretical framework. A promising approach is provided by ecological perception-action theory, in particular by the concept of *affordances*, presenting a relational, and perception-action-based, view on human cognition. An affordance is the relation between a set of physical characteristics of an object or space and a set of (perceptual, psycho-motor) abilities of a person. In this relation, the physical characteristics allow, invite or trigger the person to use his or her abilities to act upon these physical characteristics (Chemero, 2013; J.J. Gibson, 1979/1986). Perceiving new stimuli in the environment and reacting to it, by moving towards it, reaching for it, looking at it and manipulating it, enable the child to gather both new information and to develop new skills to act (E.J. Gibson, 1988). Exploring affordances, thus, consists of a recurrent combination of two steps, perception and action. Perception leads to action, action leads to new information to be perceived, which provides feedback and triggers for new actions (Oudgenoeg-Paz, 2014; Soska, Adolph & Johnson, 2010). The concept of affordances, therefore, is all about exploration. By acting upon the affordances provided by, for example, a chair, children discover that they can crawl under it, put objects on its seat, can push it, can use it to stand upright, and can sit or stand on it. Which affordances a child can act upon depends on his or her bodily and cognitive skills at that point in time, and on the chair's physical characteristics (e.g., how high, stable, heavy it is). In the course of development children learn to adapt their maturing body to an environment that offers a variety of affordances (Adolph & Robinson, 2015). While the infant can crawl under but not climb on the child-sized chair, the four-year-old can sit and stand on it, but not move under it anymore. To continuously stimulate children's development at different ages, environments should, thus, offer a variety of perception-action opportunities that match the rapidly developing abilities of children and that can sustain children's curiosity-driven exploration. In this dissertation, the concept of affordances is employed to investigate the exploration of the indoor playroom space by children of different ages in center-based child daycare.

Dutch daycare: policy, system, quality and space

Center-based child daycare in the Netherlands differs in many ways from center-based daycare in other countries. Dutch daycare centers usually accommodate children between 3 and 48 months of age. In the Netherlands, children start attending a daycare center at an earlier age than in many other countries, but they also end daycare at an earlier age,

because primary school, with kindergarten classrooms for children from age four to six years, starts at age four. Although primary school is not obligatory at age four (but is at age five), virtually all children start primary school, and therefore leave daycare, shortly after their fourth birthday, while some of them continue in an after-school care program next to primary school. This typical situation in the context of a privatized daycare market, with pressure on childcare organizations to work in economically efficient way, has several consequences for how daycare centers compose their groups of children. Whereas some daycare centers have separate groups for infants between 0 and 1.5 years of age, with 1.5 years being the age at which most children in the Netherlands are able to walk independently, and separate groups for younger and older toddlers, most common are either same-age groups with wider age ranges, for instance comprising of children between 0 and 2 years and between 2 and 4 years, respectively, or completely mixed-age groups, with children's ages in a single group ranging between 0 and 4 years.

The Dutch government has set clear rules for the adult-child ratios in daycare, which are differentiated by age-group. For instance, infants should be cared for in groups with an adult-child ratio of 1:4 (and from 2019, following new legislation, 1:3), whereas for toddlers older than 3 years of age, a ratio of 1:8 is required. In general, these rules are accurately observed by daycare organizations (Slot, Jepma, Muller, Romijn, & Leseman, 2017). In age-heterogeneous groups, a weighted ratio is applied that usually corresponds rather accurately with the representation of different ages in the groups. However, in contrast to the meticulous, age-differentiated regulation of this aspect of daycare quality, regulations regarding interior design and number of square meters per child are less refined, do not differentiate between age-groups, and do not provide guidelines on how to arrange the play space in age-heterogeneous *vs*. age-homogeneous groups.

This may be an omission as may become clear from this dissertation. There are reasons to suspect that children in mixed-age groups, the focus of this dissertation, are adversely affected by the predominant wide age-range and mixed-age grouping strategies in Dutch daycare centers - not so much with regard to the caregiver-child ratio, but in particular with regard to the physical environment provided to them. Firstly, infants and young toddlers need different, age-appropriate play materials and different play areas than older toddlers. Sharing the same space implies that adjustments have to be made that run the risk to benefit some children while limiting the opportunities for others. Small toys, for example, need to be stacked away for safety reasons when infants are present in a group, but this measure limits older toddlers' opportunities of self-regulated play. Likewise, daycare centers have been observed to introduce big playpens for infants and young children to separate them from the older toddlers for reasons of safety, but this measure seriously limits the space available to the youngest children to move around. Outcomes of a recent nationally representative assessment of the quality of Dutch daycare in mixed- and same-age groups indeed showed that the

quality of spaces and furnishings as measured with the ITERS-R/ECERS-R was lower in mixed-age groups than in same-age groups (Slot et al., 2017). Moreover, observations of interaction process quality in the same study with the Classroom Assessment Scoring System (CLASS) Infant and CLASS Toddler, showed considerably lower educational process quality for both infants and toddlers in age-heterogeneous compared to age-homogeneous groups for infants and toddlers, respectively. The results suggest that especially for older toddlers in age-heterogeneous groups the playroom space is less suited than in age-homogeneous groups. In the study reported in this dissertation we investigated specifically how children from different ages in a mixed-age group explore and interact in their shared play space.

This dissertation

In Chapter 2 of this dissertation, we present a narrative review of studies on the relation between the indoor physical environment of daycare centers and preschools and young children's (six months to six years of age) social and cognitive behavior and development. In this Chapter, we describe and discuss the current state of knowledge in the field, and identify leads for future research. Chapters 3 to 5 report the findings of a cross-sectional study conducted in ten Dutch daycare centers, part of a large non-profit provider of daycare, with age-heterogeneous grouping policy. The study involved 61 children between 11 and 48 months of age, all of whom were able to crawl or walk independently. Children were observed during self-managed, unguided free play time. An observation instrument was developed to code children's use of the spatial components of the play room, based on Gibson's concept of affordances (Gibson, 1979/1986). The instrument was applied to obtain fine-grained measures on a number of coding dimensions to assess children's exploration and relevant contextual factors, including the social setting. The study reported in Chapter 3, using these fine-grained nested data, examined the relations between the spatial characteristics of the play room and the depth and breadth of children's exploration of the play room space. The study reported in Chapter 4 examined how children's (parallel, social, and solitary) play and (transition, onlooking, unoccupied) non-play behaviors related to the depth of their exploration of the playroom space. The study reported in Chapter 5 deepens the previous studies by focusing on children's use of the three main spatial components, as apparent from the previous studies (i.e., free floor space, activity centers, tables), and available play materials. The study examines how exploring the space relates to social, parallel and solitary play, and how the use of play materials moderates these relations. In Chapter 6 the findings reported in the previous chapters are integrated and discussed. Directions for future research are suggested and implications for practice and policy are presented.

Chapter 2

Relations between spatial characteristics and social and cognitive behavior and development in center-based early childhood education and care settings: a narrative review

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Author contributions: HvL and PL designed the research; HvL collected the data; HvL analyzed the data and wrote the paper; OOP and PL provided feedback on the paper.

Abstract

There is increasing awareness that the physical environment plays a critical role in young children's cognitive and social development, by offering opportunities for action, exploration and interaction. In this article a narrative review is presented of 19 studies, published between 1987 and 2017, into the relation between spatial characteristics of the indoor play environment of center-based early childhood education and care settings and children's social and cognitive behavior and development. Studies were included in the review if they pertained to center-based care or education facilities and involved children between six months and six years of age. This review shows that a variety of spatial characteristics have been studied. Several studies reported consistent, interesting outcomes. A layout with an open-zoned arrangement which enables children to keep eye contact with the caregiver was consistently found to stimulate children to use the space more fully. Designated activity areas for activities such as pretend play, literacy and construction elicit different types of social and cognitive behaviors than non-designated areas. However, overall, the number of studies is small, and studies are very diverse, both methodologically and with respect to the topics studied. Several suggestions for future research are offered.

Keywords: center-based early childhood education settings; physical environment; spatial arrangement; spatial characteristics; social behavior; cognitive behavior; narrative review

Introduction

The quality of early childhood education and care (ECEC) settings is related to structural characteristics such as group size, adult-child ratio, teacher education, and several other factors (Burchinal et al., 2000; Phillips & Lowenstein, 2011). Whereas several studies have addressed the effects of these structural characteristics on interaction processes in the ECEC setting and child outcomes (e.g., NICHD Early Child Care Research Network, 2002; Pianta, Barnett, Burchinal & Thornburg, 2009), the relationship between the physical environment and children's outcomes is an understudied topic. Yet, both in recent research into child development and in the practice field of early childhood education and care there is an increasing interest in the influence of the physical environment on children's behavior and development. One line of study is motivated by the increasing awareness that the physical environment plays a critical role in children's cognitive and social development by affording opportunities for action, exploration and interaction (Iverson, 2010; Smith, 2005; Thelen, 2000). Research in this line is related to the theoretical perspective of embodied cognition, which focuses on the developmental relations between perception, action, sensorimotor cognition and higher order cognitive and linguistic skills (Garbarini & Adenzato, 2004; Smith, 2005). In this paradigm, acquiring knowledge about the spatial environment through exploration is assumed to be of central importance for children's cognitive and language development (Iverson, 2010; Oudgenoeg-Paz, Leseman, & Volman, 2014) and social development, in particular perspective-taking skills (Creem-Regehr, Gagnon, Geuss, & Stefanucci, 2013). This research aligns with ideas and principles from ecological psychology (J.J. Gibson, 1979/1986), the core of which is the relational concept of affordances: the idea that objects and spaces offer opportunities for action relative to what a person can perceive and perform. Thus, affordances are defined by both the object or space and the acting agent (E.J. Gibson, 1988). Furthermore, studies on executive function in preschoolers emphasize the stimulating role of environmental factors for the development of attention and goal-directed behavior (Garon, Bryson & Smith, 2008). A second line of study is motivated by a growing concern about children's health, especially concerning the observed lack of physical activity as a possible cause of overweight and obesity in children (Hodges, Smith, Tidwell, & Berry, 2013; Monasta et al., 2010), but this topic is not within the scope of the current review.

The importance of the physical environment is also acknowledged in early childhood education and care practice, where the relation between the furnishing and spatial lay-out of the physical environment and children's behavior and development is recognized as an essential component of curriculum and pedagogy. This, for example, is reflected in the pedagogical approach of Reggio Emilia in which a well-designed esthetical space is seen as the "third educator" (Gandini, 1994; Musatti & Mayer, 2011) and in

curricula like Tools of the Mind (Barnett et al., 2008). These curricula require specific environmental features, such as special play equipment and activity areas. Furthermore, widely used instruments for measuring the quality of child daycare, such as the Infant-Toddler Environment Rating Scale Revised edition (ITERS-R; Harms, Cryer, & Clifford, 2003) and the Early Childhood Environment Rating Scale Revised edition (ECERS-R; Harms, Clifford, & Cryer, 2005), comprise sections about spaces and furnishings, recognizing their importance as a quality indicator (see also Abbott-Shim & Sibley, 1998). However, while being used as indicators for evaluating process and structural quality, little is known about the specific impact spaces and furnishings as such could have on childcare quality and child outcomes.

In sum, while theoretical insights, quality assessment instruments and common practices in the field of center-based childcare recognize the importance of the physical environment, knowledge is lacking about how children's social and cognitive behavior and their development are related to spatial characteristics of the indoor physical environment in center-based ECEC settings. To the best of our knowledge no systematic review on this topic has been published since the review by Moore (2002), who summarized results of studies published between 1970 and 1987. Therefore, given the rising interest in the effects of the physical environment on child development, a review of recent work on this topic is warranted.

In the present review we first describe how research into the relation between the physical environment and children's behavior and development evolved until 1987. Subsequently, we present a *narrative review* of studies published between 1987 and 2017, with a focus on the relation between spatial characteristics of the indoor play environment in early education and care settings and young children's social and cognitive behavior and development. The choice for a narrative review is motivated by the fact that only a limited number of studies addressing this relation were found, which, moreover, focused on a wide variety of topics, making a systematic review or quantitative meta-analysis premature. Moreover, given the small number of studies on this topic, selecting studies based on rigorous methodological quality criteria, as is standard in systematic reviews and meta-analyses, would have resulted in only very few eligible studies.

Early Studies (1970 – 1987)

Under the influence of the eco-behavioral approach, developed by Barker (1968), and the interdisciplinary approach of environmental psychology, research focusing on the relations between the physical environment in which children grow up and their behavior and development prospered for a short period of time around 1980. Barker's concept of behavior settings implies that both the social and the physical environment influence behavior, and it stresses the importance of studying behavior in the natural

setting in which this behavior normally occurs (Barker, 1968). Environmental psychology, likewise, addresses the relations between human behavior and the physical environment (Proshansky, Ittelson, & Rivlin, 1976). In about the same period, James Gibson developed the principles of what became to be known as ecological psychology, building on his previous work on perception-action couplings as the basis of human cognition (J.J. Gibson, 1979/1986). Both Barker and Gibson concluded that, in studying person- environment relations, researchers need to take into account characteristics of the environment, of the person and the actions of the person concerned (Heft, 1988). These theoretical perspectives have been applied in different empirical studies into the relation between the quality of the space in early childhood education and care settings, and children's behavior.

A dominant theme of study in ECEC settings has been the effect of *density*, commonly defined as the amount of space available to a group, on children's social behavior. For example, Smith and Connolly (1980) and Rohe and Patterson (1974) found an increase in aggressive behavior once the amount of space per child was reduced. However, Fagot (1977) found that positive social interactions occurred more often in high density areas than in low density areas. A review by Driscoll and Carter (2004) of twelve studies on density conducted between 1970 and 1987 showed that researchers differed considerably in their definitions of high *vs*. low density. This, and other methodological issues, complicated a straightforward interpretation of the seemingly inconsistent findings in the reviewed studies. Another theme of study concerned the layout of the play space in child daycare centers (Field, 1980; Moore, 1986). Moore (1986), going beyond a characterization of the play space in mere square meters, introduced the concept of *well-defined settings*, referring to recognizable areas within the playroom or classroom that are limited to a single type of activity and well-equipped with relevant materials, as opposed to poorly defined settings that are lacking these resources or are not suited for a particular activity. He found that exploratory behavior, social interaction and cooperative behavior occurred more frequently in well-defined settings than in ill-defined settings. Also the availability of play resources (e.g., toys, construction materials) has been found to affect children's behavior (Rohe & Patterson, 1974; Smith & Connolly, 1980). Aggressive behavior increased if more children had to share the same play resources, and, conversely, cooperative behavior increased if more equipment was provided to a particular group of children.

In 1987, an edited collection of articles on the relation between the built environment and children's development marked a milestone in the field, describing the state of knowledge regarding the impact on children of various environments, including early childhood education settings (Weinstein & David, 1987). By combining theoretical and methodological issues with empirical research outcomes, and by identifying topics for future research, this publication can be regarded as the most complete synthesis

of knowledge concerning the relation between children and the built environment until then. Another landmark publication in this field was the comprehensive narrative review by Moore (2002) of the extant research until 1987 on the relation between the physical environment and young children's behavior and development in early childhood education and care settings. In Moore's review, studies were summarized that focused on several aspects of the physical environment as discussed above, and also on characteristics such as the overall center size, group size and child-caregiver ratio, and how they impacted on children's task-focused behavior and involvement. However, although these topics can be considered to be related to the physical environment, assuming, for example, that group size is related to the size of the space, direct evidence linking the physical environment to children's behavior was lacking in the studies reviewed by Moore.

In conclusion, empirical research into the physical environment in early childhood education settings, published between 1970 and 1987, addressed different topics such as density, number of square meters and spatial layout, and suggests that there is a relation between the physical environment and children's behavior and development.

Current Review

In view of a renewed interest in environment-behavior studies in early childhood education and care provisions, both driven by new theoretical insights and by a growing interest of the child daycare sector as well, we conducted a review of the studies on the indoor physical play-environment of early childhood education settings and its relation with young children's behavior and development that were published since 1987 until 2017. We focused specifically on studies which examined spatial characteristics of the physical environment. Spatial characteristics as defined in this review refer to the spatial arrangement (Legendre & Fontaine, 1991), including aspects such as: the layout of furnishings and play-equipment in a playroom, providing for separate zones and activity areas, the number of square meters, functional and esthetical quality, and the design of activity areas (type, physical properties and variety of activity areas).

In this review we aim to discuss the research of the last thirty years into the relation between spatial characteristics of the indoor physical environment in early childhood education and care settings with young (0- to 6-year-old) children's behavior and development. We focus on the following questions:

1. Which spatial characteristics have been examined?
2. How are different spatial characteristics of the indoor physical environment related to social and cognitive behavior of young children, and their development in these domains?

Method

Selection of studies

Studies in this review were found by conducting a search in the digital databases PsycInfo, ERIC and Web of Science. An additional search was conducted in Google Scholar, by going through the first 200 results provided upon entering keywords. This was considered as sufficient since Google Scholar does not have much added value beyond this number when the purpose is to find peer-reviewed papers, most of which are already indexed in databases such as Web of Science (Haddaway, Collins, Coughlin, & Kirk, 2015). The following combinations of keywords were used: terms related to child behavior (behavior, behaviour, activit*, involvement, play), terms related to the physical environment (space, environment*, play area, indoor, design*, furnish*), and terms related to the type of institution (child care, childcare, preschool, kindergarten, daycare, early childhood). In addition a search was performed in three journals with a special focus on environment and behavior: the Journal of Environmental Psychology, Environment and Behavior, and the electronic journal Children, Youth and Environments. A second phase consisted of searching for references to other studies in the obtained studies.

Studies were included in this review if they met three criteria. First, studies had to relate to early childhood education and care settings, and had to examine relations between spatial characteristics of the indoor physical environment and children's social or cognitive behavior, or children's development in one or both of these domains. Second, children in the studies had to be between zero and six years of age. Finally, papers had to be peer-reviewed and published in English in the period between January 1987 and December 2017. We excluded publications that did not report original empirical research and studies reporting research carried out in a lab situation. Studies that measured the quality of early childhood education settings using global instruments, comprising some aspects of the physical environment next to other features such as program structure or quality of staff, but not reporting separately on these physical aspects in the study, were also excluded. Likewise, if a study focused on both the indoor and the outdoor physical environment, it was included only if separate data were reported for the indoor environment.

A first selection was made based on a combination of keywords in the titles, resulting in 2,522 hits in the digital databases. After screening for duplicates, we found 127 articles that were assessed for eligibility, based on reading of the abstracts. Of these articles, 108 studies were rejected because they did not meet the criteria for inclusion, for instance because articles were not peer-reviewed, focused on the outdoor environment or on physical activities only, or were not reporting original research, leaving 19 studies that were included in the current review. Two publications pertained to the same intervention study, but were both included since they reported on different outcomes (Legendre, 1999; Legendre & Fontaine, 1991).

Coding of Study Characteristics

Relevant information from the selected studies was extracted using a coding scheme, consisting of four parts. The first part related to the setting and context of the study. Studies were coded in terms of setting (preschool, kindergarten, daycare center), location, number and age of participants, and number of centers involved. The second part related to the spatial characteristics of the physical environment. Building on earlier studies (Maxwell, 2007; Prescott, 1987), spatial characteristics were coded in four subcategories: available square meters per child, design of activity areas (type and variety, spots for group- and solitary play, spots for privacy, circulation space for moving from one spot to another), spatial arrangement (layout of furnishing and play areas within playrooms), esthetical and functional quality of space (color, texture, tidiness, storage, accessibility for children). The third part of the coding scheme involved methodological characteristics of the study. A study was categorized as experimental if random assignment was used. A study was categorized as quasi-experimental if an intervention in the physical environment was involved, for instance by re-arranging furnishings or by introducing new spatial objects in the group, and a comparison with an equivalent, but not randomly assigned control group was applied, or when a pre-post intervention comparison without control group was used. The study was coded as correlational if relations between aspects of the physical environment and child behavior were examined without implementing changes in the environment. The fourth and final part of the coding scheme related to the outcome measures of the study regarding children's behavior and development. Reported outcomes were categorized in three domains: cognitive play and development (e.g., problem solving ability, intelligence, development of language, literacy, math, daily life skills), social behavior and development (e.g., social play, interaction with adults, interaction with peers, problem or positive behavior), and exploratory behavior. Following Moore (1986) we defined exploratory behavior as an activity that is aimed at investigating a (new) object, person or setting. The quality of exploratory behavior can be measured by assessing the degree of involvement in the activity.

All studies were independently coded by two researchers. Inter-coder reliability was evaluated with Cohen's kappa for nominal variables and the intra-class correlation coefficient (ICC, absolute agreement) for interval variables. Inter-observer reliability varied between .64 and 1.00, with a mean of .87 for Cohen's kappa and 1.00 for the ICC. Most studies identified in the search included multiple outcomes reflecting different aspects of the hypothetical relation between the indoor physical environment in center-based ECEC settings and child outcome measures. Studies were classified according to their main child outcome measures, resulting in 13 studies with a focus on social behavior and development, and six studies with a focus on cognitive behavior and development. No studies were found with a main focus on exploratory behavior, although some studies also reported outcomes on involvement in (exploratory) play.

The ages of participants ranged from six months to six years, but most studies (17) concerned children between two and six years of age. Only two studies pertained to children younger than 12 months. Studies were conducted in Brazil, Canada, France, Italy, Malaysia, Turkey and the US. No experimental studies were found. Seven studies had a quasi-experimental design. In these studies, part of the physical environment was modified and changes in children's behavior were observed. Six of these studies used a pre- and posttest design, one study only tested child outcomes after the intervention. Twelve studies were correlational and studied the relation between spatial characteristics of existing indoor play environments and children's behavior or development. Two of these studies used a design with contrasting groups. Three correlational studies were longitudinal, with observations covering a relatively long period of time, ranging from two to seven years. In Table 2.1 the main characteristics and results of the studies included in this review are summarized.

The findings from the included studies are presented using a narrative approach. This type of review summarizes and synthesizes independent studies that focus on the same topic, thus providing insight in the current state of knowledge, and can identify leads for future research.

Results

Studies into the relation between behavior and the indoor play environment focused on different aspects of the physical environment and different types of behavior. The majority of outcomes reported were relating to social behaviors and social development. Therefore we first review the studies that focused on this domain, and then look into studies with a focus on cognitive behavior and cognitive development.

Social Behavior

Social behavior was the main focus in 13 studies. Twelve studies reported child behaviors during free play, one study (Wachs, Gurkas, & Kontos, 2004) focused on cleaning-up activities and teacher-guided group time. The studies reported mainly about the relations of social behavior with the spatial arrangement, activity areas, and overall quality of space. Below we discuss these studies in more detail.

Spatial arrangement and peer interactions

Four studies reported effects of the spatial arrangement, that is the layout, furnishing and play equipment of a playroom, with creating separate zones or activity areas, on peer interactions. In one study, among 2- to 3-year-olds, existing furniture was rearranged, creating a visually open arrangement with activity areas with low boundaries that allowed

children to oversee the whole room. This arrangement was compared to a visually restricted arrangement, in which children were not able to see the entire playroom if they were in an activity area. Outcomes showed that children stayed closer to one another and had more friendly interactions in the open-zoned arrangement (Legendre, 1999). The open-zoned arrangement also elicited more social interaction. Children's behavior was more peer-oriented and children were watching other children more often in open-zoned areas, while more conflict situations occurred in the visually restricted areas. After removing an 80 cm high barrier in front of the housekeeping area in the playroom, positive peer-interactions in this area increased significantly (Legendre & Fontaine, 1991). A correlational study, also among 2- to 3-year-old children, with access to two classrooms of similar size, one with an open arrangement and one with three low (80 cm) cupboards as visual barriers, showed only a minimal effect of the visual dividers on children's proximity to one another. Other types of interactive peer-to-peer behaviors were not reported (Burgess & Fordyce, 1989). In a study among 5-year-olds, a classroom with only tables in the center and cupboards along the wall was reorganized in an arrangement with various zones with designated activity areas. No changes in the amount of social interactions were observed, but the frequency of solitary play increased while frequency of parallel play decreased. However, no statistical data were provided, making evaluation of the outcomes difficult (Acer, Gözen, Firat, Kefeli, & Aslan, 2016).

The three studies discussed above that used an intervention to create zoned arrangements consistently showed that changing the spatial arrangement affected children's social behaviors, but the outcomes across studies differed. The correlational study that found no effect of the presence of visual barriers, did not provide information about the spatial configuration, for instance if the barriers marked activity areas, which makes comparing outcomes with the other studies difficult. Furthermore, the situation that was investigated here was atypical, involving two large classrooms for one small group of children.

Spatial arrangement and caregiver-child interactions

Four studies examined the relations between changes in adult-peer proximity and spatial arrangement. The previously mentioned study by Legendre and Fontaine (1991) showed that children spent significantly more time in the area most distant to the caregiver if they were still able to see the caregiver, i.e., in the open-zoned arrangement. In a study involving children between 1.5 and 3 years of age, where the intervention consisted of changing an open arrangement without zones into a semi-open arrangement with two activity areas with low (50 cm) visual barriers, children stayed closer to the adult in the open arrangement and moved further away from the adult in the semi-open arrangement (Campos-de-Carvalho & Rossetti-Ferreira, 1993). A similar result was found in the aforementioned study by Burgess and Fordyce (1989). Children stayed closer to the

adult in the open arrangement. In a qualitative case study, involving children between 9 and 28 months of age, children's free play was observed during two consecutive years, in two playrooms with a spatial arrangement in well-defined thematic units. The authors found differences in the use of play areas between infants and toddlers. Infants who were able to move independently by crawling or walking, tended to gather around the teacher and were not moving around very much. In contrast, toddlers were observed to move around between different well-defined areas with low or no barriers, gathering together and sharing attention in a well-defined activity area for more than ten minutes before moving to another activity area. The teacher either initiated the activity or joined in a child initiated activity. Both the well-defined areas and the presence of the teacher were found to stimulate prolonged engagement in the activity (Musatti & Mayer, 2011).

In sum, although these studies differed in design and methodology, they focused on the same age-group, and outcomes quite consistently indicated that dividing the playroom in zones allowing children to keep visual contact with the caregiver, enabled children to move further away from the adult and, thereby, to use the space more fully than when there are either high visual barriers or when there are no barriers at all. An open-zoned spatial arrangement could thus encourage children's spatial and object exploration, as is suggested by the Musatti and Mayer (2011) study, which shows that especially when children get older, a clear zoning of areas fosters attention sharing and prolonged involvement in an activity.

Activity areas and type of play

Five studies were found focusing on the link between activity areas, defined as an area within the playroom equipped for a specific activity with physical boundaries, and social behavior. A study using Moore's (1986) definition of well-defined versus ill-defined settings to assess 20 classrooms with children between 5 and 6 years of age, reported a higher occurrence of socially appropriate and interactive behaviors in well-defined classrooms than in moderately- and poorly-defined classrooms, which corresponds to the outcomes reported by Moore. However, no information about the criteria that were used to define classrooms as well-, moderately- or poorly-defined was reported. Moreover, presentation of statistical information was inconsistent, outcomes presented in tables differed from outcomes that were discussed. The results should, therefore, be treated with caution (Abbas, Othman & Rahman, 2012). A longitudinal study, among children between 3 and 5 years of age, reported considerable differences in the uses of activity areas for social, parallel and solitary play. The doll play/household area elicited mostly social play, while the arts setting was strongly related to parallel play. Foyers, cubby areas and bathrooms were places favored for being alone. Older children were more often involved in arts, while younger children spent more time in music and gross motor areas (Harper & Huie, 1998). In a paper reporting on three studies,

involving children between 3 and 5 years of age, linking children's play behavior and use of play areas for arts, blocks and replica (dramatic) play, two studies involved the use of experimental (lab) playrooms. Only the results of the study that was executed in the context of real classrooms are included here. In the latter study, the results of three observation sessions across four weeks showed that children mostly used the arts and blocks areas for solitary play, while in the replica area they were mostly engaged in interactive social play (Pellegrini & Perlmutter, 1989).

Two studies, both involving 3- to 5-year-old children, examined the effects of (re) designing an activity area on social behavior. One study introduced two 30 x 30 inch structures (one open and one closed) for creating privacy in two playrooms, which differed in density (number of children per square meters). In the high density playroom children favored using the closed structure for both solitary play and interactive play over the open structure, but both structures were used most often for solitary play. In the playroom with more space per child, both structures were favored equally and were mostly used for interactive play. However, the different outcomes should be treated with caution, since only two playrooms were involved, with different group sizes of 14 and 19 children, and with a big difference in the amount of square meters per child (Lowry, 1993). In the other study a dramatic (household) play area was redesigned into an extended thematic play area, alternately furnished for solitary and group use, which led to more use for solitary and group play, respectively, and to an overall increase of dramatic play (Petrakos & Howe, 1996).

To summarize, all studies described above involved children older than 3 years of age, and except for the first study which did not differentiate between types of activity areas, consistently showed a link between the presence of one or more types of activity areas and children's social behavior. Dramatic play areas were found to elicit social play, provided they were designed to offer enough space for a group of children, as was shown by Petrakos and Howe (1996). In arts settings, investigated in two studies, children were found to play more often alone or near each other (parallel play). Overall, outcomes regarding solitary play showed mixed results. The study that included a range of activity areas found that, for solitary play, children mainly resorted to areas that were not designed for play (foyer, bathroom). The finding that special privacy structures in a high density playroom elicited mostly solitary play suggests that children need such a place to be on their own, especially if there is no other space for retreat. However, since the studies including solitary play as outcome only focused on part of the activity areas in their research and did not report on the characteristics of the remaining areas, the only conclusion regarding solitary play that can be drawn is that solitary play is not consistently related to specific types of activity areas, but that children maybe just need an area for retreat to play on their own. However, if an area is specifically designed for solitary use, it will be used in that way.

Quality of space

Three studies focused on the indoor physical environment as a whole. As part of the NICHD Study of Early Child Care and Development, a study was carried out among infants at 6 months of age, with a focus on positive caregiving as related to (among other aspects) the quality of the physical environment. Quality was measured by the Assessment Profile for Early Childhood Programs (APECP; Abbott-Shim & Sibley, 1987). Outcomes showed that a higher quality of the physical environment in daycare centers was strongly related to both a higher frequency and higher quality of positive caregiving behaviors (Vandell, 1996). Another study, investigating the relation between environmental chaos and children's compliance behavior, showed (after statistical correction for child temperament, childcare quality as measured by the ECERS-R, and teacher's use of control strategies) that children's situational compliance (obeying a request by an adult) was lower if there was more environmental chaos and child care quality was lower. Children's ages ranged between 2.5 and 6 years. More environmental chaos was also related to more passive non-compliance. The scale measuring chaos assessed teachers' perceptions of use of space, crowding, environmental traffic, and the degree of control and organization in the classroom (Wachs, Gurkas & Kontos, 2004). In a longitudinal case study, involving 4-year-old children, children's use of space as related to social behavior was observed using a gridded map to code the observed child's location. Tables were found to be used mostly for solitary and parallel play, and for interactions with teachers. Transitional spaces without resources for play were hardly used, while resource-rich locations were used for various types of social activity (interaction, solitary, parallel play). A lofted area was popular both for social interaction and for solitary play. No observations of other specific activity areas were reported on (Torrens & Griffin, 2013).

Although the three studies described above showed a relation between quality of space and social behavior, outcomes are difficult to compare because of differences in focus and age- group. The study on caregiver interactions with infants is especially interesting since it is the only study involving children this young, while the longitudinal design and exploratory character of the study by Torrens and Griffin (2013) offers new insights in the use of spatial attributes such as tables, that were not studied before. The study on (non-)compliance is of interest, because to the best of our knowledge it is the first study relating this type of behavior to the physical environment, while at the same time showing that the physical environment is also related to behavior in situations other than play, for instance during meal and group times.

Table 2.1 Main Characteristics of Studies Included in the Review

Study	Participants	Study design	Spatial characteristics	Type of behavior	Outcomes
Abbas et al. (2012)	N = 494; 20 groups in 10 preschools. Age range 5-6 years, means not reported.	Correlational, contrasting groups	Well-defined *vs.* poor-defined classrooms	Appropriate, inappropriate, non- interactive and appropriate interactive behaviors during free play	MANOVA tests showed that appropriate (F = 8.798, p = .002) and interactive (F = 4.892, p = .021) behaviors occurred significantly more in well-defined classrooms than in moderately or poorly defined settings.
Acer et al. (2016)	N = 4 to 13; 1 group in 1 preschool. Age 5 years, means not reported.	Quasi-experimental pretest and post-test	Rearrangement of open classroom (one learning center at tables) *vs.* classroom with designated learning centers	Proportion of social, parallel and individual play during free play time	Frequencies were calculated, indicating an increase in solitary play and a decrease in parallel play in the classroom with designated learning centers. No further analyses were executed.
Burgess & Fordyce (1989)	N = 12; 1 group in 1 daycare center. Age 22-32 months (M = 25.4, SE = 1.1).	Correlational	Open arrangement classroom *vs.* classroom with visual barriers	Child-to-peer and child-to-adult proximity during free play	Three-factor repeated measures analysis showed no significant change in distance to peers in open *vs.* visually restricted classroom. In visually open classroom children stayed significantly closer to nearest teacher.
Campos-de- Carvalho & Rossetti-Ferreira (1993)	N = 28; 2 groups in 2 daycare centers. Age range 19-35 months, mean = 28 months.	Quasi-experimental pretest and posttest in both groups	Open arrangement *vs.* semi-open arrangement	Use of space and child-to-adult proximity during free play	Wilcoxon's matched-pairs signed-ranks test showed that circumscribed zones were used significantly more than open zones (T = 2, p < .005).Friedman two-way analysis showed that zone near adult was used significantly more in open than in semi-open arrangement (χ^2 = 10.5, p <.006).
Harper & Huie (1998)	N = 244; 6 groups in 6 pre-schools and daycare centers. Age 3-5 years, means not reported.	Correlational (observations during 7 years)	Use of activity settings during free play	Social, parallel, individual play, contact with adult during free play. Different use for gender and age	Expected amount of time use of activity settings, calculated with binomial tests of significance, assuming p = .5 showed mostly parallel play at the art setting (74.7%, p < .001), social play in housekeeping setting (76.2%, p < .0001), play with adults in cooking setting (84.2%, p < .0001), solitary play in cubby area and bathroom (87.2%, p < .0001). Age differences approached significance, F (9, 91) = 1.908, ρ = .06. Younger children (p < .063) spent more time in music/gross motor areas, older children in arts.

Table 2.1 Main Characteristics of Studies Included in the Review (Continued)

Study	Participants	Study design	Spatial characteristics	Type of behavior	Outcomes
Kantrowitz & Evans (2004)	*N* = 21; 3 groups in 3 daycare centers. Age range 4-5 years (*M* = 48.6 months, *SD* = 7.9).	Correlational	Amount of space and number of activity areas	Off-task behavior, social, parallel and solitary play. Functional, constructive, dramatic play during free play.	A proc-mixed procedure showed a marginal increase of constructive play if child/activity area ratio was lower (b = -.13, SE = .08, t = - 1.61, p < .11). No significant relation between c/a area and social, solitary, parallel play. If c/a area ratio was higher, (more children shared these areas) more time spent in off-task (less involvement in play): r = .440, p < .01. No effects for SES.
Legendre (1999)	*N* = 45; 3 groups in 3 daycare centers. Age range 21-37 months (*M* = 27, *SD* = 3.9).	Quasi-experimental pretest and posttest in all groups	Spatial arrangement: visually open-zoned *vs.* visually restricted. Three sectors: adult-distant, intermediary, adult- proximal	Child-to-peer proximity and proportion of positive interaction during free play	Analysis of variance (ANOVA) for repeated measures (dyadic use) showed that children stood in each other's proximity more often in open arrangements (F(1, 312) = 4.03, p = .045). Amount of friendly interactions was larger in open arrangement (F(1,278) = 19.64, p <.001).
Legendre & Fontaine (1991)	*N* = 45; 3 groups in3 daycare centers. Age range 21-37 months (*M* = 27, *SD*= 3.9).	Quasi-experimental pretest and posttest in all groups	Spatial arrangement: visually open-zoned *vs.* restricted. Three sectors: adult- distant, intermediary, adult-proximal. Household area: with *vs.* without visual barrier	Time spent in social interaction and attention, peer-oriented behavior, friendly interactions and conflict during free play.	ANOVA showed children spent more time in adult-distant sector in open arrangement (F(1, 42) =27.47, p < .001).More time spent in social interaction/attention (F(1, 42) = 4.74, p < 0.05) and peer- oriented behavior (F(1, 42) = 5.95, p < .025) in open arrangement. More friendly interactions in open arrangement (F(1, 42) = 9.36, p < .01), In visually restricted areas more time was spent in conflict (F(1, 42) = 6.53, p < .025). More time was spent in peer interactions in housekeeping area without barrier (F(1, 15) = 9.86, p < .01).
Lowry (1993)	*N* = 33; 2 groups in daycare centers. Age range 3-5 years, means not reported.	Quasi-experimental, no pretest	Introducing two types of privacy spaces: closed *vs.* open structure, tested in two centers with different density (sq. ft. per child)	Use of privacy spaces for solitary and interactive play during free play	T-tests show a significant preference for solitary play in the closed structure (M = .31, SE = .05) than in open structure (M = .10, SE = .03). p < .0007 (t = 3.2589 (df = 1,154), N = 78) in the high density group. No significant difference found in low density room. Interactive play occurred significantly more in the closed structure (M = .25, SE = .06) than in open structure (M = .04, SE = .02), p < .0001 (t = 4.0084 (df = 1,105.8), N = 78) in the high density group. No significant differences were found in the low density room

Table 2.1 Main Characteristics of Studies Included in the Review (Continued)

Study	Participants	Study design	Spatial characteristics	Type of behavior	Outcomes
Mashburn (2008)	*N* = 540; 124 groups in 124 preschools. Age 4 years, means not reported.	Correlational. Children's development was rated by using a pre-test in the first 2 months of preschool and a posttest after 6 months.	Quality of space (ECERS-R: spaces and furnishings)	Academic achievement (Woodcock-Johnson III test of Achievement, 1990), language skills (PPVT, 1997 and OWLS, 1995), emerging literacy (Story & Print Concepts, 1998).	Hierarchical linear modelling showed that low SES children's academic skills were higher in centers with high quality of space (B = 2.42, SE = .92, p < .01). Interaction between race/ethnicity and quality of space was significant for literacy skills (B =.47, SE =.23, p < .05).
Maxwell (1996)	*N* = 114; 8 groups in 7 daycare centers. Age range 46-66 months, median 57 months.	Correlational	Amount of space per child (M = 36 sq.ft. range: 27.3 – 52.3 sq.ft. Home density is co-variable.	Cognitive competence with Preschool Inventory (Caldwell, 1970) and Children's Embedded Figures Test (CEFT) and emotional/behavioral problems with Behar Springfield Behavioral Problems Scale (1974)	Analysis of variance (ANOVA) showed that children scored higher on CEFT in centers with more space per child (low- density): (t = .000). Behavioral problems were highest in centers with high density (t = 4.981, p < .001).
Maxwell (2007)	*N* = 79; 8 groups in 4 daycare centers. Age range 36 – 48 months (M = 52.7).	Correlational, contrasting groups	Classroom physical quality measured by the Classroom Rating Scale (social spaces, boundaries, privacy, personalization, complexity, scale, and adjacencies)	Cognitive (McCarthy's Scale of Children's abilities, 1972) and social competence (Pictorial Scale of Perceived Competence and Social Acceptance, 1984)	A linear regression model showed that cognitive competence in 3-year-olds classrooms was higher in classrooms with higher physical quality (B = 43.06 [14.31], p < .004). No significant relation was found for 4-year-olds classrooms. Higher perceived competence was significantly related to higher scores on subscale 'adjacencies'.

Table 2.1 Main Characteristics of Studies Included in the Review (Continued)

Study	Participants	Study design	Spatial characteristics	Type of behavior	Outcomes
Musatti & Mayer (2011)	*N* = 12-14; 2 groups in 1 daycare center. Age range 9-14 months (first year), 22-28 months (second year); means not reported	Correlational (case study: one group observed during two years using first infant- and then toddler room)	Spatial arrangement of furniture and play materials: well-defined and structured in both infant- and toddler room	Social and cognitive processes and relation to toddler's independent locomotion during free play	Qualitative study. Toddlers were using well-defined areas. In the first year mainly gathering around teacher, not much movement. In the second year clustering and sharing attention in three well-defined activity areas initiated or followed by teacher.
Neuman & Roskos (1990)	*N* = 37; 2 preschool groups. Age range 4-5 years, means not reported.	Quasi-experimental using pretest and posttest in both groups	Redesigned classroom defining play areas by using boundaries, labels, rearranging and redefining, and adding literacy props.	Literacy play activities during free play	Qualitative study observations showed that after intervention literacy became more interactive, activities more purposeful and complex. Interactions with peers and teachers increased.
Pellegrini & Perlmutter (1989	*N* = 86; 3 groups in1 preschool. Age range 26-68 months (group 1: *M* = 37.35, *SD* = 4.93; group 2: *M* = 48.95, *SD* = 2.60; group 3: *M* = 60.16, *SD* = 4.29).	Correlational	Play areas: replica, art and blocks	Social-cognitive aspects of play during free play time. Focus on functional, constructive and dramatic play; solitary, parallel and interactive play, and gender.	MANOVA showed a significant effect for play area on play behavior: $F(4, 322) = 2.39$, $p < .05$. Children engaged in dramatic & interactive play in the replica area and in constructive & solitary play in block and arts areas. Chi-square analysis showed that boys used the block area more frequently: χ^2 (2, N = 86) = 15.26, $p < .0001$, and girls the art area χ^2 (2, N = 86) = 23.51, $p < .0001$.
Petrakos & Howe (1996)	*N* = 31; 2 groups in 1 daycare center. Age range 43-64 months (*M* = 56.9).	Quasi-experimental pretest and posttest in both classrooms	Redesign of dramatic play settings	Social and solitary play, dramatic play during free play	Multiple chi-square analyses showed more solitary play in solitary-designed settings χ^2 (1, N = 31) = 20.47, $p < .05$. More group-play occurred in group- designed settings χ^2 (2, N = 31) = 9.94, $p < .05$, more dramatic play in redesigned settings x^2 (1, N = 31) = 8.86, $p < .05$.

Table 2.1 Main Characteristics of Studies Included in the Review (Continued)

Study	Participants	Study design	Spatial characteristics	Type of behavior	Outcomes
Torrens & Griffin (2013)	*N* = 84; several groups in 1 preschool. Mean age 44.9 months (*SD* = 0.90).	Correlational (case study with observations during 2.5 years)	Indoor areas and specific design features	Social interaction (solitary, parallel, social, teacher-oriented) during free play, and gender differences	Qualitative study showing that tables were most used for solitary, parallel & interaction with teacher. Spaces without resources were hardly used. Access to affordances altered propensity and type of interactions. Boys showed different types of social activities in different spaces, girls did not. Changes in population resulted in shifts in hotspots for social and solitary play.
Vandell (1996)	*N* = 105; number of groups and centers not reported. Age 6 months.	Correlational	Quality of indoor environment based on: cleanness, safety, crowdedness, clutter, appropriate variety of toys, protected and quiet play areas (measured by a subset of the Assessment Profile for Early Childhood Programs (APECP); Abbott-Shim & Sibley, 1987)	Caregiver-child interactions: positive caregiving frequencies (positive, responsive and stimulating behavior), measured by the Observational Record of the Caregiving Environment (ORCE; NICHD, 1996)	Outcomes showed positive correlation between positive rating ($r = .47$, $p < .001$) and frequency ($r = .31$, $p < .01$) of caregiving and higher quality of the physical environment.
Wachs et al. (2004)	*N* = 86; 23 groups in 8 preschools. Age range 31-78 months (*M* = 50.3, *SD* = 11.6).	Correlational	Environmental chaos (measured by Life in Early Childhood Programs (LECP); Kontos & Wachs, 2000), after statistical correction for temperament, childcare quality and use of control	Committed, situational and passive non-compliance during cleaning-up and group times.	Hierarchical regression analyses showed that child care quality (ECERS) and environmental chaos (LECP) negatively related to situational compliance ($\beta = -.53$, $p < .01$ and $\beta = -.29$, $p < .05$, respectively). Passive noncompliance was positively related to environmental chaos ($\beta = .42$, $p < .01$). No significant relation was found for committed compliance.

Cognitive Behavior and Development

Besides focusing on social behavior, studies have also looked into the relation between the indoor physical environment and children's cognitive behavior and cognitive development. These studies report mainly about relations between the use of designated play areas and types of cognitive play, or about the relations between the overall quality of the space and children's cognitive behavior and development.

Activity areas

Three studies examined the relation between activity areas and aspects of children's cognitive behavior. One study focused on the ratio of children, aged between 4 and 5 years, per activity area. These areas were defined as "section(s) of the learning environment described by specific materials and physical boundaries". Results show that, if more children had to share an activity area (high child/area ratio), children were significantly less involved in play activities and spent more time off-task (e.g., onlooking, lying on the floor, staring into the space). Following Moore (1986), this lower involvement could be interpreted as a lower engagement in exploratory play. No effects were found on the occurrence of social, solitary or parallel play. If fewer children had to share an activity area, this led to a marginal increase of time spent on constructive play, but no effects were found on functional or dramatic play. The increase of constructive play was to be expected, since constructive play, such as building with blocks or creating artwork, requires both free space and resources (Kantrowitz & Evans, 2004). In a quasi-experimental qualitative study, investigating literacy development among 4- to 5-year-old children, four kinds of physical changes were introduced: demarcating play areas, labelling toy storage places, enriching areas by adding literacy props, and rearranging the playroom. After the intervention children were observed to be more engaged in literacy play, and literacy play was more interactive and situated than before (Neuman & Roskos, 1990). The study by Pellegrini and Perlmutter (1989) that was discussed earlier reported that children mostly used the art and blocks areas for constructive play, while in the replica area they were mostly engaged in dramatic play.

In sum, the outcomes of the studies described above show that engagement in an activity is related to the presence and design of special activity areas: if there were more activity areas per child, and if the areas were well-defined this increased involvement in activities. If the activity area had a recognizable function, i.e., was designed for dramatic, constructive or literacy play, the activities taking place in the area strongly corresponded with these functions. This suggests that if the number of activity areas is low, or areas are not recognizable or ill-defined, children will be less involved in activities, which might hamper their exploratory behavior and subsequent learning and development.

Quality of space

Two studies related overall quality of the childcare center's indoor space to cognitive development. The first study, among 4-year-old children of 124 preschools and Head Start centers, controlling for family-income and race/ethnicity, found that quality of space, as measured by the ECERS-R Spaces and furnishing scale, was positively related to academic skills of children of low SES families. These children's academic skills were rated as higher in centers with high quality of space than in centers with low quality of space. Likewise, non-Caucasian children's literacy skills were higher in centers with a high quality of space than in centers with low quality of space. However, no relations between the global quality of space and children's academic and literacy skills were found for high SES or for Caucasian children (Mashburn, 2008). In a second study, classroom physical quality was rated testing a new instrument, the Classroom Rating Scale (CRS), in four classrooms with 3-year-olds and four classrooms with 4-year-olds. Children were predominantly Caucasian, with college degree parents. Children's tested cognitive competence and self-perceived competence were the dependent variables. In the classrooms with 3-year-olds, a higher quality of space was related to higher tested cognitive competence. In both age groups, children's self-perceived competence was specifically related to the subscale Adjacencies, meaning that children rated themselves as more competent if they had easy access to play materials, toilet areas, and other in- and outdoor play areas (Maxwell, 2007).

Thus, both studies found interesting effects of the overall quality of the child center's space on children's cognitive competence. The outcomes of the first study, with children of different backgrounds, indicate that children's cognitive competence might be less affected by spatial quality, if they are from high SES or Caucasian families. An interesting finding from the second study was that supporting children's autonomous play behavior, by giving them access to sources for play and personal care, made children feel more competent. The difference in outcomes between the two age groups could indicate that younger children are more susceptible to influences of the physical environment, but additional research is needed to corroborate this finding.

Quantity of space

One study, investigating the amount of available space per child, showed that children's cognitive competence was higher in centers with more space per child than in centers with less space per child, while behavioral problems were highest in centers with less space per child. Density at home was used as a co-variable. All children were from low- to middle-income families, living in an urban-metropolitan area, and their ages ranged from 4 to 5 years. The interaction effect of home and center density was not significant for cognitive competence. However, children living in high density homes who were enrolled in high- density centers scored significantly higher on behavioral problems than

children who lived in low density homes and visited high density centers, and vice versa (Maxwell, 1996).

The findings concerning density and problem behaviors are in line with earlier studies by Smith and Connolly (1980) and Rohe and Patterson (1974). However, group sizes in this study ranged from 16 to 23 children, while the number of teachers per group was not reported. Therefore, we cannot rule out that the effects that were found were, at least partly, due to differences in group size and adult-child ratios.

Discussion

In this paper, we reviewed studies published in the last 30 years relating spatial characteristics of the indoor physical environment in center-based early childhood education and care to young children's social and cognitive behavior, and their development in these domains. Studies in this field are still scarce, as was demonstrated by the fact that only 19 studies were retrieved that met our criteria for inclusion.

The studies focused on different aspects of the indoor environment and addressed behavior and development in the social as well as cognitive domain. An interesting finding of a number of studies that examined the relation between spatial arrangement and social behavior, was that young children, 2 to 3 years of age, felt more free to move further away from the caregiver if the room was divided in open zones so that they could keep eye-contact with the caregiver. The results suggest that young children need the security of being able to see the caregiver. At the same time such a spatial arrangement apparently encourages children to use the space more fully, and, thereby, enables them to autonomously explore the physical environment, which is regarded of central importance for cognitive and language development (e.g., Ginsburg, 2007; Iverson, 2010; Oudgenoeg-Paz et al., 2014). Although two studies reported more positive social peer interactions in playrooms with an open-zoned arrangement, two other studies found no such effects. However, the study design and, in one case, the age-group differed considerably, so that drawing definitive conclusions would be premature.

The outcomes of studies that investigated the effect of specific activity areas suggested that not only the theme of a play area affects the type of social behavior, but also the design of that play area. Solitary play, which was overall an understudied aspect in the studies that were included in this review, could not be consistently linked to particular types of play areas. However, the findings indicated that if a 'special' place was created where children could play alone, this place was rather frequently used for solitary play, and if such a place was not present, children turned to other (non-play) areas to be alone. This suggests that children need a place to be alone where they are enabled to play

uninterruptedly, as has been previously suggested in the literature (Prescott, 1987; Wachs & Gruen, 1982), but possibly also to withdraw from overstimulation (Olds, 1987). The studies relating cognition to activity areas were not easily comparable with regard to focus and design. The outcomes of the study that focused on literacy development are in line with the outcomes of an experimental study by Morrow (1990), which did not include spatial-physical changes in the playroom and was for that reason not included in this review. The study by Kantrowitz and Evans (2004) is of interest and should be replicated. If indeed off-task behavior increases when there are insufficient activity areas, as this study found, it would be interesting to know if there is a certain threshold in the child/activity area ratio that should be considered.

The studies that reported on the relation between the overall quality of space and children's behavior, focused on different aspects of behavior. Therefore, the outcomes are difficult to integrate. A problem of using global measures to investigate the relations between the physical environment and children's behavior and development, is that, although adequate psychometric properties have been reported for the most frequently used instrument, the ECERS-R, the diverse set of items involved in this instrument makes it difficult to assess which specific physical components affect child outcomes most. As the subscale analysis of the CRS instrument (Maxwell, 2007) suggests, some spatial characteristics may relate to children's competence development, whereas others do not. Outcomes of the two studies reporting an association between the amount of space available per child (density) and children's social and cognitive behavior, should be treated with caution because of the small sample sizes in one study and the differences in group sizes between both studies. The effects that were found could be equally well related to the available space per child as to the number of children in the group.

The present review furthermore showed that studies involving very young children, below age 2, in early childhood education and care settings are rare. Remarkably, we found no studies relating activity areas to children's social or cognitive behavior that involved children younger than 3 years of age. While in daycare practice it is quite common to create areas for specific activities (for example, construction, arts, pretend play areas) for infants as well as toddlers, how these areas should be arranged, and whether this affects young children's behavior and development, has not been a subject of recent studies. Although activity areas are an important component in quality assessment instruments for the center- based care of young children, such as the ITERS-R (Harms et al., 2003), the quality indicators underlying this instrument are based on common sense rather than rigorous research, or stem from studies with older children. In the same vein, it is remarkable that no study into the relation between spatial characteristics and cognitive behavior or cognitive development pertained to children below age 3. The relation between the physical environment and young children's sensorimotor development, cognitive development and language acquisition has been a topic of recent

studies in infants and toddlers in both the home environment and in lab situations (e.g., Clearfield, 2010; Clearfield, Osborne & Mullen, 2008; Thelen, 1994). This line of study should be expanded to center-based early childhood education and care. In addition, it would also be worthwhile to extend studies into the role of spatial arrangements to older children, for example 4- to 6-year-olds, because it is conceivable that at this age children do not so much need the security of visual eye contact with the caregiver as they do need the privacy and the feeling of competence to play with peers out of sight of the caregiver (Weinstein & David, 1987).

Implications for Practice

Although the studies included in this review were too diverse and suffered from several limitations to draw firm conclusions, some consistent findings are of interest for practice. Particularly the spatial arrangement (e.g., the layout of the playroom and the furnishing with play equipment, providing separate zones and clearly recognizable activity areas) shows a strong relation with, especially, young children's social behavior. Daycare centers wanting to encourage young children's autonomous exploration of the playroom and to stimulate peer interactions should create playrooms that are divided in zones by way of low visual barriers, where children can see the caregiver, but also find a variety of designated, appropriately equipped play areas. Outcomes from several studies also suggest that enriching existing activity areas or introducing new activity areas can positively affect children's social and cognitive behavior. In addition, some studies indicate that daycare centers should be more aware of children's need not only to interact with others, but also to be enabled to play or be alone. However, more research is needed into the exact relation between children's social, cognitive and exploratory behavior and development, and the indoor physical environment in early childhood education settings.

Future Directions

This review shows that both the focus and the quality of studies into the relation between the indoor environment of center-based early education and care settings and children's behavior and development diverged considerably, and that more research in this field is clearly needed. Some studies had a robust design (Kantrowitz & Evans, 2004; Legendre, 1999; Legendre & Fontaine, 1991) or combined a relatively large sample size with longitudinal data (Harper & Huie, 1998), and these studies should be replicated to determine if the results can be confirmed in different samples and contexts (Westfall, Judd, & Kenny, 2015).

Few studies were found that investigated the relations between spatial arrangement and children's cognitive development. These studies mostly focused on global environmental quality and were not informative about the effects of specific arrangements on children's

cognition. Future studies addressing this topic could integrate the findings on how spatial arrangements relate to young children's use of the playroom and their social interactions, summarized in this review, with outcomes from studies emphasizing the importance of spatial exploration for cognitive development (e.g. Iverson, 2010; Smith, 2005). Such studies could shed more light on how the playroom arrangement, via children's exploratory behavior and use of various parts of the playroom, relates to the development of both cognitive and social skills.

The majority of studies reviewed in this article focused either on the spatial arrangement of the whole playroom or on specific activity areas within the playroom. Future studies should investigate the combination of both, because both seem important components of the physical environment, and their effects could reinforce each other in stimulating child development. It would be interesting to investigate how combining an open-zoned arrangement of the playroom with well-defined and enriched activity areas affects children's social and cognitive behaviors. Future studies that focus on specific activity areas (e.g. Lowry, 1993; Petrakos & Howe, 1996) should at least also include observations of children's use of other parts of the playroom, to avoid misinterpretation of the data regarding the specific area under investigation (Westfall et al., 2015). Furthermore, most studies retrieved for this review were correlational. No experimental studies were found. Future studies should use an experimental design with random assignment to be able to draw grounded causal conclusions from study findings (Marczyk, DeMatteo, & Festinger, 2017).

Finally, research into the relation between children's behavior and development and the physical environment requires a strong theoretical framework. The theoretical approach of embodied cognition, which defines movement, action and perception as the first steps of exploring and learning about the world, could be a good candidate for a unifying theoretical framework (Creem-Regehr et al., 2013; Soska, Adolph, & Johnson, 2010). In this line of thought, children's development is embodied and embedded, and learning new cognitive and social skills is related to both the child's current bodily status and to the possibilities for (social) action the environment offers.

Conclusion

This review focused on the relations between indoor spatial characteristics of center-based settings for early childhood education and care, and children's behavior and development in the social and cognitive domain. The number of suitable studies found was limited and the focus of the eligible studies and their methodologies diverged, but, overall, the results suggest that the indoor physical environment of daycare centers is indeed related to children's social and cognitive behavior and development. A consistent finding was that a zoned-arrangement of the physical play space increases children's exploration of the space. A limitation of this review is that due to the small number of

relevant peer-reviewed studies no further differentiation could be made by study design and methodological quality.

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Chapter 3

Young children's exploration of the indoor playroom space in center-based childcare

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Abstract

Exploration plays a key role in the development of children. While exploring, children develop new skills by perceiving and acting upon the possibilities for action that are specified in the environment. This study examined the relations between young children's exploration during free play and the spatial characteristics of the indoor playroom space in daycare centers, using an observation scheme based on Gibson's theory of perception-action affordances. The study was carried out in mixed-age groups, with ages ranging between 11 and 48 months. The results showed that depth of exploration of space was positively related to the use of tables and activity centers, and also to the child's task-orientation as rated by the caregivers. Breadth of exploration revealed a reversed pattern of relations. The findings indicate that studying children's exploration of indoor playroom space as affordances-guided perception-action cycles can contribute to a more comprehensive understanding of the role of spatial attributes in children's exploratory play.

Keywords: day care centers; exploration; task-orientation; spatial characteristics.

Introduction

Young children discover the world around them by actively exploring the possibilities for action their environment offers and by doing so they not only acquire information about the environment, but they also improve their abilities to act upon the environment. A growing number of children worldwide attend a day care center or preschool in the first years of their lives before enrolling in primary school (OECD, 2014), raising interest in the developmental effects of child day care. Most studies into the effects of child care on children's social- emotional and cognitive competence development have focused on the quality of caregiver- child interactions and on structural quality characteristics such as group size, adult-to-children ratio and caregivers' pre- and in-service professional training (Burchinal, Vandergrift, Pianta, & Mashburn, 2010; Slot, Leseman, Verhagen, & Mulder, 2015). Studies relating developmental effects to the physical environment provided by child day care centers, however, are scarce. The present study focused on a particular aspect of child development, exploratory play, seen as driver of both cognitive and social-emotional development. We examined how young children in daycare centers, in mixed-age groups with ages ranging from one to four years, explore the playroom during episodes of free, unguided play. We studied differences in intensity (depth) and variety (breadth) of exploration as related to characteristics of the child and the playroom characteristics. More specifically, we examined how children's exploration is related to the physical-spatial lay-out and presence of particular components in the environment provided by the centers.

The present study relates to previous work on the role of exploratory play in children's cognitive development (e.g., Oudgenoeg-Paz, Leseman, &Volman, 2015; Ginsburg, Cannon, Eisenband, & Pappas, 2006). However, the current perspective differs from that of the earlier work. We did not examine how exploration of spatial characteristics relates to cognition, but instead how particular constellations of spatial characteristics of playrooms relate to the nature of children's exploration of the playroom space.

Exploration and development

Exploration is an essential condition for development. Having opportunities to discover the environment and to practice skills in acting upon the environment, stimulates the development of new, more complex skills (Oudgenoeg-Paz, Boom, Volman, & Leseman, 2016). By actively exploring the features in the environment that are accessible to them, children learn to solve context-dependent problems (Thelen, 2000) and they discover the causal relations between actions and outcomes, which can facilitate logical reasoning (Legare, 2014). Exploring the spatial-relational properties of objects, for example by stacking objects or by putting objects in containers, provides children with opportunities to learn about spatial relations and sets the stage for acquiring spatial language such as

prepositions and verbs of movement (Oudgenoeg-Paz et al., 2015). Likewise, exploring the spatial properties of objects and environments provides children with opportunities to develop basic mathematical ideas about shape, size, order and number (Ginsburg et al., 2006). Exploratory play in young children can have long-lasting effects on cognitive functioning in middle childhood and adolescence. In a longitudinal study a significant relation was found between infants' motor maturity and active exploration at age 5 months and their academic achievement at age 14 years (Bornstein, Hahn, & Suwalsky, 2013). Similarly, parent-reported exploration behavior in infancy and toddlerhood was found to predict children's spatial memory at age 6, while controlling for fluid intelligence, gender and socioeconomic background (Oudgenoeg-Paz, Leseman, & Volman, 2014).

Exploration has often been defined as a goal-oriented activity, the goal being to learn about an object or a situation, and to simultaneously learn how to interact with that object or situation (Rusher, Cross, & Ware, 1995; Weisler & McCall, 1976; Wohlwill, 1984). Recent studies of young children (Koziol, Budding, & Chidekel, 2012; Smith & Gasser, 2005; Thelen, Schöner, Scheier, & Smith, 2001) indicate that exploration often starts with a spontaneous movement, which elicits an effect, for instance a noise or the displacement of an object. Perceiving this effect, in turn, leads to acquisition of knowledge, at first coincidentally, and next to a new stage, where movement and cognition become coordinated to reach a goal or to master a skill (Koziol et al., 2012). The child that accidentally causes an effect can use this experience to intentionally repeat, alter or extend his or her activities by reproducing the newly discovered effect and by elaborating on it.

Children's exploration of spatial characteristics is obviously related to their motor development. For example, in order to be able to explore and manipulate particular objects the stage of neuromuscular development of the child's hand skills and the body-scaled relations for grasping should afford grasping these objects (i.e., the objects may be too big or too heavy for the child). Similarly, reaching important motor milestones such as sitting, crawling and walking enables new ways of exploring the environment (Oudgenoeg-Paz et al., 2015). Yet, exploring the environment while being guided by the spatial structures of the environment, in turn, leads to new motor skills and thereby propels motor development (e.g., Adolph & Robinson, 2015; Thelen, 2000)

Most studies investigating exploration behavior in young children have focused on children's use of play objects (e.g., Caruso, 1993; Fitneva, Lam, & Dunfield, 2013; Oudgenoeg-Paz et al., 2014; Power, Chapiesky, & McGrath, 1985; Schuetze, Lewis, & DiMartino, 1999), using various methods to assess exploratory play (e.g., Oudgenoeg-Paz et al., 2016; Soska, Adolph, & Johnson, 2010). Some studies found a relation between object exploration and motor skills, indicating that the way a child explores and uses a three- dimensional object is linked to his or her motor abilities, such as being able

to crawl or to sit (Oudgenoeg-Paz et al., 2014; Soska et al., 2010). Power et al. (1985) investigated exploratory styles, using the concepts of breadth of exploration, referring to the diversity of ways a toy was used, and depth of exploration, referring to the amount of time a child was engaged in playing with an object. Both breadth and depth of exploration were related to children's developmental level. In studies among infants between 9 and 12 months of age, Caruso (1993) and Schuetze et al. (1999) found that a greater variety in use of an object was related to more time spent on exploring and higher problem-solving ability.

Exploration of the playroom space

Various aspects of exploration of space in young children have been studied in laboratory and home situations. Studies have shown that once a child is able to move independently, by crawling and subsequently by walking, he or she is able to perceive the environment in new ways and to explore it by moving objects, by going from one place to another, and by manipulating the spatial arrangement of the environment (Karasik, Tamis- LeMonda, & Adolph, 2011). Other studies have shown a connection between the way in which children explored their environment and the characteristics of this environment. For instance, the onset of locomotion was found to be delayed in infants growing up in an environment that restrained their movement by placing them on a soft mattress (Campos et al., 2000). A study testing young children's walking on uneven floors demonstrated that subtle variations in floor height led children to adjust their steps to stay upright, indicating real-time coupling of perception and action (Gill, Adolph, & Vereyken, 2009). In a cross- cultural study into unsupported sitting of 5-month-old infants remarkable differences were found between sitting habits of children which were related to mother's behavior toward the child and to postural positions. In cultures where children sit on the floor unsupported, children sit stable at an earlier age than in cultures using supportive child furniture (Karasik, Tamis-LeMonda, Adolph, & Bornstein, 2015). These studies indicate that having opportunities to practice and develop new skills, made possible by both the social and the physical environment, stimulate children to gather knowledge about the environment and to simultaneously acquire new skills. Possibilities for exploration thus not only depend on the child's exploratory abilities, but also on characteristics of the physical environment. Also adults can influence children's exploration, either directly by guiding children's attention or by modelling exploration behavior, or indirectly by arranging the physical environment (Weisberg, Hirsh-Pasek, Golinkoff, Kittredge, & Klahr, 2016).

To the best of our knowledge only a few studies to date have investigated the relation between exploratory behavior and spatial characteristics of the environment in center-based childcare (Kantrowitz & Evans, 2004; Moore, 1986). Exploration in these studies was defined as the type of play behavior that is directed toward investigating

an object, a person or a space. Moore (1986) introduced the concept of well-defined settings, referring to recognizable areas within the playroom that are limited to one activity and well-equipped with relevant materials, as opposed to ill-defined activity settings. He found that exploratory behavior occurred more frequently in well-defined than in ill-defined settings. Kantrowitz and Evans (2004) discovered a relation between the child-activity-area ratio and the time children spent off-task. If there were more children per activity area, children spent less time on play activities. In this study, an activity area was defined as a section of the environment delineated by specific materials and physical boundaries, for instance an area for arts and crafts, dramatic play or construction play.

The concept of affordances as theoretical framework

Although sophisticated methods were used in the studies reviewed above, a coherent and comprehensive theoretical framework for relating exploration behavior to physical characteristics of the environment is still lacking. A promising framework is provided by the ecological psychology theory developed by James and Eleanor Gibson (J.J. Gibson, 1979/1986; E.J. Gibson, 1988). The core of this framework is the concept of affordances, entailing the idea that objects and spaces offer opportunities for action relative to what a person can perceive and perform (E.J. Gibson, 1988). Following Chemero (2003), affordances exist in the relationships between physical features of the environment and the abilities of an organism to perceive and act upon them. When a child perceives new stimuli in the environment and reacts to it by, for example, moving towards it, reaching for it, looking at it and manipulating it, the child gathers both new information about the environment and learns new skills, which subsequently enable the child to perceive new affordances to act upon (E.J. Gibson, 1988). Exploring affordances thus consists of recurrent perception-action cycles: perception leads to action, action leads to new information to be perceived, which in turn elicits new actions (Oudgenoeg-Paz et al., 2016; Soska et al., 2010). Young children's action-abilities develop rapidly and changes in body and posture due to neuromuscular maturation result in new possibilities for action (Adolph & Robinson, 2015). In the course of development, children learn to be flexible and to adapt their actions to the maturing body within a natural environment that offers a variety of affordances (Adolph & Robinson, 2015). To stimulate children's development, environments are required that offer a diversity of opportunities for perception and action, matching the rapidly developing abilities of the child. An important question, to be addressed in the current study, is whether early childhood childcare provides such an environment.

To the best of our knowledge, only one study to date used the concept of affordances to study children's exploration behavior in an early childhood classroom. McLaren, Ruddick, Edwards, Zabjek and McKeever (2012) investigated exploration behavior in

an integrated kindergarten playroom which enrolled disabled and non-disabled children. Children's interactions with the physical features of the indoor play environment were observed, with a focus on children's movement and exploratory behavior being defined as goal-directed movement. The results showed that open, non-designated areas such as circulation paths were used the most often and elicited the biggest variety of non-habitual uses. The present study extended the method used in the study of McLaren and colleagues to examine to what extent daycare centers provide environments that can stimulate children's development through offering a diversity of opportunities for exploratory perception and action. The concept of affordances was employed to investigate children's exploration of the indoor playroom space. An observation instrument was developed to observe children's acting upon the wide array of affordances provided by designated areas, special furniture and other elements in indoor playrooms, further elaborating on McLaren's set of affordances (McLaren et al., 2012). The observation instrument used in this study was based on a preliminary model for analyzing affordances in outdoor environments developed by Heft (1988), using functional categories such as 'climbable feature' or 'flat smooth surface' in combination with the possible actions they entail, such as 'affords running'. Following earlier studies regarding styles of object exploration (Caruso, 1993; Powers et al., 1985; Schuetze et al., 1999), both breadth of exploration (how extensively children explored a wide variety of affordances in the playroom) and depth of exploration (how intensively children explored a smaller subset of affordances in the playroom) were investigated.

Present study

The main objective of the present study was to examine how spatial characteristics of objects and areas in the playroom of daycare centers relate to the breadth and depth of children's exploration of playroom space as observed in free play situations. The purpose of this study was also to investigate if using an observation instrument, based on the concept of affordances, would offer new leads to measure quality of early childhood daycare centers. The choice for free play was based on the consideration that guidance of exploratory play by caregivers could obscure the relation between spatial characteristics and exploration. Free play is a relevant context in Dutch childcare. Several studies have shown that children in Dutch childcare spend an important part of the day, often up to one third, to free play (De Haan, Elbers, & Leseman, 2014; Slot, Leseman, Mulder, & Verhagen, 2015; similar findings are reported for the USA, see Ansari & Purtell, 2017). The present study involved children between one and four years of age. Since active self-induced locomotion has been found to play an important role in exploring the physical environment (e.g. Adolph & Robinson, 2015), only children that could already crawl or walk were included. The age heterogeneity allowed us to examine age effects that might reflect constraints of the stage of motor and cognitive development. To the best of our

knowledge, no studies to date have investigated exploration of the indoor playroom space in center-based childcare involving children below 2.5 years. Moore's study (1986) involved children between 2.5 and 6 years of age, the other studies concerned children between 4 and 6 years of age. In addition, we included a measure of children's general task orientation, as a temperamental characteristic that could influence their exploration behavior, as was found in previous research (Kantrowitz & Evans, 2004; Power et al., 1985).

Method

Participants

Participants were 61 children (49.2% girls) from ten child day care centers, all part of a large provider of childcare in the Netherlands. In each center one group participated in the study. The selection of centers and groups was based on two criteria. To avoid disturbing effects of recent changes in group composition, the groups had to function as a mixed-age group for at least six months. Each group had to consist of both young (under 18 months) and older (above 18 months) children, to guarantee that we could recruit enough children from different ages. In each group 5 to 7 target children were observed. Because the study focused on exploration of space, only children that could actually move around without help by crawling or walking were included. The mean age of the observed children was 29 months and use of the childcare facility varied between one and five days a week (see Table 1). At the time of the study, children had been attending the center on average for 21 months. The total number of children in the groups during the observations ranged from 8 to 11 (M= 9.98*; SD* = 0.88). Informed consent of the parents was obtained for 88% of the children. The remaining children, for whom no consent of the parents was obtained, were temporarily cared for in another group during the observations or carefully kept out of sight.

Procedure

Children were observed during free-time play periods on two different mornings, with one to two weeks between the first and the second visit. On both mornings video recordings were made during two rounds of 30 minutes. Recordings started with a period of about ten minutes to make the children familiar with the observer and the video camera. During each round every target child was followed for a continuous period of five minutes. In this way each child was observed during a total of four episodes of five minutes on the two mornings, 20 minutes in all. Some children were absent on the second day. To collect sufficient data per center extra children were recruited in these cases. This resulted in 7 children who were observed on only one morning.

After removing interruptions (for instance because of diapering, leaving the room) and episodes that were not suited for the study purpose (e.g., when children became involved in a teacher-led activity), a total of 216 episodes remained for analysis (M = 17.5 min. per child), with 7% of the episodes being excluded from the analysis for the reasons mentioned above.

Coding of the video recordings was done by dividing each 5-minute episode into 10-seconds intervals (N = 6419). Recordings were paused after each interval to enter the codes for the spatial component and affordance acted upon during that interval. If a child during an interval switched between components, for instance moved from the table to the activity center, or used different affordances, the code for the component or affordance used most frequently, that is during the largest part of the interval, was entered. If two components were used together at the same time, for instance a table and chair, the component most relevant for the ongoing activity of the child was coded. For example, if the child was wobbling on the chair and doing nothing else, this component was coded. If the child was sitting on the chair at the table but actually busy with something on that table (for example reading a book), the table was coded. Prior to the first visit a plan of the indoor playroom(s) of each group was obtained and a square meter grid with coordinates was drawn to be able to register the exact location of the child during the observations. In addition, the spatial components in the room (e.g., tables, cupboards, activity centers) were drawn on the plan and the teachers were asked not to make any major change in the room between the two visits. For every 10-second interval, the location where the child spent most of the time during that interval and the components used by the child were coded based on the grid-plan. In addition, the global quality of the playroom was evaluated focusing on the spatial lay-out, available square meters, furnishing, and the presence of activity centers. Finally, teachers were asked to fill out a structured questionnaire on characteristics of the children participating in the study.

Measures

Using spatial affordances

An observation instrument was developed to code children's use of the spatial components and playroom space in detail, the Spatial Affordances in Childcare Interior Design (SACID) tool. This tool builds on previous studies by Heft (1988) and McLaren et al. (2012), and was designed to collect detailed behavioral data of children's exploration of space. It consists of two main coding categories (for a complete overview, see Appendix 1). The first category comprises of a list of spatial components that frequently occur in playrooms for childcare. Components can be movable objects (such as a table, chair, decorations) or fixed areas (activity center, floor, door, window). The second category features a list of potential affordances for each component, for instance 'affords climbing'

or 'affords crawling under'. After a training session, the instrument was tested in a pilot study by the three observers who also conducted the main study. Codings of the pilot data were compared and discrepancies were discussed until agreement was reached. A few additional affordances were detected and added to the final version of the tool, for instance 'banging on the table' and 'standing on big play object'. For each interval the observer scored which component (e.g., table, floor, chair) the child used and which affordance specified by this component the child acted upon (e.g., by climbing on the chair, crawling over the floor, sitting on the couch). For the main analyses of the current study, the data were aggregated to the episode level, yielding counts of component and affordance use per episode (see below). In line with this, the inter-rater reliability was determined on a random selection of 40% of the episodes that were independently scored by two researchers. *ICC*s were satisfactory, ranging between .70 and .99, with a mean value of .88.

To construct measures of quantity, breadth and depth of exploration of space, data were aggregated to the level of episodes (*N*= 216), with each episode comprising of 30 intervals of 10 seconds each. For each component, the *total number of affordances used* was calculated as the number of intervals in which at least one affordance of a spatial component was used during a five minute episode (with 30 as maximum). In line with Caruso (1993), for each component, *breadth* of exploration was defined as the number of different types of affordances of a component used by the child during the five minutes episode; *depth* of exploration was defined in terms of the mean number of uses per type of affordance during this episode and was calculated by dividing the total number of affordances used by the breadth of use. If, for instance, during a 5-minute episode, the child used the table during 10 intervals, while using two different types of affordances (e.g., affording climbing, sitting), and the floor during 20 intervals, while acting on three types of affordances (e.g., affording crawling, standing, running), breadth of exploration for the table would be 2 and for the floor 3. Depth of exploration for the table would be 5 and for the floor 6.7. Finally, the total number of affordances explored, and the breadth and depth of exploration were summed over all components.

Quality of playroom space as assessed with the ITERS/ECERS

The global quality of the playroom spaces in the ten centers involved in the study was assessed using a combination of the space and furnishings scales of the Early Childhood Environmental Rating Scale (ECERS-R) (Harms, Clifford, & Cryer, 2005) and the Infant Toddler Environmental Rating Scale (ITERS-R) (Harms, Cryer, & Clifford, 2003). The ITERS-R is designed to assess the quality of spaces for children up to 30 months and the ECERS-R for children between 30 and 48 months. Therefore, given the current age range, the two instruments were used in combination. The observed quality aspects were rated on 7- point scales varying from 1 (inadequate), 3 (minimal), 5

(good) to 7 (excellent), focusing on the indoor space, furniture for routine care, play and learning materials, furnishings for relaxation and comfort, room arrangement for play, space for privacy, and child-related display. Assessments were made by two observers during the first visit to the center. The internal consistency of the combined scales (Cronbach's Alpha) was a = .76. In all groups, the combined scales were independently applied by two researchers to determine the inter- rater reliability. *ICC*s were satisfactory and ranged between .75 and 1.00, with a mean value of .91. In addition, the available space in square meters per child and the number of activity areas in the playroom were determined.

Child characteristics

The caregiver caring for the child on a daily basis at the center was asked to fill out a child profile questionnaire (Veen et al., 2013). The questionnaire contained questions about the child's age, age of enrollment and number of days per week the child attended the center. In addition, caregivers were asked to rate children's task orientation, a construct closely related to the construct of executive functioning and effortful control, using a scale from the Early Childhood Behavior Questionnaire (ECBQ; Putnam, Gartstein, & Rothbart, 2006). Sample items of this scale are: 'While playing, this child can be busy with an activity for a long time' and 'This child is not quickly distracted'. Caregivers were asked to rate to what extent the presented behaviors were true for a child on a 5-point scale, varying from 1 (false) to 5 (true). The internal consistency of the scale was satisfactory with Cronbach's a = .77.

Analytic procedure

Data analysis proceeded in three steps. First, a descriptive and correlational analysis was conducted of global spatial quality of the 10 centers involved in the study. In addition, descriptives of children's personal characteristics were calculated. Second, a descriptive analysis was conducted of the key variables of the current study describing children's use of spatial components, the affordances they acted upon, and the breadth and depth of their exploration. Third, two series of multilevel regression analyses were carried out with breadth and depth of exploration as dependent variables and the most frequently used spatial components as independent variables. Child, group and global center characteristics were added as control variables.

Results

Descriptive data

Table 3.1 shows the descriptives of the spatial characteristics of the centers, children's characteristics and children's observed exploration of space behavior. The quality of space as assessed with the ITERS/ECERS diverged widely between the centers, with two centers slightly scoring below 3, which is considered 'minimal', and three centers scoring 5 or higher, which is considered 'good'. Large differences were also found regarding the square meters available to the child for free play. Available square meters and the number of activity areas were highly inter-correlated (r = .80, p <.01). The ITERS/ECERS-scores and the number of activity areas were also highly inter-correlated (r = .75, p < .01). No significant relations were found for the ratio of square meters per child.

Children's task orientation showed a positive tendency, with children on average being moderately task-oriented according to their caregivers. The wide score range, however, suggests that children diverged rather strongly with regard to this characteristic. Children were observed to act upon affordances during every interval included in the current analysis, but the breadth and depth of their affordance use diverged. Depth of exploring affordances varied most strongly, with scores ranging from 2.0 to 30.0. Overall breadth and depth were negatively related (r = -.71, p <.01). Note that this strong correlation is partly due to the way in which these variables were constructed, the variable types of affordances was used to calculate both breadth and depth of exploration.

Table 3.1 Means, Standard Deviation and Range for Spatial Characteristics, Child Characteristics and Exploration of Playroom Space

Variables	*N*	*M*	*SD*	Observed range
Spatial characteristics				
ITERS/ECERS spaces and furnishings	10	4.16	0.96	2.5 - 5.2
square meters per child (play area)	10	6.60	2.35	3.8 - 10.4
number of activity areas	10	9.07	1.54	7.0 - 11.0
Child characteristics				
age (months)	61	29.30	9.85	11 - 48
attendance (days a week)	58	2.20	1.00	1 - 5
time being enrolled (months)	59	20.42	10.82	1 - 44
task orientation	61	3.45	0.52	2.3 - 5.0
Exploration of playroom space				
total uses of affordances	216	28.77	2.68	8.0 - 30.0
overall breadth of affordances	216	7.14	2.70	1.0 - 14.0
overall depth of affordances	216	5.16	4.23	2.0 - 30.0

Notes. *N* = daycare centers (10). children (61). 5-min episodes (216).

Upon closer examination, the results for exploration of space showed that, during free play sessions, children spent most of the observed intervals on the floor (see Table 3.2), mostly for moving from one place to the other (in 54% of the intervals; not presented in Table 3.2), but also for standing, sitting or crouching. Other relatively frequently used spatial components were the activity centers, the table and big play objects. Tables, but also chairs and cupboards, were often used by children to pull themselves up or to stabilize their standing. Overall, 94 different types of affordances were coded, excluding affordances that were acted upon only once. Spatial components that were used in less than 4% of the intervals (see Table 3.2) were because of the low prevalence not included in further analyses.

Table 3.2 Exploration of Playroom Space: Use of Spatial Components and Affordances per 5-min Episode (N= 216)

Spatial component	Affor-dances	Intervals	Breadth of use		Depth of use		Affords*
	#	%	M	SD	M	SD	
Floor (flat, smooth surface)	11	38.3	2.97	1.36	4.20	2.45	walking, sitting, standing
Activity centers (for dramatic play, construction, reading)	8	17.9	2.12	1.16	5.48	5.31	sitting, standing, walking
Table (child height)	7	13.2	1.61	0.89	5.83	7.01	sitting at, standing at, pull oneself up/ stabilizing,
Big play objects (play house, tunnel, car)	9	8.0	2.15	1.35	3.38	2.54	sitting, standing, climbing/sliding
Chair (child height)	12	5.6	1.76	1.02	2.69	2.69	sitting, moving it, pull oneself up/stabilizing
Bars (door, fence)	6	4.6	1.68	0.93	2.50	1.68	standing at , opening/ closing, looking through,
Cupboard	10	4.0	1.58	0.89	2.78	3.43	take things out/in, stand at, play at
Carpet	10	3.2	1.70	1.02	2.63	2.15	sitting, kneeling, standing
Chair (adult height)	8	2.1	1.52	0.71	2.42	1.84	pull oneself up/ stabilizing, climbing, moving (around)
Window	4	2.1	1.39	0.63	3.06	2.13	looking through, touching, standing at
Table (adult height)	6	0.8	1.17	0.39	2.75	3.33	sitting under, standing at, sitting at
Decorations (photos, drawings)	3	0.2	1.33	0.82	1.72	0.77	looking at, touching, pointing at

Notes. Spatial components are ordered according to frequency of use. *N*= 216 episodes.
= number of affordances. * The three most frequently used affordances.

Child characteristics such as age, gender, number of days and time being enrolled in daycare center were related to the behavioral characteristics, as rated by the child's teacher. Age, gender and time since enrollment correlated with task-orientation (r = .43, p < .01, r = .30, p < .05, r = .33, p < .05 respectively). Children were rated as overall more focused in activities when they were older, if they were girls and when they had been attending the center for a longer time. Age and time since enrollment, as expected, correlated strongly (r = .69, p < .01), therefore only age was included in further analyses. Regarding spatial characteristics, a negative correlation was found between the number of children and the available square meters per child (r = -.57, p <.01).

Multi-level analysis of depth and breadth of exploration of space

To examine the relations of the depth and breadth of children's exploration of the playroom space with child characteristics and spatial characteristics of the playroom, multi-level analyses were conducted using MLwiN (Rasbash, Steele, Browne, & Goldstein, 2009). Breadth and depth of exploration were significantly and substantially inter-correlated due to the way in which these variables were constructed. Note that the two constructs were not mutually exclusive and thus could in principle provide different information on how children's exploratory play relates to spatial and child characteristics. Therefore, separate analyses were conducted with breadth and depth of exploration as dependent variables. Breadth and depth of exploration were calculated at the 5 minutes episode level (see Method section). Therefore the analyses were run on data aggregated to the episode level (N= 216). The distribution of the scores for depth of exploration appeared to be skewed. A log-transformation was applied to this variable to better meet the normality assumption.

As first step, two empty two-level fixed effects models were estimated, with depth of exploration respectively breadth of exploration as dependent variables. The levels distinguished were the child level (N = 61) and the episode level (N = 216). Because of the small sample size at the center level (N= 10), it was decided not to add a third level. As second step, child and group characteristics were added to the models as control variables. Child characteristics were age, gender, number of days in daycare, and teacher rated task orientation. Attendance of the childcare facility varied and differences in familiarity with the playroom setting were expected to influence exploration of space. Therefore attendance was included as a control variable. The number of children in the group was found to be negatively related with available space per child. Less space per child was expected to lead to more disturbances and to decrease depth of exploration. Therefore, the number of children was included as a control variable as well. Due to missing data in one of the control variables (number of days attending the center) the sample size decreased to N = 205 at the episode level and to N = 58 at the child level. As third step, the spatial components that were used during more than 4% of the intervals

were added to the models. Use of components was aggregated to the episode level, representing the proportion of intervals during an episode that a particular component was used. Proportions were converted to *z*-scores to avoid problems of multicollinearity. As a final step, indicators of global spatial quality at the center-level as measured with the ITERS/ECERS and the number of square meters per child were added to the models. Another measure of global spatial quality, the number of activity areas, was strongly correlated with both the ITERS/ECERS scores and the square meters per child, and was therefore not included.

Table 3.3 shows the results for the different models. Models were evaluated by comparing the relative model fit using the *ΔDev (Δdf)* index and by inspecting the R^2s. Regarding depth of exploration, adding the spatial components resulted in the biggest improvement of model fit (Model 2). Adding the quality of space scores as assessed with the ITERS/ECERS and the square meters per child did not lead to a substantial improvement of the model fit. Regarding breadth of exploration, adding child characteristics, in particular the child's task orientation, led to the biggest model improvement (Model 1), but also the spatial components were found to be important predictors (Model 2).

Table 3.3 shows that the use of tables and activity centers was significantly positively related to depth of exploration. Also children's task-orientation was significantly positively related to depth of exploration. A reversed pattern of outcomes was found for breadth of exploration. Use of tables and activity centers and children's task-orientation were significantly negatively related to breadth of exploration. No significant relations were found for other child characteristics, such as age and group size. Depth and breadth of exploration of space were not related to the indicators of global spatial quality (ITERS/ECERS) at the center level.

The proportion of variance in depth of exploration explained by Model 3 corresponds to a medium to large effect. A closer look at the results shows that most of the variance is explained by the use of the spatial components, which were added in Model 2. The proportion of variance in breadth of exploration explained by Model 3 shows a medium to large effect as well. Again most of the variance is explained by the spatial components.

Table 3.3 Multilevel-analysis Depth of Exploration of Space and Breadth of Exploration of Space (*N* = 205)

	Depth of exploration				Breadth of exploration			
	Model 0	Model 1 child characte-ristics	Model 2 spatial compo-nents	Model 3 spatial characte-ristics	Model 0	Model 1 child characte-ristics	Model 2 spatial com-ponents	Model 3 spatial character-ristics
Fixed effects								
Intercept	0.506* (0.016)	0.643* (0.173)	0.554* (0.160)	0.491* (0.238)	7.135* (0.198)	6.883* (2.317)	9.697* (2.003)	9.096* (2.999)
Age(gm)		0.001 (0.002)	-0.000 (0.002)	-0.000 (0.002)		-0.009 (0.023)	0.004 (0.022)	0.004 (0.021)
Gender (boy=1)		-0.004 (0.033)	-0.005 (0.031)	-0.006 (0.030)		0.064 (0.408)	0.058 (0.384)	0.075 (0.375)
Child-profile: taskorientation (gm)		0.068* (0.036)	0.076* (0.033)	0.068* (0.033)		-0.965* (0.439)	-1.064* (0.417)	-0.948* (0.414)
Number of days		0.021 (0.016)	0.020 (0.015)	0.021 (0.015)		-0.231 (0.199)	-0.216 (0186)	-0.248 (0.189)
Number of children (gm)		-0.018 (0.017)	-0.009 (0.016)	-0.013 (0.021)		0.103 (0.214)	-0.005 (0.201)	-0.013 (0.263)
Table			0.063* (0.024)	0.071* (0.025)			-0.635* (0.308)	-0.739* (0.312)
Chair			-0.017 (0.018)	-0.014 (0.018)			0.253 (0.230)	0.207 (0.231)
Floor			0.020 (0.028)	0.023 (0.028)			0.269 (0.354)	-0.323 (0.354)
Activity center			0.064* (0.029)	0.071* (0.029)			-0.712* (0.370)	-0.800* (0.372)

Note. * $p < .05$.

Table 3.3 Multilevel-analysis Depth of Exploration of Space and Breadth of Exploration of Space (*N* = 205) (Continued)

	Depth of exploration				Breadth of exploration			
	Model 0	**Model 1 child characte-ristics**	**Model 2 spatial compo-nents**	**Model 3 spatial characte-ristics**	**Model 0**	**Model 1 child characte-ristics**	**Model 2 spatial com-ponents**	**Model 3 spatial character-ristics**
Big play object			-0.004 (0.020)	0.003 (0.020)			0.070 (0.249)	0.061 (0.247)
Bar (fence, door)			-0.026 (0.018)	-0.025 (0.018)			0.102 (0.240)	0.114 (0.225)
Cupboard			-0011 (0.019)	-0010 (0.019)			0.136 (0.224)	0.080 (0.241)
ITERS/ECERS spaces and furnishings				0.027 (0.018)				-0.296 (0.228)
Square meters per child				-0.002 (0.010)				-0.006 (0.121)
Random parameters								
Variance: child-level	0.003 (0.003)	0.001 (0.003)	0.001 (0.002)	0.000 (0.002)	0.449 (0.475)	0.177 (0.427))	0.089 (0.373)	0.000 (0.000)
Variance: episode-level	0.044* (0.005)	0.044* (0.005)	0.037* (0.004)	0.037* (0.004)	6.813* (0.769)	6.599* (0.764)	5.946* (0.688)	5.962* (0.589)
R^2	-	4.3%	19.2%	21.3%	-	6.7%	17%	17.9 %
Deviance (-2 LL)	-47.44	-54.73	-90.94	-93.44	1040.18	973.82	950.18	947.77
ΔDev (Δdf)	-	7.29 (5)	36.21* (7)	2.50 (2)	-	66.36*(5)	23.64*(7)	2.41 (2)

Note. * $p < .05$.

Discussion

The aim of this study was to examine relations between young children's exploration of space and spatial characteristics of the playroom in center-based childcare during free play. Exploration of the playroom space was studied by observing children's use of affordances, for which a new observation instrument was developed based on Gibson's ecological psychology theory of affordances (J.J. Gibson, 1979/1986; E.J. Gibson, 1988).

The results of the present study, first of all, showed that during free play children use a wide variety of spatial components in the playroom. The floor, activity centers and tables, however, were used most frequently, amounting to 70% of the observed time-intervals. The floor was the component used most often and also the component related to the largest variety in affordance exploration, showing actions such as jumping, running, kneeling, riding cars, crawling, sitting, walking and standing. This suggests that free floor space is an important component of the playroom, not only for moving from one spot to another, but also for affording a variety of actions. This is in line with the outcomes of the study by McLaren and colleagues (2012).

Based on previous studies (McLaren et al., 2012; see also Caruso, 1993; Moore, 1986; Power et al., 1985), we expected the depth of children's exploration of a subset of different affordances to be positively related to the use of designated, well-defined spatial components, and the breadth of children's exploration of a wide range of different affordances to be related to the use of non-designated, less well defined spatial components. The results of the multi- level analyses provided partial support for this expectation. Depth of exploration was significantly positively related to the use of designated spatial components such as the table and the activity center, whereas breadth of exploration was negatively related to the use of these components. For the other spatial components, including the non-designated, ill-defined spatial component floor, no clear pattern of relations with children's exploration of space was found.

The outcomes suggest that in-depth exploration of space indeed occurs mostly in distinct, recognizable and well-equipped play areas (tables, activity centers for construction, fantasy play etc.), as was suggested by Moore (1986), whereas these same areas were not or negatively related to the breadth of exploration. The most frequently used spatial component, the floor, was not significantly related to either depth or breadth of exploration. A possible explanation is that the floor has a multi-functional character. The floor is used for transition and moving around, but also for toy play, physical play and expressive activities, and therefore specifies combinations of diverse affordances for both broad and in-depth exploration. Big play objects are also clearly recognizable, well-defined spatial elements, but no relation was found with depth or breadth of exploration. A possible explanation is that big play objects often had a limited

function (car, slide) and often lacked additional materials that could be moved or manipulated to expand an activity. In contrast, activity centers, such as the construction area, were always equipped with a variety of movable and manipulable materials, likely stimulating children to prolong their use of this area and to explore materials in-depth. Tables provided a limited set of affordances in this study, and were mostly used to sit or stand at while playing in-depth with small toys or doing a focused creative activity.

Children who were rated by the caregivers as more task-oriented displayed more depth in their exploration of space. This is in line with findings by Power et al. (1985), who found that depth of exploration of an object was related to children's persistence in executing the task. While Power and colleagues investigated persistence by observing a child executing a single task (removing a toy from a jar) in a single session, task-orientation in the current study was based on teacher reports of the children covering a longer time period and a variety of situations. The current study thus extends the findings by Power and colleagues by providing evidence that task-orientation, as perceived by the caregiver during daily activities, is a child- characteristic that is related to the depth of exploration of space. Task-orientation and age were significantly inter-correlated, indicating that older children were more task-oriented. The results of the multilevel analysis showed that task orientation was a stronger predictor of depth of exploration than age. This is also in line with outcomes of the study of Power and colleagues, who found no direct relation between the age of the children (ranging from 12 to 24 months) and their exploratory style.

We further examined to what extent the overall quality of space and furnishing, as measured by the ITERS/ECERS at the center-level, was related to depth and breadth of exploration. No relations were found. Although the ten centers varied in quality and amount of space per child, they all met the minimum standards of the Dutch childcare quality regulations. A possible explanation for the lack of correlation, therefore, might be that the overall quality was sufficient. It is conceivable that the results could have been different in more extreme circumstances. Another explanation for the fact that no relation was found between exploration of space and the quality of space as assessed with the ITERS/ECERS, is that the scale evaluates spatial quality in a rather global way and pools the scores of several different spatial quality dimensions into a single score. It would be interesting to examine if the underlying quality dimensions are differentially related to children's exploration and, through exploration, to developmental outcomes. To the best of our knowledge, this has not been studied yet (see also Mashburn, 2008).

To summarize, investigating the use of playroom spaces by observing the affordances specified by these spaces allowed us to obtain detailed information not only about the possibilities for action particular spatial components offer to children, but also about children's actual use of these action possibilities. The results of this study show that exploration of playroom space during free play comprises of a broad range of varying

uses of spatial components, and that different spatial components are associated with different patterns of use. Designated and well-defined activity centers and tables were associated with depth of exploration, regardless of children's age. Dutch daycare centers usually offer a variety of activity centers for children of 2.5 years and older, but for younger children the playroom mostly consists of a more open, less well-defined play area. The results suggest that for stimulating in-depth exploration of space in younger children who can crawl or walk, the playroom should also contain activity centers and tables at child height.

Earlier studies into the relation of spatial characteristics and exploration in daycare centers have mainly focused on designated activity areas (e.g. Moore, 1986), neglecting a major spatial attribute in the playroom space, the floor. The floor tends to be regarded mainly as a circulation space. However, the frequent use of the floor, not only as a circulation space, but also as a space for play, suggests there is more to it. Use of free floor space can satisfy the child's need for movement, which may partly explain why the floor was used so often during free play. On the other hand, frequent use of free floor space for movement can also lead to a turbulent atmosphere, for instance by disrupting quiet play at a table or activity center, especially if circulation space and activity centers are not well separated. In the current study, we found that in almost half of the time-intervals children used the floor for stationary actions (e.g., sitting, standing, kneeling). Perhaps this concerns activities that do not fit well in an activity center due to the limited space within the center or to other factors. Future research should investigate if there is a relation between number and type of activity centers and floor use, especially use of the floor for play and exploration activities other than circulation. Furthermore, it seems important to study if the design of the playroom is related to the frequency of moving around, comparing situations where space for circulation is clearly separated from activity centers with situations without clear boundaries.

Future studies could work with the concept of affordances as a theoretical framework to study the relation between physical-spatial environment, behavior, and development. Including the actual use of all spatial components in the playroom could help researchers to obtain a more comprehensive view on children's exploration behavior. Future research should include the use of small-sized play materials that are related to the relatively big spatial components studied here (e.g., small toys on the table desk), to examine if additional affordances for fine-motor actions are associated with depth of exploration of playroom space. In line with findings from recent studies on young children's spatial-object exploration using play materials (e.g., Ginsburg, Lin, Ness, & Seo, 2003; Hendershot, Berghout- Austin, Blevins-Knabe, & Ota, 2016; Karasik et al., 2011; Oudgenoeg-Paz et al., 2016), we expect that adding a fine-grained affordance analysis to the present approach can contribute to the further understanding of children's exploratory behavior in childcare settings. Finally, future studies could look into the

relations between affordance-based exploration and measures of children's emotional experiences while exploring, such as signs of excitement or boredom.

Limitations

A limitation of the present study is the relatively small sample size of 61 children attending ten daycare centers. This limitation was partly compensated by the detailed interval observation method used, resulting in a large number of data points. Yet, the present findings should be treated with caution. Another limitation of this study is the use of a newly developed instrument for measuring exploration of playroom space, limiting the possibilities to relate the current findings to findings in other studies. Moreover, information on the psychometric quality of the new instrument is still lacking. Note however that the inter-rater reliability for the new instrument was satisfactory and that the pattern of findings (e.g., in-depth exploration occurring more frequently in designated areas) and the observed inter-correlations (e.g., of depth of exploration correlated substantially with teacher rated general task orientation) attest to the reliability and validity of the new instrument. A third limitation is the relatively short time children were observed. Future studies should extend the observation time per child, to obtain more detailed and reliable information about the breadth and depth of exploration at the child level. Finally, only free play situations were examined in the current study for reasons outlined above. Exploration of space during caregiver-guided activities, however, may be very different from what has been observed in the current study. Future research should therefore also include use of space during caregiver-guided activities, such as eating, storytelling, resting and group play. Despite these limitations the current study contributes to the understanding of children's use of the physical environment in center-based childcare and offers new leads for future research into exploration of space.

Conclusions

This study used a fine-grained observation method to examine exploration of playroom space focusing on children's use of affordances. The results show that there is a relation between the physical characteristics of the playroom and young children's exploration of space in center-based childcare. Different spatial components are related to a variety of different uses. Carefully designing and furnishing playrooms following findings in studies like the present one can stimulate children to expand the range of exploratory behaviors and thereby foster their development. Future studies into young children's exploratory behavior could benefit from a strong theoretical basis provided by the Gibsonian theory of perception- action affordances.

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Chapter 4

Children's exploration of the playroom space during unguided free play time in center-based childcare

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Abstract

This study examined how young children's play behaviors during unguided free play episodes in center-based childcare were related to their exploration of the playroom space. The study was carried out in ten mixed-age groups, with children's ages ranging between 11 and 48 months. A total of 61 children were observed. The results show that during free child-directed play children were engaged in actual play activities in less than half of the observed time. Transitional behaviors occurred during 25% of the time and were not related to age, level of task-orientation or familiarity with the facility. Task-orientation and social play were positively related to depth of play space exploration, while transitional behavior was negatively related to depth of play space exploration. Results contribute to the understanding of children's use of time and play space during free play. Future studies should investigate if changes in the spatial arrangement of the play room and increased teacher support during free play might enhance the proportion of time children spend in actual play and thereby stimulate in-depth exploration.

Keywords: free unguided play; exploration; daycare centers; spatial components; transition.

Introduction

Worldwide, a growing number of children are attending a child care center or preschool in the first years of their lives (OECD, 2014), raising interest in the quality of experiences as related to child development in these institutions, in particular regarding opportunities for exploration. Daycare centers do not only offer children the opportunity to engage in social interactions with peers, but also to explore an environment that is designed especially to accommodate a group of young children, and differs in many ways from their home environment. However, the opportunities provided by this special environment have not yet been studied widely. Daycare quality is often defined as a combination of structural aspects, such as the adult-child ratio, group size and teacher training level, and process features referring to daily adult-child and peer interactions, and the activity programs provided (Pianta, Barnett, Burchinal, & Thornburg, 2009). Many studies on center-based childcare and preschools have examined relations between children's social behavior and the social environment (e.g., NICHD Early Childcare Research Network, 2002), examining for instance the quality of teacher-child interaction (see Burchinal et al., 2009; Curby et al., 2008) or peer-interactions (e.g., Aarts, Burk, & Riksen-Walraven, 2016; Fabes, Hanish, & Martin, 2003). Other studies investigated structural characteristics such as the number of days per week children were enrolled in childcare (Broekhuizen, van Aken, Dubas, & Leseman, 2015) and teacher-child ratio and group size (see Pianta et al., 2009). However, studies relating children's play-behavior to the typical physical environment provided by center-based childcare are scarce. The present study focused on 11- to 48-months-old children's play and non-play behavior during unguided free play time in center-based child daycare and examined how children's behavior relates to their exploration of the physical indoor play environment.

Free Play in Center-based Child Care

Studies regarding time use in early years child care settings usually distinguish three types of activities taking place during the day: free play, which means children can make their own choices as to where, with what and with whom they play in a specific area (indoor play space, outdoor play area); teacher-assigned or guided activities, during which the caregiver determines the choice of activities which can involve the whole group, a small group or an individual child; and routines time where children are engaged in group activities such as eating, bathroom use or standing in line (see Early et al., 2010). In addition, depending on the age of children, there is naptime. Various studies have shown that children in center-based childcare spend a significant part of the day, often up to one-third, engaging in free play (De Haan, Elbers, & Leseman, 2014; Early et al., 2010; Wildgruber, Wertfein, Wirts, Kammermeier, & Danay, 2016). The role of free play in child care and preschools, however, is a much debated topic

among early childhood researchers and practitioners (Early et al., 2010; Fuligni, Howes, Huang, Hong, & Lara- Cisinomo, 2012). While some express a preference for frequent free unguided play (Harms, Clifford, & Cryer, 2005), others emphasize the importance of teacher-child interactions (Pianta, LaParo, & Hamre, 2008).

A number of studies investigating the use of time in preschools (Chien et al., 2010; Fuligni et al., 2012) found that children, aged three and four years, who spent more time in unguided free play than others, were less well prepared for school, especially regarding language and literacy activities. In contrast, an international comparative study by Montie, Xiang and Schweinhart (2006) showed that more time spent in free play at the age of four was positively related to language performance at age of seven. Other studies showed that by reducing time for free play, children's opportunities to explore materials on their own and to practice their autonomy diminished (Early et al., 2010). Less time for free play was also found to result in fewer opportunities for fantasy play and gross motor activities (Fuligni et al., 2012). In a study among children between 12 and 36 months of age, Hooper and Hallam (2017) found that engagement, i.e. attention to or active participation in classroom activities, during free play was significantly higher than during teacher-led whole group activities, suggesting that a context in which children direct their own activities leads to more active involvement. If children have the opportunity to independently explore their environment, they can discover new areas of interest and practice decision-making skills at their own pace (Ginsburg, 2007). Exploring the spatial properties of objects and environments provides children with opportunities to gain knowledge about basic mathematical notions such as shape, height and size (Ginsburg, Cannon, Eisenband, & Pappas, 2006). If children do not have opportunities to explore materials and spatial relations on their own, this could, unintentionally, reduce their autonomy and constrain self-induced exploration (Bonawitz et al., 2011; Ginsburg, 2007).

Most recent studies on free play in center-based care or preschools examined free play as part of the daily schedule while focusing specifically on the role of the teacher (e.g., Chien et al, 2010; Fuligni et. al., 2012; Hall-Kenyon & Rosborough, 2017). Play itself has been a subject of research for many years, but most studies focus predominantly on a specific type of play, such as pretend play (e.g., Lillard et al., 2013) or physical play (e.g., Bower et al., 2008; Gubbels, Van Kann, & Jansen, 2012). Other studies investigated the relation between play in general with aspects of child development, for instance regarding social skills (e.g., Coplan, Prakash, O'Neil, & Armer, 2004). According to Early et al. (2010; see also Pellegrini, 2009) more research into what actually happens during free play sessions is needed, since a focus on specific types of play might misrepresent what actually happens during free play time and how this can contribute to child development.

Elaborating on well-known play theories as proposed by Parten (1932), Piaget (1962) and Smilansky (1968), Rubin, Maioni and Hornung (1976) developed a comprehensive theoretical framework which combines two dimensions of play: a social dimension, distinguishing between social, parallel and solitary play, and non-play behaviors, and a cognitive dimension, classifying play as functional, constructive, dramatic, exploratory or games-with-rules. Non-play behaviors, in this framework, include unoccupied, onlooker and transition behaviors, as well as conversations with peers or adults (Rubin, 2001). In this study, we use specifically the social dimension of the framework to examine the play behaviors of children during free play time and how they relate to self-directed exploration of the playroom space.

Play and Exploration

According to Singer, Singer, D'Agostino and DeLong (2009) young children's play mostly consists of physical actions in which they, for example, explore an object by tasting and touching it. Play, in this view, can be interpreted as a form of experiential learning. Singer and colleagues postulate that this experiential learning is incited by the child's urge to explore and is mostly self-guided. Exploration is related to reaching developmental motor milestones, for instance hand-eye coordination or crawling, which opens new action possibilities within which the child uses this newly acquired skill to explore new ways of using an object or to communicate with others (Smith & Gasser, 2005). In Smith and Gasser's view, cognition develops in the interaction of the child with the environment and as a result of sensorimotor activity. In this embedded-embodied cognition view, play of young children is regarded as exploration, primarily of the spatial-physical environment, but subsequently also of the social environment (Smith & Gasser, 2005). Young children's exploration is intrinsically motivated by the possibilities offered to act upon the environment and, thereby, to learn about the environment and to develop new skills for more complex action possibilities. Following this line of thought, functional play, defined by Rubin as an activity done for the simple enjoyment of a physical sensation (climbing on a chair), and constructive play, defined as manipulation of objects to create something (stacking blocks) would be both a type of exploration: can I get on the chair, how high can I make the stack before it tumbles down? Other play activities, such as games-with-rules, are still uncommon in young children (e.g., Rubin, Watson, & Jambor, 1978). The cognitive dimension as defined by Rubin and colleagues, therefore, seems better suited for studying the play behavior of children older than the children involved in the current study.

A useful framework for studying children's exploration of space, complementing the embedded-embodied framework outlined by Smith and Gasser (2005), is offered by the ecological psychological theory developed by James and Eleanor Gibson (J.J. Gibson, 1979/1986; E.J. Gibson, 1988). The ecological approach provides a framework

to relate the physical aspects of the environment to behavior. The core of Gibson's theory is the concept of affordances, representing the idea that objects and spaces offer opportunities for action relative to what a person or organism can perceive and perform, while perceiving these opportunities triggers the actions afforded by them (E.J. Gibson, 1988). The continuous affordance-guided interaction of a person with his or her environment is called exploration. For example, when a child perceives a new object in the environment with physical properties that match his or her action possibilities and the child reacts to it by moving towards it, reaching for it and manipulating it, he or she gathers new information about the object. The knowledge about this object and the skill of acting upon it can subsequently be used to discover new action affordances, such as the possibility of combining this object with other objects by stacking them based on matching physical properties the child has discovered through exploration (Oudgenoeg-Paz, Boom, Volman, & Leseman, 2016).

Present Study

The aim of the present study was to investigate how children spend their time during free play episodes, and if their play behaviors during unguided free play are related to their exploration of spatial components in the playroom. Free play time was defined as the *scheduled time slot in which children are expected to engage in unguided child-initiated play activities*.

Two research questions were formulated:

1. What kinds of play and non-play behaviors occur during free play episodes?
2. How are these types of play and non-play behaviors related to children's spatial exploration?

To answer the first question, we conducted an observation study in daycare centers catering for children of three months to four years of age during free play time, applying the social dimension of Rubin's Play Observation Scale (POS, 2001). The second question was addressed using a new observation instrument, based on Gibson's theory of affordances, which was developed to investigate how children explore the physical properties of the playroom environment (Van Liempd, Oudgenoeg-Paz, Fukkink, & Leseman, 2018; Chapter 3 of this dissertation). Following earlier studies regarding styles of exploration (Caruso, 1993; Power, Chapiesky, & McGrath, 1985; Schuetze, Lewis, & DiMartino, 1999), we investigated how intensively children explored the different affordances offered by spatial components, such as tables, floor, cupboards and activity centers, in the playroom.

Method

Participants

Participants were 61 children (49.2 % girls) from ten child-care centers, all part of a large provider of child care in the Netherlands. In each center one group participated in the study. The selection of groups was based on two criteria. To avoid disturbing effects of recent changes in group composition, groups had to function as a mixed-age group for at least six months. To guarantee that we could recruit enough children from different ages, each group had to consist of both young (under 18 months) and older (above 18 months) children. In each group, five to seven target children were observed. Because this study's central point of focus was active exploration of the playroom space, only children that could actually move around without help, by crawling or walking, were included. The mean age of the observed children was 29 months and use of the childcare facility varied between one and five days per week (see Table 4.1). At the time of the study children had been attending the center on average for 21 months. The number of children attending the groups during the observations ranged from 8 to 11 (M = 9.98; SD = 0.88).

Informed consent of the parents was obtained for 88% of the children, including all target children. During the observations the children for whom no consent was obtained, were carefully kept out of sight.

Procedure

Children were observed during free-time play periods on two different mornings, on the same day of the week, with one or two weeks between the first and the second visit. On both days video recordings were made during two rounds. Video recordings started with a period of about ten minutes to make children familiar with the observer and the video camera. During each round every target child was followed for a continuous period of five minutes. In this way each child could be observed during a total of four episodes of five minutes, 20 minutes in all. Some children were absent on the second visit. To collect sufficient data per center, extra children were recruited in these cases. This resulted in seven children who were observed only on one morning. After removing interruptions (for example, because of diapering, leaving the room) and episodes that were not suited for the study purpose (e.g., children becoming involved in a teacher-led activity) a total of 216 episodes remained for analysis (M = 17.5 min. per child), with 7% of the episodes excluded from the analysis for reasons mentioned above.

Coding of the video recordings was done by dividing each 5-minute episode into 10-seconds intervals (N = 6419). After each interval, recording was paused to enter the codes for the type of play behavior the child displayed, the spatial component that was used and the affordance that was acted upon during that interval. If a child during an

interval switched between components, for instance moved from the table to the activity center or used different affordances, the code for the component and affordance used most, that is, during the largest part of the interval, was entered. Likewise, if a child switched between behaviors, for instance changed from solitary play to social play, the code for the behavior shown most during that interval was entered. Prior to the first visit a plan of the indoor playroom(s) of each group was obtained, and a square meter grid with coordinates was drawn to be able to register the exact location of the child during the observations. During the first visit the visual attributes in the room (tables, cupboards, activity spots) were drawn on the plan. The teachers were asked not to make any major changes in the spatial arrangement of the room between the two visits.

Measures

Play behavior

Children's behavior during free play was analyzed using the Play Observation Scale (POS) developed by Rubin (2001). Play behavior was subdivided in solitary, parallel and group play. Play behavior was rated as solitary when a child was playing on its own, apart from other children, at a distance of more than one meter from others. If a child was playing within a distance of one meter of other children, besides or in the company of others, but not *with* them, this was coded as parallel play. Whenever a child was engaged in play together with one or more other children, with a common goal or purpose, the behavior was rated as group play. Non-play behavior was coded as unoccupied, transition, onlooker or conversation with peers and/or adult. Behavior was rated as unoccupied when a marked absence of focus or intent was observed.Transition was coded when a child was moving from one activity to another, was tidying up after an activity, was looking for a toy or was walking across the room carrying a toy. Note that transition in this study was not teacher-initiated but child-initiated. When a child was watching an activity but was not taking part in it, behavior was coded as onlooker. Whenever a child was involved in active conversation with a peer, was talking to or was being spoken to by one or more other children, behavior was rated as conversation with peers. If the conversation involved an adult, this was coded as interaction with adult. To determine inter-observer reliability, a random selection of 40% of the episodes was independently scored by two researchers. *ICCs* were satisfactory, ranging between .72 and .99, with a mean value of .87.

Spatial exploration

A new observation instrument was developed to code children's use of spatial components and playroom space in detail, the Spatial Affordances in Childcare Interior Design (SACID) tool. This tool builds on previous studies by Heft (1998) and McLaren, Ruddick, Edwards, Zabjek and McKeever (2012), and was designed to collect detailed

behavioral data of children's use of spatial components and their affordances. The SACID consists of two main coding categories (for a complete overview, see Appendix 1). The first category includes a list of spatial components that frequently occur in playrooms for child daycare. Components can be movable (such as a table, chair, decorations) or fixed (activity center, floor, door). The second category comprises a pre-defined list of possible affordances for each component, for instance 'affords climbing' or 'affords opening'. For each interval the observer scored which spatial component (e.g., table, floor) the child used and which affordance specified by this component the child acted upon most during that interval (e.g., acting upon 'affords crawling under' by crawling under the table).

For the main analysis of the current study, the data were aggregated to the 5-minutes episode level, yielding counts of component and affordance use per episode (see below). In line with this, inter-rater reliability was determined on a random selection of 40% of the episodes that were independently scored by two researchers. *ICCs* were satisfactory, ranging between .70 and .99, with a mean value of .88. To construct a measure of the depth of exploration of the playroom space, data were aggregated to the level of episodes (N= 216), with each episode comprising 30 intervals of 10 seconds each. For each spatial component, first the number of pre-defined affordances used was calculated by adding up the number of intervals in which at least one affordance of a spatial component, for instance the table, was used during a five minute episode (with 30 as maximum). In line with Caruso (1993), subsequently for each component, *depth* of exploration was defined as the mean number of uses per type of affordance during this episode and was calculated by dividing the total number of intervals a spatial component was used by the number of different types of affordances acted upon for this component during this episode. For example, if within a 5-minute episode, the child used the floor during 12 intervals, while using three different types of affordances (e.g., acting upon affordances by running, sitting, standing), depth of exploration for the floor would be 4 (12:3). If during that same episode the activity center was used during 18 intervals, while using two types of affordances (by walking, manipulating), depth of exploration would be 9 (18:2). Finally, to calculate an overall measure of depth of exploration, depth of exploration was averaged over all components.

Child characteristics.

To control for individual child characteristics, the center's caregiver caring for the child was asked to complete a child profile questionnaire (Veen et al., 2014). This questionnaire contained questions about children's age, date of enrollment and the number of days per week the child attended the center. In addition, the caregiver was asked to rate children's task orientation, using a six-item scale from the Early Childhood Behavior Questionnaire (ECBQ; Putnam, Gartstein, & Rothbart, 2006). Sample items of this

scale are: 'While playing, this child can be busy with an activity for a long time' and 'This child is not quickly distracted'. Caregivers were asked to rate to what extent the presented behaviors were true for a child on a 5-point scale, varying from 1 (false) to 5 (true). The internal consistency of the scale was satisfactory with Cronbach's a = .77.

Analytic procedure

Data analysis proceeded in two steps. First, a descriptive analysis was conducted of children's play and non-play behaviors. In addition, descriptives of children's personal characteristics were calculated. Furthermore, a descriptive analysis was conducted of children's depth of exploration of the spatial components. Second, a multilevel regression analysis was carried out with overall depth of exploration as dependent variable and children's play and non-play behaviors as independent variables. Child characteristics were added as control variables.

Results

Descriptive Data

Table 4.1 shows the descriptive data for child profile and play behavior. Child characteristics age and time since enrollment, as expected, correlated strongly (r = *.69,* p < .01), and consequently only age was included in further analyses. Children's task orientation as rated by the caregiver showed a positive tendency, indicating that children were found moderately task-oriented, in general. However, the wide score range suggests that children diverged rather strongly regarding this characteristic. Task-orientation correlated significantly with age (r = .43, p < .01). Older children were rated as overall more focused in activities. An independent t-test showed that the mean scores for task-orientation differed significantly between boys and girls (t(59) = .238, p = .021): girls were rated as more task-oriented than boys with a medium to large effect size (Cohen's d = .61).

Because group play and conversations with peers both involve interaction between peers, it was decided to merge both variables into a new variable: social play. The data regarding play behavior show that during free play time children were actually playing (alone, parallel or social) in 48% of the intervals. During non-play, transition and onlooker behavior occurred most frequently. Unoccupied behavior was the least frequent. Since both unoccupied and onlooker behavior can be regarded as passive behaviors, for further analyses these variables were merged into a new variable: reticent behavior.

Table 4.1 Means, Standard Deviations, Range of Spatial Characteristics, Exploration and Behavior

Variables	*N*	*M*	*SD*	range
Child characteristics				
age (months)	61	29.30	9.85	11 – 48
attendance (days a week)	58	2.20	1.00	1 – 5
time being enrolled (months)	59	20.42	10.82	1 – 44
task orientation	61	3.45	0.52	2.3 - 5.0
Play behavior (POS)*				
solitary play	216	0.16	0.19	0.0 – 0.8
parallel play	216	0.20	0.20	0.0 – 0.8
social play	216	0.12	0.17	0.0 – 0.9
transition	216	0.25	0.16	0.0 – 0.7
onlooker	216	0.18	0.17	0.0 – 0.9
conversation with adult	216	0.05	0.08	0.0 – 0.6
unoccupied	216	0.04	0.09	0.0 – 0.9

Note. * = average proportion of intervals per episode.

Since the distribution of age was bimodal (D (61) = .14, $p < .05$), for further analyses two age groups were created, divided by median split (Mdn = 27), resulting in 30 children between 11 and 26 months, and 31 children between 27 and 48 months. Independent t-tests showed that the mean scores for social play ($t(59) = 4.054$, $p < .001$), solitary play ($t(59) = -2.302$, $p = .025$) and conversation with adults ($t(59) = 3.060$, $p = .003$) differed significantly between age-groups.

Older children were more often engaged in social play and in conversations with adults than younger children, and were less often engaged in solitary play than younger children. The effect size for social play was large (Cohen's d = 1.04), for parallel play small (d = .12), and for solitary play medium (d = .59). No significant relations were found between play and non-play behaviors, on the one hand, and gender, daycare attendance or task-orientation, on the other hand.

Table 4.2 shows the spatial components that were used, the proportion of intervals each component was used, and the depth of exploration per component. The results reveal that during free play sessions children spent most of their time on the floor. Other frequently used spatial components were the activity centers, tables and big play objects. Overall depth of exploration was calculated as the average of the depth of exploration per component.

Table 4.3 shows that social play and parallel play were both significantly positively related to the overall depth of exploration of the playroom space, transition behavior was significantly negatively related to depth of exploration.

Table 4.2 Exploration of Playroom Space: Proportion of Use of Spatial Components and Depth of Exploration per 5-minute episode (N = 216)

	Intervals	Depth of exploration	
Spatial component	**%**	***M***	***SD***
Floor (flat, smooth surface)	.38	4.20	2.45
Activity centers (for dramatic play, construction, reading)	.18	5.48	5.31
Table (child height)	.13	5.83	7.01
Big play objects (play house, tunnel, car)	.08	3.38	2.54
Chair (child height)	.06	2.69	2.69
Bars (door, fence)	.05	2.50	1.68
Cupboard	.04	2.78	3.43
Carpet	.03	2.63	2.15
Chair (adult height)	.02	2.42	1.84
Window	.02	3.06	2.13
Table (adult height)	.01	2.75	3.33
Decorations (photos, drawings)	.00	1.72	0.77
Overall depth of exploration		5.16	4.23

Notes. Spatial components are ordered according to frequency of use. *N* = 216 episodes.

Table 4.3 Correlations for Play Behaviors and Depth of Exploration (*N* = 216)

	Play behaviors	1	2	3	4	5	6
1	Social play	-					
2	Parallel play	-.105	-				
3	Solitary play	-.343**	-.272**	-			
4	Transition	-.282**	-.362**	-.049	-		
5	Reticent	-.204**	-.329**	-.286**	-.156*	-	
6	Conversation w. adult	-.019	-.071	-.122	-.038	-.160*	-
7	Depth of exploration	.196**	.177**	-.073	-.334**	.011	.006

Notes. *N* = 5 min. episodes. ** $p < .01$. * $p < .05$.

Multi-level analysis

To examine the relations of children's play and non-play behaviors with child characteristics and depth of children's exploration of the playroom space, a multilevel linear regression was conducted, using MPlus 7.0 (Muthén & Muthén, 2013). A model was constructed with overall depth of exploration as the dependent variable. Depth of exploration was calculated at the 5-minutes episode level (see Methods section). Therefore, the analyses were run on data aggregated to this level (*N* = 216). Because

the distribution of the scores of depth of exploration appeared to be skewed, a log-transformation was applied to this variable to meet the normality assumption. For the analyses two levels were distinguished: level 1 is the episode-level (N = 216) which is nested in level 2, the child level (N = 61). Play and non-play behaviors were included as predictors. All behavior types were standardized, and unoccupied behavior was used as the reference category to avoid problems of multicollinearity. Child characteristics age and task-orientation were added as control variables.

Children were nested within groups. However, the number of groups (10) involved in the study was too small to include the group level as a distinct level in the multilevel analysis, as with such a small number variance estimates are inaccurate (Hox, 2010). To examine whether leaving out the group level would bias the analyses, a preliminary analysis was conducted including dummy variables representing nine groups (the tenth groups was the reference) as predictors of children's depth of exploration. Only one dummy showed a significant relation with depth of exploration. Moreover, adding the dummies to the model did not result in a significant decrease in the maximum likelihood estimate, indicating that model fit did not improve. Group, therefore, was not included in the final analysis. Gender was significantly and strongly related to task-orientation and also added to this preliminary analysis together with task orientation. The results showed no remaining significant relation of gender with the dependent variable beyond the shared variance with task-orientation. Therefore, gender was also not included in the final analyses.

As first step, an intercept-only model (Model 0) was specified to estimate the amount of variance at both the episode and child level, and to calculate the intra-class correlation (ICC). As second step, age-group was added as predictor at level 2 (Model 1). Then task-orientation was added as predictor at level 2 (Model 2). In the next model, play-behaviors (social, parallel, solitary) and non-play behaviors (transition, conversation with adult) were added as predictors at level 1 (Model 3a). Fixed effects and the residual variances at both levels were calculated in these models. To determine the effect sizes for the different predictors, an additional model was estimated with standardized regression coefficients (Model 3b). Finally, we examined if the variance of play behavior as related to depth of exploration differed at the child level by including the random slopes (Model 4). Model equations for the multilevel regression models were based on Hox (2010).

Table 4.4 shows the results of the multi-level analysis. The intercept-only analysis shows that 2.2% of the variance of depth of exploration can be attributed to the child level, with the remainder of variability in depth of exploration occurring at the episodes level. Models were evaluated by comparing the relative model fit using the likelihood ratio test (Diff. Deviance) and Akaike's Information Criterion (AIC). Model 1 shows that age significantly predicted depth of exploration: older children showed more in-depth exploration. Task-orientation, added in Model 2, was positively related to depth of exploration.

Table 4.4 Multilevel-analysis Depth of Exploration of Space (*N* = 216).

Depth of exploration	Model 0: random intercept	Model 1: fixed effects age	Model 2: fixed effects task orientation	Model 3a: fixed effects play behaviors	Model 3b: fixed effects standardized	Model 4: random slopes
	Parameter (SE)	*Parameter (SE)*	*Parameter (SE)*	*Parameter (SE)*	*Parameter (SE)*	*Parameter (SE)*
Fixed effects						
Intercept	0.342**(0.021)	0.294**(0.029)	-0.006 (0.144)	0.049 (0.138)	0.782 (2.440)	0.047(0.144)
Age (1 = older group)		0.100**(0.041)	0.070 (0.142)	0.058 (0.043)	0.470[b] (0.421)	0.054(0.044)
Task-orientation			0.091**(0.043)	0.077* (0.041)	0.638[b](0.483)	0.075*(0.044)
Social play Z				0.027 (0.024)	0.091[a](0.083)	0.018(0.030)
Parallel play Z				-0.003 (0.024)	-0.009(0.081)	-0.011(0.027)
Solitary play Z				-0.002 (0.023)	-0.008(0.08)	-0.002(0.023)
Transition Z				-0.088**(0.023)	-0.301**[c](0.078)	-0.078**(0.025)
Conversation w. teacher Z				-0.011 (0.020)	-0.038 (0.068)	-0.009(0.022)
Random effects						
VAR (within)	0.088**(0.010)	0.087**(0.010)	0.086**(0.009)	0.076**(0.009)	0.886**(0.043)	0.058**(0.009)
VAR (between)	0.002 (0.005)	0.001 (0.005)	0.000 (0.005)	0.001 (0.005)	0.162(1.068)	0.000(0.005)
VAR social play						0.006(0.006)
VAR parallel play						0.011 (0.006)
VAR solitary play						0.000 (0.004)
VAR transition						0.000(0.008)
VAR conversation w. teacher						0.002(0.003)
Likelihood	-46.643	-43.732	-41.484	-28.792	-28.792	-23.933
Deviance	93.286	87.464	82.968	57.584	57.584	47.866
Diff Deviance		5.822** (1)	4.496**(1)	25.384**(5)	25.384	9.718 (5)
AIC	99.287	95.464	92.968	77.584	77.584	77.867
Variance partitioning ICC	0.022					
Explained variance pseudo R^2		2.2%	4.4%	14.4%	14.4%	

Notes. ** $p < .05$, * $p < .10$; reticent behavior is reference category; effect size: [a] = small, [b] = medium, [c] = large.

In this, and further models, age was no longer significant, but note that age and task-orientation correlated strongly. When the play and non-play behaviors were added (Model 3a), transition was significantly negatively related to depth of exploration. The standardized version of this model (Model 3b) showed a small positive effect of social play, a medium sized positive effect of both age and task-orientation, and a large negative effect of transition behavior on depth of exploration. The random slopes model (Model 4) showed no significant variance at the child level regarding play and non-play behaviors, and did not lead to a significant decrease of maximum likelihood estimates and AIC. Therefore Model 3a is considered the final model. Adding the play and non-play variables resulted in the biggest improvement of the model fit. The proportion of variance for depth of exploration explained by the fixed effects (Model 3a) corresponds to a medium effect size. Outcomes show that the relation between children's task orientation and depth of exploration was marginally significant (p =.060), indicating a trend towards significance. Transitional behavior was the variable most strongly, and negatively, related to depth of exploration.

Since transition behavior was the strongest predictor of depth of exploration, we conducted an exploratory analysis to examine if transitional behavior differed from the other two main types of behavior, i.e. play behavior and reticent behavior, with regards to the use of specific spatial components. Spatial components that were used during less than 4% of intervals were combined in a new variable: other components. Figure 4.1 shows the proportions of the different spatial components children used during play, transition and reticent behaviors, respectively. All behaviors occurred most often

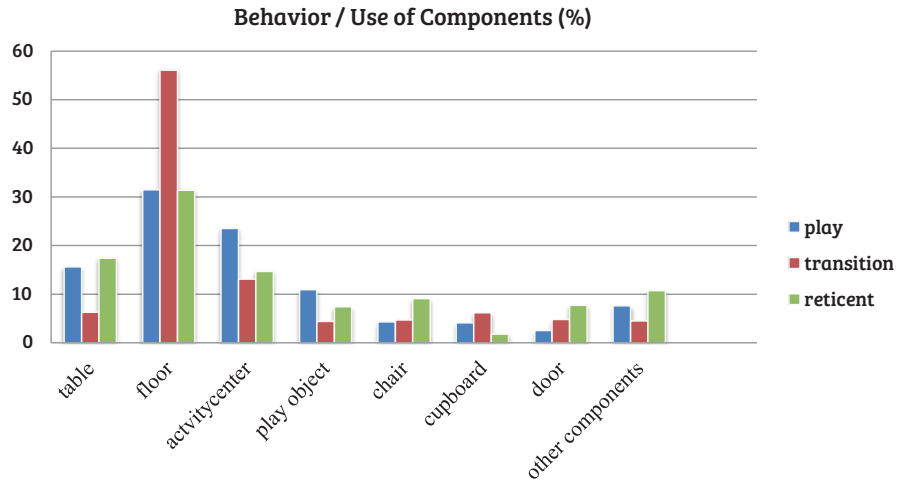

Figure 4.1. Play behavior and use of spatial components.
N **= 6032 intervals.**

while children were using the floor, but transition behaviors occurred even more frequently at the floor: 56 % of the intervals coded as transition involved the floor, against 31% of the intervals coded as play or reticent behaviors. Use of the table was mostly associated with reticent and play behavior, with transitions occurring at the table in only 6 % of the intervals. Activity centers were used for play during 24% of the intervals, while transitions occurred only in 13% of the intervals when children were in the activity center.

As the free floor space was clearly the component used most frequently during all types of behavior, we examined if there was a difference in the use of affordances, as indicated by the affordance-related type of actions children displayed, between transition, which was found to be negatively related to depth of exploration, and social play, which showed a small positive effect on depth of exploration. Figure 4.2 shows the outcomes of the comparison.

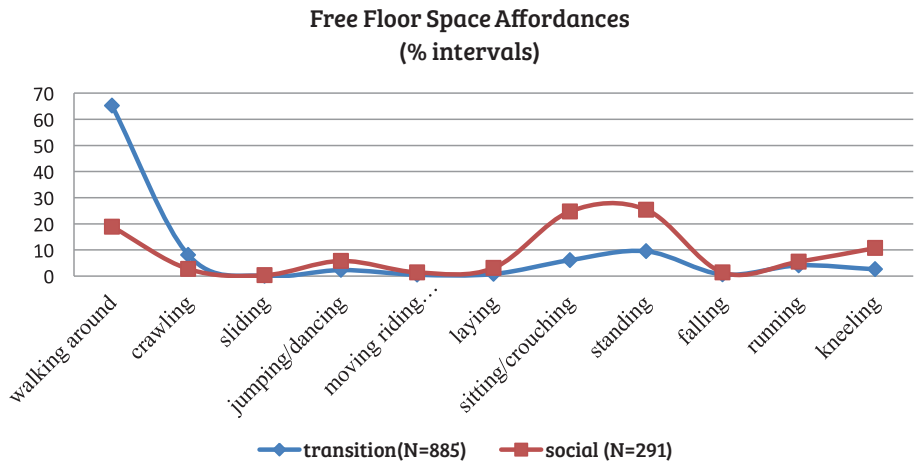

Figure 4.2. Use of pre-defined affordances as manifest in affordance-related observed actions during transition and social play.

Focusing on the spatial component floor, transitions were mostly marked by children walking around (65% of the observed intervals), thus acting upon the physical properties of the floor that afford walking-on. Other afforded actions during transitions occurred between 0% (sliding) and 9.5% (standing) of the intervals. Social play, occurring overall less frequently, was associated with more varied actions relating to the pre-defined affordances of the floor, with sitting (24.7%), standing (25.4%) and walking around (18.9%) occurring most often during social play intervals. Overall, during social play on the floor children's behavior was stationary (laying, sitting, standing, kneeling) during

64% of the intervals, while during transitions children were mostly (73.3% of intervals) moving around, for instance walking or crawling. Interestingly, actions with movement during social play differed from actions with movement during transition. Jumping, running, sliding and falling occurred almost twice as often during social play (14.4%) than during transition (7.5%), suggesting that the social context affords different uses of the same physical properties of the floor.

Discussion

The aim of this study was to examine how young children in center-based childcare actually spend their time during unguided free play time, and to what extent their play and non-play behaviors were related to the depth of exploration of the spatial components in the playroom. Play and non-play behaviors were studied using Rubin's Play Observation Scale (POS, 2001). Exploration of the playroom space was studied by observing children's use of affordances with a new observation instrument based on Gibson's theory of affordances (J.J. Gibson, 1979/1986).

The results of the present study show that during scheduled unguided free play time, non-play behaviors (transition, reticent, conversation with adults) occurred more than half of the time, with transition being the most frequent type of non-play behavior. Social play, and conversations with adults, occurred more frequently in the older age group than in the younger age group, which was to be expected given that social-communicative competence increases with age (e.g., Rose-Krasnor, 1997; Tomasello, 2016). Younger children were significantly more often engaged in solitary play, while parallel play was not related to age, which is also in line with earlier studies (Coplan & Arbeau, 2009; Howes & Matheson, 1992). No relation was found between age and the occurrence of both reticent and transition behavior, which suggests that these types of behaviors are neither related to age nor to the duration of daycare attendance, and may depend on other factors, such as guidance by the teacher, social relations with peers or the design of the play space. This finding is similar to outcomes of a study among young school children (Pellegrini & Goldsmith, 2003). The outcomes also showed that there was no relation between these types of behaviors and the number of days per week children attended the child care center, suggesting that being less or more familiarized with the daycare environment does not affect children's reticent and transitional behaviors either.

We further examined which spatial components were used during free play and how intensively these components were used. Free floor space, tables and activity centers were used most frequently. Mean depth of exploration was highest at tables and in activity centers, indicating that in these activity areas children were more focused on

using a subset of affordances during a longer period of time than, for instance, when using a chair or the free floor space. The outcomes of the multilevel-analysis showed that transition behavior was significantly negatively related to depth of exploration. If depth of exploration is indeed an indicator for being engaged in a task, as we assumed, this outcome is in line with various studies that found that during transition children show low engagement in activities (e.g., Booren, Downer & Vitiello, 2012; Early et al., 2010; Hooper & Hallam, 2017). However, these studies defined transition in a different way than the current study, namely as a teacher-initiated activity involving a group of children, which makes it difficult to compare these findings with the results of the present study, where transition was observed during a free unguided play time slot and, therefore, always child-initiated. The outcomes of the present study, however, do suggest that also when transitions are self-initiated, children's engagement is possibly low too.

There was a small positive effect of social play on depth of exploration, while solitary play and parallel play were not related to depth of exploration. This finding was unexpected, as especially playing alone, not being distracted by others, has in other studies been found to lead to more in-depth exploration (Katz & Buchholz, 1999; Coplan & Ooi, 2014). A possible explanation is that solitary play occurred mostly in the group of younger children, who were less engaged in in-depth exploration overall. However, the finding contradicts the results of a number of studies into young children's spatial and object exploration (Banerjee & Tamis-LeMonda, 2007; Oudgenoeg-Paz, Leseman & Volman, 2015; Power et al., 1985), which found no significant differences in exploratory engagement between one and two-year-old children when playing alone. Note that these studies were conducted in lab situations or at children's homes, where no other children were present. It is possible that the presence of older and physically more mature peers in the same room had a distracting influence on younger children's solitary play. Playrooms in center-based childcare which cater for children in a wide age range, as in the current study, mostly consist of open play areas, tables and activity centers that are intended for use by children of different ages. Future studies in center-based childcare could examine if altering the playroom lay-out in a way that also enables undisturbed solitary play of younger children, for instance by creating individual play zones for them, could stimulate their in-depth exploration during solitary play.

Children who were rated by the caregivers as more task-oriented displayed more depth in their exploration of the playroom space. This finding is in line with findings by Power et al. (1985), who observed that in-depth exploration of an object was related to persistence in executing the task. In the study by Power and colleagues persistence was studied while observing a child executing a task. In the present study task-orientation was rated by the caregiver, who based her assessment on experiences with the child over a longer period and a variety of situations. Hence, this study extends the findings of Power and colleagues by providing evidence that task-orientation, as reported by the caregiver,

is a temperamental characteristic that is related to observed depth of exploration. The finding that teacher-rated task-orientation was substantially related to observed depth of exploration supports the validity of the way in which depth of exploration was defined and measured in the current study. Note that, while task-orientation and transition were both related to depth of exploration, no significant relation was found between task-orientation and transition behavior. This suggests that the occurrence of transition behavior does not depend on child characteristics such as task orientation, but possibly on situational factors.

The present study showed that during free play children were mostly using the free floor space in all their activities, but during transitions the floor was used almost twice as often. This was to be expected since transition implies that children are often moving around, which is likely to occur typically on the floor as a circulation space. Regarding floor use, the comparison between social play, which was positively related to depth of exploration of space, and transition, which was negatively related to depth of exploration, revealed that during transition children indeed were moving around most of the time, while during social play children used the floor in a variety of ways, including ways that may reflect the influence of social factors (e.g., jumping together). The fact that depth of exploration was negatively related to transition, suggests that transitions were actually 'in-between moments' with brief, superficial exploration of several affordances at best or no exploration of affordances at all. The rather high occurrence of transition behaviors and the negative relations found suggest that these in-between moments were not functional in promoting play and depth of exploration.

To summarize, investigating children's play and non-play behaviors during unguided free play time in the perspective of the affordances specified by the physical properties of the playroom, allowed us to gather detailed information about how children's play behaviors relate to their exploration of spatial components of the play room. During free play time most of the time spent on play took place in the activity centers and on the floor, while reticent behavior mostly occurred on the floor and at the tables, but was distributed more evenly over the different components. Transitions mainly occurred on the floor. The high occurrence of transitions, which could not be explained by age, degree of task orientation and familiarity with the daycare facility, requires further investigation. A possible explanation could lie in socio-environmental factors that were not examined in the present study due to the focus on unguided free play. Maybe teacher involvement is needed to reduce transition time. Perhaps teachers should set up play materials at the start of a free play period, organize the play environment in a way that facilitates perceiving a diversity of action-affordances that trigger exploration. Maybe teachers should offer children support to start and continue a play activity, and extend it to discover more affordances (by scaffolding children), while leaving children mostly free in their choices (Musatti & Mayer, 2011).

Another possible explanation of the fact that the children in the current study displayed a high degree of transition behavior could lie in the age heterogeneity of the groups. This diversity in age can affect the way the playrooms are furnished. Arts and crafts materials and small play toys, for example, are often put out of children's reach to prevent that the youngest children get injured. Indeed, during our observations, we noted that in some groups part of the play materials were out-of-reach and not perceivable for children because they were stacked away in closed cupboards. The overall arrangements of the playroom space in the observed groups, although differing in details, were largely similar, mostly consisting of a large free floor space, one or more tables, and three to five activity centers (e.g., for fantasy play, construction play, reading). Yet, despite the presence of other spatial components, during free play time the most 'undefined' area was observed to be used most often by the children. Future studies should examine if changing the spatial arrangement, for instance reducing the free floor space in order to create more activity spots, different in size and type of activity, affects the type and amount of actual play during unguided free play episodes.

Finally, although probably not related to children's learning about the spatial environment as is suggested by the current study, transition behavior may be functional in serving children's need for physical gross motor movement. Unguided free play time provides children with the opportunity to move around at their own pace, while during indoor teacher-guided activities and routines the possibilities for gross motor movement are often limited, and in any case not self- chosen. Several studies have shown that active gross motor movement in daycare centers mainly occurs in the outdoor play space, while indoor activities are predominantly sedentary (Brown et al., 2009; Gubbels et al., 2011). It would be of interest to examine if more time spent outdoor during a day at childcare, leads to less time spent to transition indoor.

Limitations

A limitation of the current study is the relatively small sample size of 61 children and 10 daycare centers. This limitation was partially compensated by the number of measurement moments used in the study, thus increasing the total number of data points. Nonetheless, the current conclusions regarding children's play behaviors during scheduled free play time and the role of spatial aspects in play should be treated with caution. Another limitation of this study is the use of a newly developed instrument for measuring spatial exploration, which makes it difficult to compare the current findings with those of other studies. However, the inter-rater reliability for the new instrument was satisfactory and the observed inter-correlations (e.g., depth of exploration correlated substantially with teacher-rated task orientation) attest to the reliability and concurrent validity of the instrument. Despite these limitations, this study contributes to the understanding of how children in center based childcare use their time during unguided

free play time slots in relation to their exploration of the indoor physical environment. The present outcomes offer several new leads for future research into play and non-play behaviors and how the physical environment relates to this.

Conclusions

This study examined children's play and non-play behaviors during unguided free play episodes and how these behaviors related to the depth of their exploration of the playroom space. The results indicate that during unguided free play children are involved more in non-play behaviors than in actual play. Especially transitions occur frequently and are negatively related to children's depth of exploration. Future studies should investigate if changes in the spatial arrangement of the play room and increased teacher support during free play can enhance the proportion of time children spend in actual play and thereby stimulate in-depth exploration.

Chapter 5

Young children's play and use of spatial components in center-based childcare

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Abstract

Center-based care and education provides children with ample opportunities for social interaction and, therefore, for social competence development. Whereas research has mainly focused on the role of caregivers and teachers in promoting social behavior and social competence development, the role of the physical space of the center and the arrangement of particular spatial components such as tables, activity centers and free floor space in the playroom, has received remarkably little attention. The present study examined the relations between young children's social, parallel and solitary play behavior as related to their use of three main spatial components (free floor space, table and activity center) and exploration of play materials in the playroom during free, unguided play time. Participants were 61 children aged 11 to 48 months, in 10 mixed-age groups. Multi-level analyses showed that the younger children's (11 to 26 months) solitary play occurred mostly on the floor. Younger children's social play occurred mostly in activity centers when they were engaged in simple manipulation of play materials. Parallel play and solitary play occurred at all three spatial components and were strongly related to complex manipulation of play materials.

Keywords: day care centers; spatial components; social, parallel, solitary play; play materials; early childhood

Introduction

Successfully engaging in positive interactions with others in early childhood is an important predictor of mental health and well-being during adolescence (e.g., Denham et al., 2003). A growing body of evidence suggests that social-emotional competence is also positively related to economic success in adulthood (Borghans, Duckworth, Heckman, & Ter Weel, 2008; Heckman & Masterov, 2007; Shonkoff & Philips, 2000). Socio-emotional competence is defined as the ability to engage in prosocial behaviors and to refrain from negative (e.g., anti-social or aggressive) behaviors (Broekhuizen, 2015). In early childhood education and care settings, children are developing social and emotional regulatory skills that enable them to interact with peers, and as they grow older they become increasingly adept in engaging in social and collaborative play activities (Coplan & Arbeau, 2009; Rubin, Watson, & Jambor, 1978; Van Schaik, Leseman, & de Haan, 2017). At the same time, children are frequently observed to play alone (solitary play) or next to each other (parallel play) in daycare settings, without directly being engaged with peers. These types of play have long been seen as less mature and less complex stages of play, which should become less frequent with increasing age (e.g., Katz & Buchholz, 1999). This predominant view has been questioned. For example, studies have demonstrated that solitary play is not merely an indicator of relative immaturity, but, just like parallel play, remains a common type of play over the years, contributing to child development (Lloyd & Howe, 2003). Indeed, several studies have associated solitary play with task-persistence and attention regulation (Katz & Buchholz, 1999; Coplan & Arbeau, 2009). However, most studies regarding play in center-based childcare still focus mainly on types of play that involve social interaction, while studies on solitary behaviors have often confused play with reticent behaviors, for instance when children are merely watching other children or waiting passively (Coplan & Arbeau, 2009), which may have contributed to a less favorable view on the role of solitary (and parallel) play in child development. Yet, as will be argued in this study, solitary and parallel play can also indicate deep exploration of the play materials and spatial attributes provided in the playroom.

Research into center-based childcare shows that high quality childcare can enhance children's socio-emotional competence (Barnett, 2011; Burchinal et al., 2009; Pianta, Barnett, Burchinal, & Thornburg, 2009; Reynolds, Temple, Robertson, & Mann, 2001). Quality of childcare in these studies is often defined by a combination of structural characteristics such as group size, teacher training level and adult-to-child ratio, and process features referring to caregiver-child interactions, peer interactions and the provision of educational activities (Pianta et al., 2009). Most studies have investigated relations between social behavior and the social environment (Pingault et al., 2015), examining for instance the effects of the quality of teacher-child interactions on social

competence (Burchinal et al., 2009; Curby et al., 2008). Other studies have examined the influence of structural characteristics on social competence such as the number of days per week children were enrolled in childcare (Broekhuizen, van Aken, Dubas, & Leseman, 2015). However, studies investigating the relations between children's social behavior and their use of the indoor playroom space are scarce. In view of this, the present study focused specifically on the relations between social, solitary and parallel play behaviors, on the one hand, and the use spatial components and play materials provided to children in center-based childcare, on the other hand.

To the best of our knowledge only a few studies to date have investigated the relation between young children's social behavior and characteristics of the space in center-based childcare (Legendre & Fontaine, 1991; Legendre, 1999; Moore, 1986; Musatti & Mayer, 2011; Torrens & Griffin, 2013; Zimmons, 1997). A study by Legendre (Legendre & Fontaine, 1991; Legendre, 1999) found that two- to three-years-old children exhibited more social play and friendly interactions when play-areas had low visual boundaries enabling them to be visually connected to the caregiver's location than when the playroom was divided into separate play-areas by high visual obstacles. This suggests that being able to see the caregiver may encourage young children to actively engage in social play. Moore (1986) introduced the concept of well-defined activity settings, referring to recognizable areas within the playroom that are equipped with play materials for a specific activity (e.g., dramatic, creative, constructive play), as opposed to ill-defined settings. In a study among 2.5- to 6-year-olds, he found that more social interaction and cooperative behavior occurred in centers with well-defined settings than in centers with ill-defined settings. In a study based on Moore's concept, Zimmons (1997) found that well-defined settings elicited more prosocial behavior than ill-defined settings. In a recent study (Musatti & Mayer, 2011), a qualitative analysis of young children's peer interactions and cognitive engagement indicated that, although the level of engagement and duration of interactions varied greatly between children, engagement and interaction were overall positively related to well-defined activity areas in the playroom. In addition, a longitudinal observation study among 3- to 5-year-olds by Torrens and Griffin (2013) revealed that peer-interactions occurred mostly in designated play-areas in the playroom, while tables were used predominantly for solitary and parallel play, or for interaction with adults. Social interaction was especially low in areas without resources, such as furniture and play materials.

Other studies have focused on specific parts of the playroom. In a study among 3- to 5-year-olds, dramatic play areas, originally designed for solitary use, were altered into areas for group play by adding extra equipment, resulting in an increase in group play and social interactions in these redesigned areas (Petrakos & Howe, 1996). In a study focusing on the need for privacy among 3- to 5-year-olds, Lowry (1993) introduced two structures for retreat, varying in degree of enclosure (open *vs*. almost closed), in

two classrooms, which differed in the amount of available square meters per child. In the classroom with the highest density (number of children per square meter) both structures were mostly used for solitary play, suggesting that in a crowded room children prefer a secluded area to play alone. In both classrooms children preferred the closed structure over the open structure for interactive play, suggesting that when forming a small group, children preferred to visually exclude others. In sum, studies have found several spatial characteristics of playrooms in childcare that affect children's social play behavior. However, the number of studies is small, and studies mainly focused on either specific activity centers or on the overall arrangement of the playroom. Prominent spatial components in playrooms, such as the table or the free floor space, have not been studied.

Research into spatial components in childcare is of interest since studies into child development indicate that the physical environment plays a critical role in children's cognitive and social development by offering opportunities for action, exploration and interaction (Iverson, 2010; Smith, 2005; Thelen, 2000). Studies regarding young children's exploration of (play) objects show that children progress from single object exploration to combining objects. When combining objects, children use properties of objects to manipulate the spatial relations between them by, for example, stacking or inserting them. In this process, complex skills (i.e., creating combinations) are building on earlier acquired simple skills (i.e., single object exploration of single object properties; Oudgenoeg-Paz, Volman, & Leseman, 2016). Similarly, studies show that infants explore relations between objects and surfaces, for instance banging a block on a tabletop. As infants gain more experience with objects and surfaces, this exploration becomes more consistent and intentional, setting the stage for the development of tool use such as hammering (Adolph & Franchak, 2017; Kahrs & Lockman, 2014). According to Iverson (2010) the development of exploratory skills, together with an increasing experience in self-locomotion, offer the child a growing range of opportunities for social interaction (see also Karasik, Tamis- LeMonda & Adolph, 2011). The child can gather information about the affordances the setting offers by self-exploring these affordances, but also by watching other persons' actions (Moll, Meltzoff, Merzsch, & Tomasello, 2013). Self-initiated locomotion enables the child to (literally) take the other person's perspective by actually going to this person's location and look at a space or objects from the other's point of view (Creem-Regehr, Gagnon, Geuss, & Stefanucci, 2013; Frick, Möhring & Newcombe, 2014). This in turn can lead to more active engagement with others. Using objects and space, and having knowledge about how others use them, seems to be an important precondition for social engagement (Moll et al., 2013).

Present Study

The aim of the present study was to examine whether there is a relation between the occurrence of social, parallel and solitary play and children's use of distinct spatial components in playrooms for child care. In addition, children's exploration of play materials was assessed to investigate if this was related with types of play and use of spatial components. In a previous study into young children's exploratory behavior (Van Liempd, Oudgenoeg-Paz, Fukkink, & Leseman, 2018; Chapter 3 of this dissertation), we found that spatial components in playrooms, such as the floor and the table, offered a variety of possibilities for action, with considerable differences in uses across components. The present study involved children between one and four years of age attending daycare centers in the Netherlands. To investigate if, within the same environment, differences between younger and older children regarding use of space and social play would occur, the study was executed in mixed-age groups, ages ranging from 11 to 48 months. Since active self-induced locomotion has been found to play an important role in perspective taking and actively interacting with others (Karasik et al, 2011), only children that could crawl or walk independently were included.

Following Creem-Regehr et al. (2013), we assumed that younger children, being less experienced in judging and predicting other children's actions, would be less adept than older children in interacting with other children. We hypothesized that less experienced children would prefer to socially interact with other children in a recognizable area (e.g., table, doll-house), with a predictable set of uses of play materials, over a hybrid area that elicits a variety of uses such asthe free floor space. Only free unguided play was observed. This choice was based on the consideration that activities guided by caregivers could obscure the relation between spatial characteristics and children's play.

Method

Participants

The present study is part of a larger study investigating relations between spatial affordances and child development. Participants were 61 children (50.8% boys) from ten centers for center-based daycare, all part of a large provider of childcare in the Netherlands. In each center one group participated in the study. The selection of centers was based on two criteria. To avoid effects of recent major changes in group composition, the groups had to function as a mixed-age group for at least six months. Each group had to consist of both young (under 18 months) and older (above 18 months) children, to assure that we could recruit enough children from different ages. Because this study focused on the relation between children's social behavior and their use of spatial features, only children that could actually move around without help by

crawling or walking, were included. In each group 5 to 7 target children were observed. The mean age of the observed children was 29 months (*SD* = 9.95; age range: 11 to 48 months) and use of the childcare facility varied between one and five days a week (*M* = 2.2; *SD* = 1). At the time of the study children had been attending the center on average for 21 months (*SD* = 10.84) with a range of 1 to 44 months. The total number of children in the groups during the observations ranged from 8 to11 (*M*= 9.98*; SD* = 0.88). Informed consent of the parents was obtained for 88% of the children. The remaining children, for whom no consent was obtained, were temporarily cared for in another group during the observations or carefully kept out of sight. The study design was approved by the Ethical Review Board of the Department of Child Development and Education of the University of Amsterdam (protocol number: 2015-CDE-4107; name: 'Room for vertical groups').

Procedure

Children were observed during free-play periods in the morning. In each group data were collected on two different days, with one or two weeks between the first and the second visit, but always on the same day of the week. On both days video recordings were made during two rounds of 30 minutes. During each round every target child was followed for a continuous period of five minutes. In this way each child could be observed during a total of four episodes of five minutes on the two days, 20 minutes in all. Some children were absent on the second day. In these cases an extra child was recruited to gather sufficient data per center. This resulted in a total of 7 children who were observed only on one day. After removing interruptions (for instance because of diapering, the child leaving the room) and episodes that were not suited for the purpose of the study (e.g., when a child became involved in a caregiver-led activity) a total of 216 episodes remained for analysis (*M* = 17.5 min. per child), with 7% of the episodes being excluded from the analysis.

Coding of recorded data was done by dividing each 5-minute episode into 10-seconds intervals (*N* = 6419). Recordings were paused after each interval to enter the codes for type of play and the spatial component acted upon during that interval. If, during an interval, a child switched between behavior type or component, the code for the behavior or component used most frequently, that is, during the largest part of the interval, was entered. During the first visit, the physical attributes in the room (e.g., tables, cupboards, activity centers) were drawn on a plan of the indoor playroom(s). The teachers were asked not to make any major change in the room between the two visits. Finally, teachers were asked to fill out a structured questionnaire, consisting of questions regarding characteristics of the children participating in the study.

Measures

Using spatial components

An observation instrument was developed to code the children's use of spatial components in detail, the Spatial Affordances in Childcare Interior Design (for short: SACID) tool. This instrument builds on earlier studies by Heft (1988) and McLaren, Ruddick, Edwards, Zabjek and McKeever (2012), and was designed to collect comprehensive data of children's use of spatial components and play materials. For the present study three dimensions of the tool were applied. The first dimension consists of a list of spatial components that frequently occur in playrooms for childcare (see Appendix 1). Components can be movable objects (such as a table, chair, decorations) or fixed (floor, door, window, activity center). A component was coded as 'activity center' if it was clearly set up for a specific activity such as construction and dramatic play or reading picture books. The second dimension comprises of a list of possible affordances for each component, for instance 'affords climbing' or 'affords standing on'. To investigate if use of play materials was related to children's use of spatial components, a third dimension was included to code if a child was using play materials during the observed intervals and how the materials were used (see Appendix 2). For each interval an observer scored which component (table, floor etc.) the child used, which specific affordance the child acted upon, for instance 'running on the floor', and if and how play materials were used. To determine inter-rater reliability a random selection of 40% of the episodes were independently scored on all three dimensions by two observers. *ICC*s were satisfactory, ranging between .70 and .99 with a mean value of .88.

Type of play

Type of play was scored using the Play Observation Scale (POS; Rubin, 2001). The scale differentiates behavior as play or as non-play. Play behavior is subdivided in solitary, parallel or group play. Play behavior was rated as solitary when a child was playing on its own, apart from other children, at a distance greater than one meter, and attention was mostly focused on his/her own activity. If a child was playing within a distance of one meter of another child, besides or in the company with another child, but not playing *with* them, this was coded as parallel play. Whenever a child was engaged in play together with one or more other children, with a common goal or purpose in the activity, behavior was rated as group play. Play behavior was distinguished from non-play behavior which included unoccupied, transition, or mere onlooker behavior. Non-play behaviors occurred frequently, about half of the scheduled free play time in the current study (see also Van Liempd, Oudgenoeg-Paz, & Leseman, submitted; Chapter 4 of this dissertation), but were not included in the main analyses to be reported in this chapter. In addition, conversations with peers and adults were separately coded initially, but conversations with peer were later pooled with social play behaviors (see below). To

determine the inter-observer reliability a random selection of 40% of the episodes were independently scored by two researchers. *ICC*'s were satisfactory, ranging between .72 and .99 with a mean value of .87.

Child characteristics

To control for child characteristics, the center's caregiver caring for the child on a daily basis was asked to fill out a child profile questionnaire (Veen et al., 2013). This questionnaire contained questions about the child's age, date of enrollment, number of days per week the child attended the center, and scales to assess temperamental characteristics. These scales are derived from the Early Childhood Behavior Questionnaire (ECBQ; Putnam, Gartstein,& Rothbart, 2006) and the BRIEF-Infant Toddler Social and Emotional Assessment (BITSEA; Briggs-Gowan & Carter, 2001). For the current analysis, three scales were used: the degree of self-regulation (impulsiveness, anxiety, detachment), the degree of social competence (helpfulness, cooperation, socializing), and the degree of interaction with the pedagogue, as rated by the caregiver.

Caregivers were asked to rate to what extent the presented statements were true for the child on a 5-point scale, varying from 1 (false) to 5 (true). Internal consistency of the scales (Cronbach's alpha) was satisfactory with a = .77, a = .68 and a =.78, respectively.

Analytic Procedure

Data analysis proceeded in four steps. First, a descriptive and correlational analysis was conducted of children's personal characteristics and type of behavior. In addition, children's use of spatial components was calculated. As a second step, an analysis was conducted describing children's use of affordances of the three most used spatial components during social, parallel and solitary play. Third, a series of multilevel regression analyses were conducted with social play, parallel play and solitary play as dependent variables, and the most frequently used spatial components as independent variables. Child characteristics were added as control variables. As a fourth step, a similar series of multilevel analyses were conducted, combining children's use of spatial components with their use of play materials as independent variables.

Results

Descriptive data

Table 5.1 shows the means and standard deviations of children's temperamental characteristics and observed play and non-play behavior. Children's self-regulation was rated as relatively high, with a low score (1) indicating a high level of self-regulation. Social competence was also rated as relatively high, with a high score (5) reflecting

high competence. Interaction with the caregiver also showed a positive central tendency, where a low score reflects positive interactions. Self-regulation (reverse coded) correlated significantly with social competence (r = -.508, p < .001) and with caregiver interaction (also reverse coded: r = .668, p < .001).

Because group play and conversations with peers involved both interactions with peers, it was decided to merge both variables into a new variable: social play. Actual play behaviors(social, parallel, solitary) occurred during 49% of the observation intervals, with parallel play occurring most frequently. The scores diverged widely between the centers, most notably for social play. Other (non-play) behaviors that frequently occurred, were transition, observed in 25% of intervals, and onlooker behavior, which occurred in 18% of intervals.

Table 5.1 Means, Standard Deviation and Range for Temperamental Characteristics and Behavior (POS)

Variables	*N*	*M*	*SD*	Observed range
Child profile[a]				
self-regulation	61	1.94	0.48	1.0 – 2.7
social behavior	61	3.75	0.38	2.9 – 5.0
interaction with caregiver	61	2.17	0.39	1.0 – 3.2
Behavior (POS)[b]				Range **
solitary play	6419	0.16	0.36	0.08 – 0.22
parallel play	6419	0.21	0.41	0.09 – 0.28
social play	6419	0.12	0.32	0.02 – 0.22
other behaviors(transition, unoccupied, onlooker, conversation with adults)	6419	0.51	0.50	0.44 - 0.63

Notes. N = children (61), intervals (6419). [a] = scores 1 – 5. [b] = scores yes/no (0 = no). ** = between centers (N.=10).

Table 5.2 shows the mean proportions of use of spatial components, excluding those that were used in less than 4% of the intervals. The results show that, during free play sessions, children spent most of the observed intervals on the floor. Proportion of uses diverged between the centers.

No significant correlations were found between the child's age, gender, number of days and time being enrolled in the center and his or her temperamental characteristics. Temperamental characteristics, number of days and gender were not related to types of play and were therefore not included in further analyses. Age and time since enrollment in the center correlated strongly (r = .69, p < .01), as could be expected. For that reason only age was included in further analyses. Since the distribution of age was bimodal (D (61) = .14, p < .05), two age groups were created by median split (Mdn = 27), resulting

in a group of 30 children between 11 and 26 months of age and a group of 31 children between 27 and 48 months of age. Social play (group play and conversation with peers) and age were positively related (r = .52, p < .01), indicating that social play occurred more often as children were older. Regarding solitary play, a negative correlation was found with age (r = - .38, p < .01), indicating that solitary play decreased with age. No relation was found between age and the occurrence of parallel play.

To investigate the relations between age, type of play and the use of spatial components in the playroom, we first examined the data at the coding interval level. In order to reduce the number of variables in the analysis, only the three spatial components with the highest frequency of use were included: free floor space, table and activity centers. Because the component 'big play objects' (observed to be used during 10% of the intervals) was missing in two centers, this component was not included in further analyses. Likewise, as the focus of this study was on social, solitary and parallel behavior, other (non-play) behaviors were also not included in the further analyses. This resulted in a total of 4460 intervals, comprising all children (N = 61). Table 5.3 shows mean proportions, indicating how often a type of behavior was observed at a spatial component.

Table 5.2 Means, Standard Deviations and Range of Use of Spatial Components

	Uses per center (N=10)		
Spatial component[a]	***M***	***SD***	**Range**
Floor (flat, smooth surface)	.38	.49	.28 - .55
Activity center (for dramatic play, construction, reading)	.18	.39	.05 - .33
Table (child height)	.13	.34	.03 - .22
Big play objects (play house, tunnel, car)*	.10	.30	.04 - .18
Chair (child height)	.06	.23	.00 - .20
Bars (door, fence)	.04	.20	.01 - .10
Cupboard	.04	.20	.01 - .08

Notes. [a]= scores yes/no (0=no). *present in 8 centers.

Table 5.3 Spatial Components Use by Type of Behavior, Mean Proportions and Standard Deviations (N = 4460)

	Social play		Solitary play		Parallel play		Non-play		
Spatial component	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	**Total (N)**
Table	.10	.30	.20	.40	.30	.46	.16	.37	852
Floor	.53	.50	.50	.50	.36	.48	.65	.48	2447
Activity center	.37	.48	.30	.46	.33	.47	.19	.39	1161

Note. N = number of intervals.

Use of play materials was coded as complex manipulation when multiple objects were combined, such as making a puzzle or stacking blocks, or when social awareness was required (giving an object to a peer or hiding it for a peer). When the child was visually examining, carrying or mouthing, riding or rolling, picking up or throwing a play object, use of play materials was coded as simple manipulation. During 35.8 % of intervals no play materials were used, simple manipulation occurred during 46.6 % of intervals, while complex manipulation occurred during 17.6 % of intervals. Figure 5.1 shows the proportion of intervals in which play materials were used while children were engaged in social, parallel or solitary play, respectively.

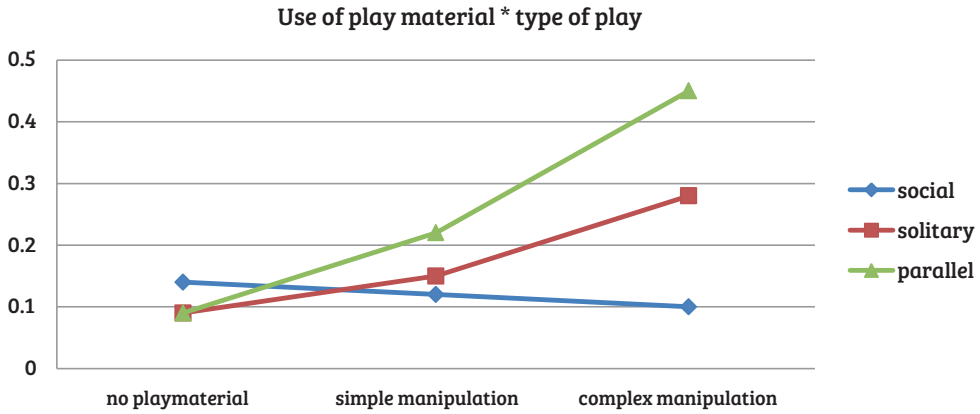

Figure 5.1. Use of play materials during social, parallel and solitary play.

Complex manipulation of play materials diverged strongly and significantly (p < .001) between types of play. During parallel and solitary play, complex manipulation occurred more often (M= .45, SD = .50 and M= .28, SD = .45, respectively) than during social play (M= .10, SD = .30). During social play, the proportion of intervals in which children were playing without play materials was significantly higher (p < .001) than during parallel and solitary play.

Figures 5.2, 5.3 and 5.4 show which actions children showed relative to the affordances offered by the spatial components during the three types of play. While using the activity center (Figure 5.2), children were mostly sitting and standing, during all three types of play. Active moving (jumping, dancing, running) occurred mostly during solitary play (7.8% of intervals), while manipulating parts of components occurred mostly during parallel play.

Children were mostly sitting or standing at the table, using the 'sitting on' and 'standing at' affordances of the table (Figure 5.3). During social play, the table was used slightly less to stand at than to sit at, while during parallel and solitary play sitting

prevailed. Climbing and banging on the table occurred more than three times as often during social play than during solitary and parallel play. During social play on the floor (Figure 5.4), the most frequent actions were standing and sitting, while during solitary play children were mainly sitting (29% of intervals) or walking around (18%). During parallel play children were walking around in almost a quarter of the observed intervals. Overall, most of the time children were stationary (standing, sitting, kneeling), but movement occurred more often during parallel and solitary play than during social play. Moving with riding or rolling materials (e.g., toy cars) was mainly a solitary or parallel activity, while running around occurred mostly during social play.

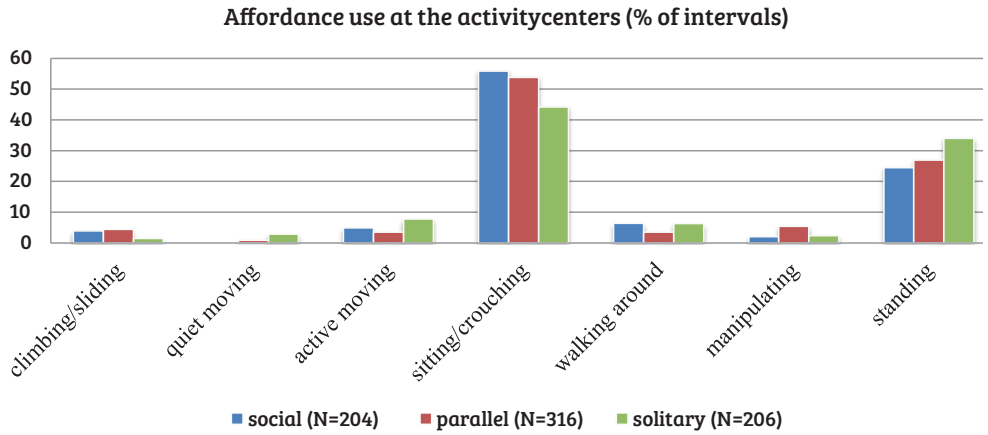

Figure 5.2. Affordances used in the activitycenters.

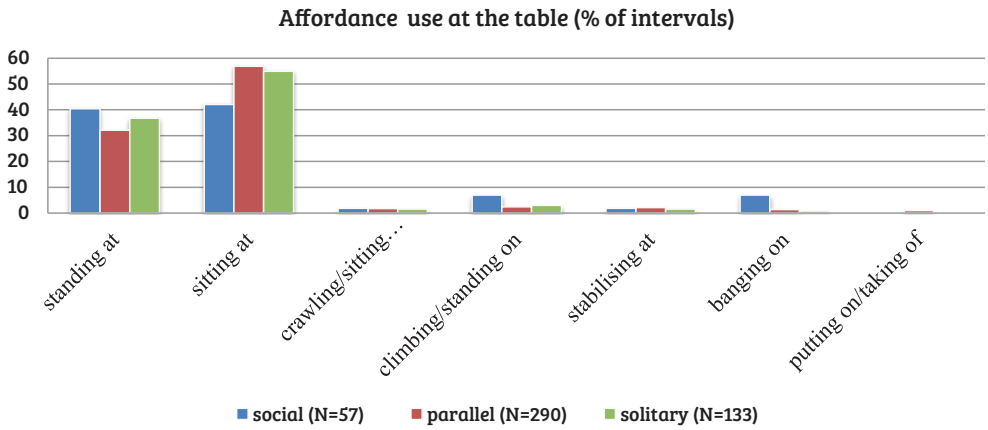

Figure 5.3.Affordances used at the table.

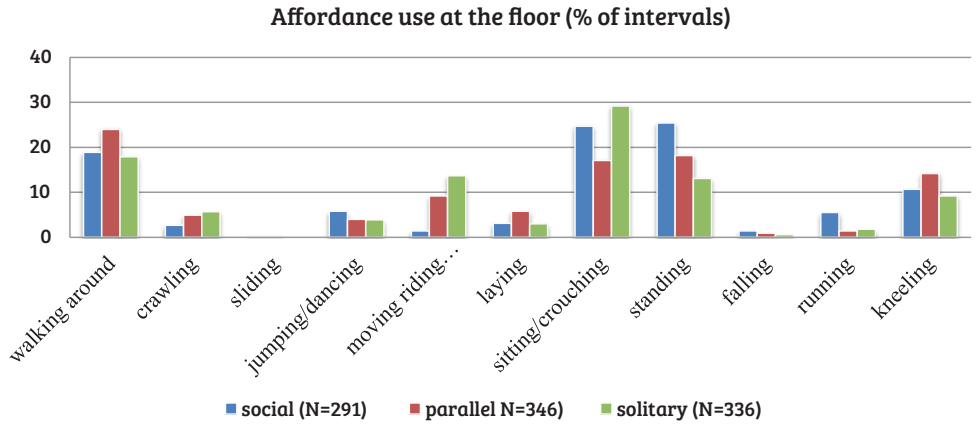

Figure 5.4. Affordances used at the free floor space.

Multi-level Analysis: Predictors of Social, Solitary and Parallel play

To examine the relations between play behavior and spatial components, a series of logistic multilevel regression analyses were conducted using MPlus 7.0 (Muthén & Muthén, 2013). Two levels were distinguished: the interval-level (*N*= 4460) and the child-level (*N* = 61). Because of the small sample size at the center level (N = 10), it was decided not to include centers as an extra level in the analysis. Three series of analyses were executed, with the number of intervals coded as social play, solitary play, and parallel play, respectively, as dependent variables. Three predictors were included in the analysis: a dummy variable for age-group, with 0 for the youngest group and 1 for the older group; a dummy variable for use of the floor (0 = other component, 1 = floor) and a dummy variable for use of activity centers (0 = other component, 1 = activity center). The table was implied as the reference category. The multilevel analysis followed several steps (Hox, 2010). In the first step, an intercept-only model with no predictor variables was run. In this model, the amount of variance in the outcomes at the interval- and child-level was estimated and the Intraclass Correlation Coefficient (ICC) was calculated. In the second model, age-group (level 2) was added as a predictor. In the third model, the use of the spatial components floor and activity center (level 1) were added as predictors. In both models fixed effects and the explained and unexplained variances were calculated. In the fourth model, the random slopes model, we examined if the variance in the use of spatial components for type of play differed at the child-level. If the random slope variance was significant at the child-level, the model was expanded with a cross-level interaction relating the spatial component to age in order to explore if age explained part of the random slope variance at the child level. Finally, to decide which model fit best to the data, models were compared using the deviance difference *(Δdf)* index and the Akaike Information Criterion (AIC), with lower AIC

values representing a better fit. Furthermore, odds ratios were calculated to indicate the likelihood of each type of play occurring for each of the significant predictors, relative to the reference category. Model equations for these types of multilevel logistic regression models are based on Hox (2010). Table 5.4 shows the final models for the three series of analyses. ICC's for the intercept-only model and explained variance for the fixed effects models are also presented in the Table (for all tested models, see Appendix 3).

Social play

The ICC in the intercept-only model for social play showed that 37% of the variance in the occurrence of social play can be attributed to the child-level. Adding age as a predictor, and subsequently the spatial components, led to significant decreases in the maximum likelihood estimates and AIC. The proportion of variance for social play explained by the fixed effects corresponded with a small to medium effect. Most of the variance was explained by age, added in model 2. Subsequently, a random slopes model was estimated to investigate if use of floor and activity centers varied at the child-level. In this model only age significantly predicted social play. However, at the child level there was a significant random variance both for floor and activity centers, indicating that children differed considerably in their use of the spatial components during social play. The model was therefore extended with a cross-level interaction for age and both spatial components, in order to explain the random slope variance. The outcomes showed that cross-level interactions between floor and age and between activity center and age did not significantly predict social play. Therefore, the random slopes model without cross-level interaction, which also showed the lowest AIC and a significant decrease of the maximum likelihood estimates, was considered as the final model (Table 5.4, Social play final model). The model shows that older children were almost four times more likely to be engaged in social play than younger children. There remained significant unexplained variance in children's use of the spatial components for social play.

Solitary play

The ICC in the intercept-only analysis for solitary play showed that 25% of the variance in solitary play could be attributed to the child-level. The same steps were followed as in the analysis for social play. The random slopes model showed that the spatial components floor and activity center were not significantly related to solitary play, but there was significant variance at the child level. The relation between age and solitary play tended towards significance ($p < .084$). Children were 1.7 times more likely to be engaged in solitary play when they were younger.

Table 5.4 Multilevel Analysis for Social, Solitary and Parallel Play with Age and Spatial Components as Predictors, Final Models.

	Social Play			Solitary Play			Parallel Play		
	Final model, random slopes			Final model, random slopes + cross-level interactions			Final model, random slopes		
	Parameter	***SE***	***OR***	***Parameter***	***SE***	***OR***	***Parameter***	***SE***	***OR***
Fixed effects									
Intercept	3.575**	0.306		2.280**	0.183		0.624**	0.193	
Age (1 = older group)	1.324**	0.354	3.758	-0.129	0.355	0.879	-0.591*	0.272	0.554
Floor	-0.116	0.291	0.890	0.516	0.302	1.675	-1.534**	0.203	0.216
Activity center	0.317	0.342	1.373	0.471	0.546	1.602	-0.779*	0.321	0.459
Floor X Age				-1.157*	0.474	0.314			
Activity center X Age				-0.714	0.758	0.490			
Random effects									
Variance social	0.865*	0.348		1.319**	0.352		0.965**	0.263	
Variance floor	1.865**	0.710		1.561*	0.485		1.188**	0.424	
Variance activity center	2.009*	0.871		4.112*	1.604		3.189**	1.023	
Log-likelihood	-1398.841			-1625.694			-1973.246		
Deviance	2797.682			3251.388			3946.492		
AIC	2811.681			3269.388			3960.491		
ICC intercept only model	0.372			0.246			0.244		
Explained variance fixed effects only									
Explained variance	0.100			0.048			0.077		
Unexplained level 1	0.637			0.707			0.704		
Unexplained level 2	0.263			0.246			0.220		

Notes. $N = 4460$. *SE* = standard error. *OR* = odds ratio. ** = $p < .01$. * = $p < .05$. Table is reference category.

Adding cross-level interactions for the spatial components with age resulted in a significant negative relation between the floor and solitary play, indicating that younger children showed more solitary play on the floor, relative to the other spatial components. The model with random slopes and the significant cross-level interaction showed a significant decrease in the maximum likelihood estimates and the lowest AIC, and was therefore considered the best fitting model (Table 5.4, Solitary play final model). Note that in this final model age was not a significant predictor anymore due to adding the cross-level interaction effects. The model shows that young children were three times more likely to be observed playing alone on the floor than older children. Also in the model for solitary play there remained significant unexplained variance in children's use of the spatial components.

Parallel play

The ICC in the intercept-only model for parallel play showed that 24% of the variance of parallel play could be attributed to the child-level. Again, the same steps were followed as in the analyses for social and solitary play. The proportion of variance in parallel play explained by the fixed effects corresponded to a small effect. Most of the variance was explained by the spatial components, which were added in model 3. The random slopes model showed that age significantly predicted parallel play: younger children were more often engaged in parallel play than older children. The odds that younger children were involved in parallel play were 1.8 times higher than older children. The floor and activity centers were significantly negatively related to parallel play, indicating that these spatial components were less often used for parallel play than the table (the reference category). Children were over four times more likely to use the table for parallel play than the floor and two times more likely to use the table than the activity centers.

There was significant variance at the child level in the use of the floor and the activity centers. Cross-level interactions for spatial components with age were not significantly related to parallel play. Therefore, the random slopes model, presented in Table 5.4 (Parallel play final model), which showed the lowest AIC, is considered as the final model, with the best fit.

The use of play materials

As a further step, we investigated to what extent combining the use of play materials with the use of spatial components could predict type of play. Again, three series of multilevel logistic regression analyses were conducted, with social, parallel and solitary play as dependent variables, respectively, using the same method for model-building as in the previous analyses. Dummy variables were created that combined use of play materials (no use of play materials, simple manipulation, complex manipulation) with each spatial component. In this way nine dummy variables were created, for example

floor0 indicated the use of the floor without play materials, and *activity center2* indicated the use of the activity center for complex manipulation of play materials. In each analysis nine predictors were included: age-group and eight dummy variables representing the combined spatial components and uses of play materials. The variable Table without use of play materials, *table0*, was used as the reference category. The large number of predictors and the sample size resulted in a complex model. As a result, the random slopes models had to be created stepwise, by fitting one slope at a time. Subsequently, a model was fitted including slope variables that showed significant variance at the child level. Monte-Carlo integration, using 5000 samples, was applied to compute the slopes models (Muthèn & Muthèn, 2010). Table 5.5 (see pages 106-107) shows the final models for the three series of analyses. ICC's for the intercept- only model and explained variances for the fixed effects models are also presented in the Table. All tested models are presented in Appendix 4.

Play materials and social play

The model for social play presented in Table 5.5 (Social play final model) shows that the proportion of variance explained by the fixed effects corresponded to a medium effect. After fitting the random slopes model that showed significant variance at the child level, the model was extended with cross-level-interactions for age and the two components with significant variance at the child level: the floor without use of play materials and the activity centers with simple manipulation of play materials. The cross-level interaction between age and simple manipulation of play materials at the activity centers was significant. This model is therefore presented as the final model, with the lowest maximum likelihood estimates. The model shows that, while using play materials for simple manipulation in the activity centers, young children were 3.2 times more likely to be engaged in social play than older children. Age again significantly predicted social play. Older children were more often engaged in social play than younger children. The model shows that use of the floor without or with only simple manipulation of play materials and use of the table with complex manipulation of play materials negatively predicted social play, relative to the reference category (use of the table without play materials). Children were eight times less likely to use complex manipulation at the table while being engaged in social play relative to the reference category (table without play materials), and five respectively 2.5 times less likely to use the floor without play materials or for simple manipulation. Significant unexplained variance at the child level remained only for the variable use of the floor without play material.

Play materials and solitary play

The results for solitary play (Table 5.5, Solitary play final model) show that the proportion of variance explained by the fixed effects corresponded to a medium effect.

After fitting the random slopes, the model was extended with cross-level-interactions for age and the three components that showed significant variance at the child level: the floor without use of play materials, the floor and the activity centers used for simple manipulation of play materials. The cross-level interactions were not significant and the maximum likelihood estimates did not decrease significantly. The random slopes model without cross-level interactions is therefore presented as the best fitting model. This model shows a marginally significant ($p < .055$) relation between age and solitary play: younger children were more often involved in solitary play.

Except for play without play materials on the floor, all other variables were significantly and positively related to solitary play. While at the table, children using play materials for simple and complex manipulation were, respectively, two and six times more likely to be engaged in solitary play relative to the reference category (use of the table without play materials). When using the floor, children performing simple or complex manipulation of play materials were, respectively, three and ten times more likely to be engaged in solitary play relative to the reference category. In the activity centers, children using complex manipulations, simple manipulations and no play objects were, respectively, thirteen, three and five times more likely to be engaged in solitary play relative to the reference category. Significant unexplained variance at the child-level remained for both simple manipulation and play without play materials on the floor, and also for simple manipulation in the activity centers.

Play materials and parallel play

The results regarding parallel play (Table 5.5, Parallel play final model) show that the proportion of variance explained by the fixed effects corresponded to a medium to large effect. After fitting the random slopes model that showed significant variance at the child level, the model was extended with cross-level-interactions for age and the three components that showed significant variance: use of the table for simple manipulation, use of the floor for simple manipulation and use of the activity center for simple manipulation of play materials. The cross- level interactions, however, were not significant and the maximum likelihood estimates did not decrease significantly. The random slopes model without cross-level interactions is therefore presented as the best fitting model. This model shows that the relation between parallel play and age tended toward significance ($p < .055$), suggesting a trend that younger children engaged more often in parallel play. Use of play materials for both simple and complex play at the table was significantly associated with parallel play. Children at the table using play materials for complex manipulation were almost 18 times more likely to be engaged in parallel play relative to the reference category (use of the table without play materials). Children using the table for simple manipulations were five times more likely to be engaged in parallel play relative to the reference category. Use of play materials for complex

Table 5.5 Multilevel Analysis for Social, Solitary and Parallel Play with Age and Spatial Components* Play Materials as Predictors, Final Models

	Social Play			Solitary Play			Parallel Play		
	Final model with random slopes + cross-level interactions			Final model with random slopes			Final model with random slopes		
	Parameter	*SE*	*OR*	*Parameter*	*SE*	*OR*	*Parameter*	*SE*	*OR*
Fixed effects									
threshold	2.903*	0.273		3.039*	0.380		2.194**	0.267	
Age (1 = older group)	1.085*	0.459	2.959	-0.678	0.354	0.508	-0.483	0.252	0.617
Table1	-0.402	0.339	0.669	0.710*	0.325	2.034	1.579**	0.403	4.850
Table2	-1.731**	0.500	0.117	1.791**	0.312	5.995	2.887**	0.274	17.939
Floor0	-1.533*	0.602	0.216	-0.419	0.411	0.658	-0.977**	0.268	0.376
Floor1	-0.946**	0.364	0.388	1.206**	0.316	3.340	0.405	0.272	1.499
Floor2	-0.045	0.374	0.956	2.274**	0.323	9.718	1.377**	0.261	3.963
Activitycenter0	0.204	0.353	1.226	1.625**	0.290	5.078	0.660	0.395	1.953
Activitycenter1	0.620	0.520	1.859	1.032**	0.366	2.807	0.629	0.405	1.876
Activitycenter2	-0.200	0.354	0.819	2.589**	0.325	13.316	1.931**	0.267	6.896
Floor0 * age	0.856	0.672	2.354						
Activitycenter1 * age	-1.174*	0.537	0.309						
Random effects									
VAR Social	0.889	0.500		VAR Solitary	1.807*	0.434	VAR Parallel	0.739**	0.192
VAR floor0	2.868*	1.111		VAR floor0	2.294*	0.847	VAR tab1	2.950*	1.304

Table 5.5 Multilevel Analysis for Social, Solitary and Parallel Play with Age and Spatial Components* Play Materials as Predictors, Final Models (Continued)

	Social Play			Solitary Play			Parallel Play		
	Final model with random slopes + cross-level interactions			Final model with random slopes			Final model with random slopes		
	Parameter	***SE***	***OR***	***Parameter***	***SE***	***OR***	***Parameter***	***SE***	***OR***
VAR floor1	1.357	0.738		VAR floor1 1.151*	0.397		VAR floor1 0.919**	0.347	
VAR activ0	0.949	0.530		VAR activ1 1.451*	0.761		VAR activ0 1.555	0.887	
VAR activ1	1.266	0.749					VAR activ1 2.158*	1.019	
Fit (par)									
Likelihood	-1346.572			-1569.607			-1842.912		
Deviance	2693.144			3139.214			3685.824		
Diff Dev *	3.426			92.236*			114.522*		
AIC **	2727.144			3167.214			3715.823		
ICC intercept only model	0.372			0.246			0.244		
Explained variance fixed effects									
Explained variance	0.137			0.144			0.219		
Unexplained level 1	0.596			0.612			0.624		
Unexplained level 2	0.267			0.243			0.157		

Notes. Slopes model with Monte Carlo integration (5000). $N = 4460$. ** = $p < .01$. * = $p < .05$. Table0 is reference category.

manipulation was significantly and positively related to parallel play on the floor, while play without play materials on the floor was negatively related to parallel play. Children showing complex manipulation of play materials were four times more likely to be engaged in parallel play, and when they played without play materials on the floor they were 2.6 times less likely to be engaged in parallel play, relative to the reference category. Children in activity centers showing complex manipulation of play materials were almost seven times more likely to be engaged in parallel play relative to the reference category. Unexplained random slope variance at the child level was significant for simple manipulation at the table, on the floor and in the activity centers.

Discussion

The aim of this study was to examine the relations between young children's social, solitary and parallel play, and the use of spatial components and play materials in the playroom in center-based childcare during free play time. In this study the three most used spatial components were included in order to obtain a detailed overview of how children use these components for these types of play. Use of play materials was included because the use of play objects was expected to moderate the use of spatial components. We hypothesized that younger children, being less skilled and experienced in judging the possibilities for action provided in the fully equipped playroom, would prefer to socialize with other children in well-defined areas with a predictable and limited set of uses (e.g., table, activity centers). The use of a multilevel modelling enabled us to carry out an in-depth analysis of the relation between children's play behavior and their use of spatial components and play materials.

The hypothesis that younger children's social play would occur more often in well-defined areas was only partially supported by the data. Social play was not significantly associated with the use of any particular spatial component, but occurred more often when children were older. Results from the first series of analyses indicated there was significant variance between children with respect to using spatial components for social play, but age did not explain this variance. However, when the use of play materials was included in the analyses, significant variance at the child level was only found for the use of the floor without play materials and for the use of the activity centers for simple manipulation, indicating that including the use of play materials explains much of the variance between children. Moreover, the outcomes showed that when younger children were engaged in social play, they were doing so predominantly in the activity centers while being engaged in simple manipulation of play materials. This suggests that social play in younger children is more focused on objects compared to social play in older children. Older children more often engaged in sociodramatic pretend play,

with or without play materials during social interactions. This is in line with earlier studies regarding the development of social play, suggesting that pretend play develops from playing with objects to interacting and negotiating with peers (Lillard, Pinkham, & Smith, 2010). Young children's apparent preference for using the activity centers for social play is in agreement with the hypothesis that an activity center, with clear boundaries and a predictable set of uses, makes it easier to interpret the actions of the peer you are playing with. The use of the table was not related to social play. This could be due to the fact that, in contrast to a specific activity center (i.e., for construction or phantasy play), the table was usually empty. If children wanted to play at the table, they first had to fetch play materials, such as a puzzle or a book. This table-related play was predominantly associated with solitary or parallel play. Overall occurrence of social play at the table was low, and mostly involved activities without play materials.

Younger children used the free floor space significantly more often than older children for solitary play. A possible explanation could be that the floor offers young children an easier opportunity than other places to distance themselves from others. If, as proposed by Creem-Regehr et al. (2013), young children are less experienced in judging other children's behaviors, this possibly not only affects their choice for a space where to interact with peers, but also where to play alone. Another explanation could be that in a mixed-age group the younger children are less adept in claiming a space to play on their own. It is conceivable that the limited number of activity centers were occupied by the older children and that younger children, therefore, had to resort to the floor. Use of play materials, for simple and even more so for complex manipulation, was associated with solitary play at all three spatial components. Complex manipulation of play materials during solitary play occurred most often in the activity centers. This could be explained by the fact that here, in contrast to the floor and the table, a variety of play objects was always readily available.

In contrast to social and solitary play, parallel play occurred mostly at the table, predominantly while using play materials for complex manipulation. Complex use of play materials at the floor and in the activity centers was also strongly associated with parallel play, although occurring less frequently. The association of parallel play with complex manipulation of play materials could point to a mechanism that when children are near to each another, although not directly interacting, they stimulate each other's play through observing the actions of the other which elicits a more complex use of play materials. This is in line with recent research that shows that perceiving another person's actions offers the perceiver new leads for what can be done with the objects at hand (Adolph & Franchak, 2017).

The use of advanced multilevel techniques for analyzing detailed observation data at the child and observation interval level produces outcomes that are difficult to compare with outcomes of earlier studies (e.g., Legendre, 1999; Moore, 1986). In our study we

found only a partial relation between young children's use of activity centers and social play during free play time. No relation was found between social play and the use of activity centers in children between 2.5 and 4 years of age. This is in contrast to earlier studies (e.g., Moore, 1987; Zimmons, 1997), which found that children of this age were engaged in social play significantly more often in well-defined play areas such as activity centers than in other areas. However, these studies used aggregated data, thereby possibly neglecting relevant variance at the child level. Using multilevel modelling we were able to show that there was significant variance at the child level in the way spatial components were related to types of play that could not be explained by age differences. Furthermore, by including the use of play materials as a possible moderator of the association of spatial components with type of play, we were able to partially explain the variance at the child level and to offer new insights in how spatial components were used as setting for exploring play materials during social, solitary and parallel play.

Our results showed that older children were engaged more often in social play than young children, which was expected since social play requires social competence that increases with age (e.g., Rose-Krasnor, 1997; Tomasello, 2016). The outcomes showed that younger children played alone and were engaged in parallel play almost twice as often as older children. Other studies relating young children's solitary and parallel play to age showed mixed outcomes, especially regarding parallel play (e.g., Robinson, Anderson, Porter, Hart, & Wouden-Miller, 2003).

The results of this study indicate that during free play children use a variety of spatial components in a number of ways. The free floor space was the component used most often, and was clearly an important spatial component, especially for providing young children with opportunities for solitary play focusing on simple and complex manipulation of play materials. It is remarkable that the floor, which is often considered as a circulation space, was used by young children most often in a stationary way (sitting, standing, kneeling) and mainly while playing with play materials. Future studies should investigate if this intensive use of the floor satisfies a certain need, for instance to have more free space, to be able to see what happens around or to seek assistance from the caregiver. Another explanation for this high use of the floor could be the age-heterogeneity of the group, which possibly restricted younger children in their choice to play in a designated activity center. An interesting question is if creating a free floor space area that is not simultaneously a circulation zone, could lead to more or different play activities on the floor.

No relations were found between temperamental characteristics, as rated by the caregiver, and the observed proportions of social, parallel or solitary play. A possible explanation is that the teacher-rated scales measure social competence in a comprehensive way, including questions about the child's ability to play well with peers, to be friendly with others and to follow rules, which do not necessarily relate to social play as it was

observed during free play time. Individual characteristics can influence the type of play, but in a group setting other aspects could also play an important role. Finally, in the current study we found that during free play sessions, children spent a considerable amount of time in non-play activities. Future studies should investigate the reasons for this high occurrence of engaging in non-play activities during free play.

Strengths and limitations

A limitation of this study is the relatively small sample size of 61 children and ten daycare centers. This limitation was partially compensated by the number of measurement intervals used, thereby increasing the total number of data points. The major strength of the present study is the employment of multi-level modelling. Using this method we were able to conduct an in-depth analysis of the data and also to test random variance at the child-level. Most studies in this field use aggregated data at the child-level, which bears the risk of overestimating certain outcomes (Hox, 2010). The current study therefore adds to the literature by offering more precise data at the individual level. The outcomes offer several leads for future studies into play behavior and children's use of spatial components.

Conclusions and implications

This study examined the relations between play behavior, the use of different spaces in the playroom and the activities with the play materials available at these spaces, using multilevel analysis. The results show that play behavior (solitary, parallel, social) is not only related to age, but also to the use of the spatial components and play materials in the playroom. If young children were engaged in social play, this was mainly in the activity centers, while older children showed social play regardless the specific spatial components of the playroom. Tables, which in the current study were at child height so children could easily use them, had a clear function for parallel play with complex manipulation of play materials. However, many Dutch daycare centers use tables at adult-height, which restrains children to use the table at their own choice. Centers aiming to encourage complex parallel play should therefore introduce tables at child height. The outcomes of the current study show that playing alone or next to each other relates to complex manipulation, i.e. exploration, of play objects. Since exploration plays a key role in children's cognitive and motor development, it seems recommendable to extend the predominant focus in early childhood research on social interaction to the potential developmental function of solitary and parallel play.

While most daycare centers are well aware of the importance of well-defined activity-centers for play, this study indicates that the floor is a highly used section, especially for solitary and parallel play. Therefore, more attention should be paid to the floor as an area for play, especially for younger children's solitary play with play materials. More

research is needed as to how this area could be optimized to support child development. More opportunities for solitary play could be created, for example by setting up flexible activity centers on the floor during free play time, for example by putting a removable, small rug with some play materials on the free floor or making a temporary exploration corner with a toy cabinet on wheels. Future studies are needed to investigate the effects of such interventions on children's play behavior.

Chapter 6

Summary and general discussion

This dissertation addressed a topic that until now has received little attention in research: the relation between children's exploratory and social behaviors and the spatial characteristics of the indoor play space in center-based childcare. The aim of this dissertation was to investigate how a theoretical framework, inspired by the theory of embodied cognition and based on Gibson's (1979/1986) concept of affordances, can be used to study young children's exploration of the indoor play space in center-based childcare settings. Building on previous studies by Heft (1988) and McLaren et al. (2012), an observation instrument was developed to code children's use of the spatial components and playroom space in detail. A cross-sectional study was conducted in ten age-heterogeneous groups in ten daycare centers. To the best of our knowledge, this is the first study that used Gibson's concept of affordances to investigate how in center-based childcare, during free play periods, young children act upon the affordances offered by the spatial components which constitute the indoor play space.

The current study contributes to the field by demonstrating that observing children's use of different spatial components leads to a more comprehensive understanding of the role of spatial attributes in children's exploratory play. This study also adds to knowledge about children's exploratory behavior in a natural, everyday setting during free play periods. Most studies on children's exploration are in-lab or task-directed studies, that might miss out the influence of the everyday environment on exploratory behavior. In a daycare center, children are easily distracted by other features and persons in the environment, and they have to be flexible because, for example, play objects frequently change hands. Moreover, exploration may be stimulated by watching other children's exploratory activities. Studying children during free play in a normal setting thus offers new insights into children's exploratory behavior, showing, not only what children *can* do, but what they actually do (Lee, Cole, Golenia, & Adolph, 2017).

Below, the main findings of the studies described in this dissertation are briefly discussed. Next, starting points for future research and implications for policy and practice are addressed.

Relations between the physical environment and social and cognitive development in center-based childcare

The findings of the narrative review, reported in Chapter 2, showed that studies addressing the relations between the indoor physical environment of center-based ECEC-settings and children's social and cognitive behavior and development are scarce. Studies were included in the review if they were peer-reviewed and pertained to center-based childcare facilities involving children between six months and six years of age. Only 19 articles fitting these criteria were found over a period of 30 years. These articles addressed a variety of spatial characteristics. Despite this variety, some consistent findings could be extracted. An interesting finding was that a layout with an open-zoned arrangement,

which enables young children to keep eye contact with the caregiver, stimulates children to use the space more fully, and thus may stimulate spatial exploration. Findings also showed that designated areas for activities such as pretend play, literacy and construction elicit different types of social and cognitive behaviors, indicating that offering a variety of these activity areas may foster a variety of cognitive and social behaviors, and support holistic child development. At the same time, the review showed that both content and methodology of the studies diverged vastly, and that there is a clear need to develop a strong theoretical framework as a basis for future research on these topics.

Exploration of space

The study that was reported in Chapters 3 to 5 aimed to investigate children's exploration of the indoor play space, using a newly developed observation instrument based on Gibson's concept of affordances. For the exploratory study reported in Chapter 3 no hypotheses were formulated. The first main finding of the study was that, during free play time, children used a wide variety of spatial components. The free floor space, tables and activity centers were used during 70% of the observed time-intervals, but the floor was the component used most often, also showing the largest variety in affordances that children acted upon. In-depth exploration, defined as the number of affordances explored during a 5-minute episode divided by the number of different affordances, occurred mostly in distinct recognizable play areas, such as activity centers for construction and fantasy play, and at tables. Children who were rated by their caregiver as more task-oriented also showed more in-depth exploration. Older children were more task-oriented than younger children, but task-orientation was a stronger predictor for in-depth exploration than age. The floor, the most used spatial component, however, was not related to either depth or breadth of exploration. Neither breadth nor depth of exploration was related to overall quality of space as measured by the spaces and furnishings subscales of the ITERS-R/ECERS-R. A possible explanation for the lack of such a relation is that these subscales evaluate spatial quality on a variety of spatial dimensions, which are then pooled into a single score. It could be that these dimensions are related differentially to children's exploration and other child outcomes, as was also suggested in the narrative review in Chapter 2.

Exploration of space and social behaviors

In the study reported in Chapter 4, we investigated the relation between in-depth exploration of space and children's play and non-play behaviors during scheduled free play time. Descriptive statistics showed that non-play behaviors occurred more than half of the time, with transition being the most frequent type of non-play behavior. Transitions and other non-play behaviors were not related to age or to the number of days children were attending the childcare facility, nor to task-orientation as rated by

the caregiver. The strong negative relation with the measure of in-depth exploration of the play space that was found, indicated that children showed low engagement in activities during transitions. The negative relation with in-depth exploration was not surprising, since during transitions children were moving around a lot, mainly on the floor. Although a high score on in-depth exploration could have resulted if children would have used the floor consistently for one or a few concentrated activities afforded by the floor, this was not the case. A likely explanation is that transition behavior was regularly interrupted by other activities, but future research will have to investigate this further. The fact that during transitions on the floor children were mostly moving around (crawling, walking) could also indicate that transition behavior is serving children's need to move around at their own pace. Recent research suggests that this seemingly random moving around could have a function, especially in young children who in this way practice how to produce varied combinations of movements, while learning to flexibly adapt their crawling or walking patterns to an environment cluttered with people and objects (Lee at al., 2017). Free play episodes in a space with other children, in this view, indeed offers a good opportunity to do so.

We found a small positive effect of social play on depth of exploration, but no significant relations for solitary and parallel play. This finding contradicts other studies that found that young children when playing alone were often engaged in exploratory play and in-depth exploration (Banerjee & Tamis-LeMonda, 2007; Katz-Buchholz, 1999; Oudgenoeg-Paz et al., 2015). Possibly this outcome relates to the fact that the current study involved mixed-age groups. It could be that in these groups the younger children, who were the ones playing alone most often, were frequently distracted or disturbed by the older, physically more mature children in the group. The lack of a strong relation between play-behaviors and in-depth exploration might also be due to age differences in the groups, affecting the layout and furnishing of the playroom. Arts and crafts materials and small toys were often stored out of children's reach and sight, to prevent younger children getting harmed. The absence of a variety of materials for more complex play could have limited children's sustained involvement in an activity during free play.

Spatial components, play and play materials

The study reported in Chapter 5 further elaborated on the relation between children's social, parallel and solitary play and their use of the three main spatial components: floor, table and activity centers. Children's use of play materials was included as an additional variable to investigate if this moderated the relation between the use of spatial components and the type of play. Use of play materials was coded as either absent, simple or complex. Simple uses of play materials involved simple manipulations such as carrying, riding, rolling or mouthing. When multiple objects were combined, or

social awareness was required, use of play materials was coded as complex. Instead of data aggregated to the episode level, here the full dataset was used in three multi-level logistic regression analyses, with social, parallel and solitary play as dependent variables. We hypothesized that younger children, being less adept in judging and predicting other children's actions, would prefer to interact with peers in well-defined recognizable play areas instead of an open area, like the free floor space. This hypothesis was partly supported by the data: when younger children were engaged in social play *and* were using play materials for simple manipulation, they were doing so predominantly in activity centers. This suggests that younger children's social play is more object-focused, in contrast to social play by older children, who more often engaged in sociodramatic pretend play in the activity centers, either with or without play materials. Younger children were significantly more often engaged in solitary play activities, while older children were more often interacting with peers. When playing alone, younger children mainly used the free floor space. This again could be related to the age heterogeneity of the group, which might have restricted the younger children in their choice to play alone in a designated activity area. Another finding of this study was that complex manipulation of play materials occurred at all three components, predominantly during parallel play and to a somewhat lesser extent during solitary play, but was not related to age, contributing to the emerging insight that solitary and parallel play are not merely immatures stages in play development, but serve a possibly important function in cognitive development. Finally, an important finding of this study is that use of play materials explains much of the variance in children's use of spatial components during social, solitary and parallel play. For example, complex use of play materials at the table was strongly associated with parallel play. This indicates that future research into the role of spatial arrangements and spatial components for children's behavior in daycare settings should include the use of play materials.

Towards a new theory of play?

In this dissertation we presented the results of a study in which young children were observed using an observation instrument based on embodied cognition and perception-action theory to collect detailed behavioral data on children's exploration of the play space and play materials. The findings of this study offer new leads to investigate if currently widely used play theories should be reconsidered. In classical play theory, play is seen as a developmental system progressing through several stages (Parten, 1924; Piaget, 1962). According to this framework, exploration, mostly during solitary and parallel play, is regarded as an early and less mature stage of play. In contrast, recent studies suggest that exploration and discovering new strategies for problem solving is a recurrent activity at all ages in early childhood, but becoming more complex over time (Oudgenoeg-Paz et al., 2014; Siegler, 2016). The current study found that exploration

of space and play materials was not related to age. Exploration, thus, continues as an important form of play, at least in pre-school children. According to an embodied-embedded cognition view, behavior that is called play in young children, for example running around or throwing blocks, although often seemingly without a clear goal, should be regarded as exploration, primarily of the spatial-physical environment, and in later stages also of the social environment (Smith & Gasser, 2005). Young children's exploration is intrinsically motivated by the possibilities offered by the environment to act upon. By acting upon these possibilities, children develop new skills to explore the environment and they employ increasingly more complex actions. Following this line of thought, classical cognitive definitions of play stages can be redefined as types or levels of exploration. For instance, functional play, often defined as simple, repetitive motor movement with or without play objects (Rubin, 2001), can in the embodied cognition view be redefined as recurrent exploration of a set of affordances for action to become more skilled. Constructive play, defined as manipulating objects to create or construct something (Rubin, 2001), can be redefined as exploration of complex affordances for combining objects to make particular constructions.

Developing a play theory based on the concept of affordances requires further elaboration of the framework in order to be able to define and measure the perception of, and action upon, (sets of) nested or complex affordances, that can be applied to understand young children's complex exploration behavior, including social and symbolic exploration. By observing children's behavior while using an open observation scheme based on Gibson's concept of affordances, instead of pre-defining behavior as either constructive or functional play, or as matching a particular developmental stage, a more detailed insight can be obtained in what actually happens during play and how this can contribute to child development (Early et al., 2010; Pellegrini, 2009). A new theory of play along the lines of embodied cognition and perception-action theory, instigates a domain-specific approach to what children explore and learn as related to the specific environments through which children navigate in the course of their development, and, thus, to the kinds of specific knowledge contents presented to them in these environments, without any claim regarding the knowledge and level of skill in other domains not yet encountered by the child. This would be in line with the recent recommendation by Siegler (2016) that domain-specific developmental theories are needed instead of overall, but likely too global, theories. The study presented in this dissertation, focusing on children's exploration of the play space in child daycare centers, is a first tentative step in this direction.

More research is needed to examine if, and how, observing children through the lens of perception-action affordances, can contribute to a better understanding of how children's exploration of space and play materials evolves and contributes to their development.

Implications for practice and policy

Although the main aim of the study was theoretical rather than practical, some of the presented findings have implications for practice. The outcomes showed that designated activity areas (in particular tables and activity centers) were associated with intense in-depth exploration by the children, often involving play, arts and craft materials, at all ages. This implies that, in order to stimulate in-depth exploration, it is essential to provide a range of specific (thematic) activity areas, with appropriate equipment that can be reached by the children, and in particular also tables at child height instead of adult height, the latter being still quite common in Dutch daycare centers.

The free floor space was found to be the most frequently used spatial component, including transitional moving from one place to another. When children were *playing* on the floor, they were almost half of the time showing stationary actions such as sitting, standing, and kneeling, while being engaged in simple or complex exploration of play materials. This indicates that, during free play time, the floor is also an important area for play. In the mixed-age groups in this study, the floor was most often used by the younger children for solitary and parallel play with play materials. This is possibly due to the fact that the older children in the group limited the options for the younger children to use designated activity areas (which were occupied by the older children), but it could also be that the free floor space is preferred by the younger children because they can easier move around while still being able to maintain eye-contact with the caregiver more than is possible in (more separated) activity areas. Whatever the facts of the matter, in view of these findings, caregivers in age-heterogeneous groups are advised to create more opportunities for solitary play on the floor during free play time, for instance by putting a small carpet with play materials on the floor as a way to create a designated play area. This relates to a consistent finding, reported in the narrative review in Chapter 2, that arranging the room into semi-open zones in a way that enables young children to have visual contact with the caregiver, stimulates children to more fully explore the playroom. Complex manipulation of play objects, which is thought to play an important role in children's cognitive development, occurred mostly during solitary and parallel play. Tables, which in the current study were at children's height, were frequently used for solitary and, in particular, parallel play involving complex manipulation of play materials, for example by making combinations of different materials and by requiring social awareness. From the point of view of stimulating children's development, all daycare centers, therefore, should introduce these low tables and should offer a variety of play materials within the children's reach during free play time, not only in activity areas but also at the child-height table.

Some findings of this study can also be important for policymakers. Our study of mixed-age groups yielded findings that could cause concern. New legislation demands a smaller children-to-adult ratio for infant care (3:1) than currently is statutory (4:1).

In practice this demand leads to abandoning separate age-homogenous infant groups in favor of age-heterogeneous infant-toddler groups in order to reduce the costs. The current study found several indications that separate infant and toddler groups may provide better-tailored opportunities for exploratory play for each age group. Therefore, the increasing age-heterogeneity in daycare as a consequence of new legislation can be regarded as an undesirable side-effect of legislation that was intended to improve the quality of infant care. We identified several explanatory factors, varying from the need to safely store-away play materials to protect infants, which hinders self- initiated play of toddlers, to differences in bodily characteristics (length, strength, mobility) between infants and toddlers that cause disbalance in the ways spatial components can be used and are occupied during free play time.

Overall involvement in spatial exploration was low and children were engaged in actual play during less than half of the scheduled free play time. The fact that children in various stages of development had to share the same play space, is part of the explanation of these results. Dutch caregivers and educational professionals often observe the *rest, cleanliness and regularity* rule (in Dutch: 'rust, reinheid en regelmaat'), especially when they care for very young children. The rule itself is beneficial or, at least, harmless for children. However, strictly following the rule frequently results in practices governed by non-pedagogical customs such as trying to keep the room tidied-up all the time, which is, often unintentionally, at the expense of children's exploratory activities which are disrupted or cannot be followed-up after a break or on the next day. Outcomes of the recent national daycare quality monitor (LKK; Slot et al., 2017) indicate that caregivers who care for infants seem more focused on care routines and safety than on stimulating activities, play, and interaction. This effect was found to be stronger in mixed-age groups. Note that the overall spatial quality of the centers in this study as rated by the ITERS-R/ECERS-R Spaces and Furnishing scale is comparable with the national average at the time of the study (Fukkink, Gevers Deynoot-Schaub, Helmerhorst, Bollen, & Riksen-Walraven, 2013).

To summarize, it seems advisable to be cautious with, either intentionally or unintentionally, promoting the formation of mixed-age groups in center-based childcare. To avoid adverse effects on children, policymakers should be made aware of how the indoor physical environment should be improved in a way that offers young children of diverging ages opportunities to explore, socialize and thrive. It is remarkable that regulations regarding the amount of space per child are the same for age-heterogeneous groups of children as for age-homogeneous groups, although young children clearly have different needs and potentials than older children. Following the findings in this study, it is equally remarkable that children-to-adult ratios are statutory regulated and adapted to children's ages and need for care in a detailed and precise manner, while basic requirements for arranging and equipping the playroom in relation

to age differences are lacking in statutory quality frameworks. It seems sensible to offer a variety of areas tailored to either infants or toddlers, but this likely requires more square meters than the statutorily required minimum. To stimulate children to explore a variety of possibilities for quiet, noisy, messy or physical action, without disturbing other children, more than one play space is needed for a group. However, most groups in Dutch daycare centers are confined to only one indoor play space. An interesting example in this regard was offered by one of the centers in our study. This center had one quiet space. This quiet place was most of the time used by the infants in the group for exploratory play. However, also older children made use of this space when they were seeking rest and relaxation. Next to this quiet room was a small room, where only the 3-year-olds were allowed to play, being their 'special place'. Adjacent to this was a large playroom, shared with the neighboring group, which was mainly used by the skilled walkers for messy, noisy and physical play. Very important for the older children was further that this shared playroom provided them with opportunities for meeting peers from the neighboring group. This example of a so-called 'open doors policy' may show that departing from the standard model of a stable group which stays in the same room during the whole day (except maybe for some play outdoors), should be reconsidered. The perspective of exploration, grounded in embodied cognition and perception-action theory, can be helpful in identifying appropriate arrangements in the daycare center of several rooms and spaces to accommodate the diverse needs and potentials of children of different ages. Childcare centers serving mixed-age groups are recommended to develop a policy regarding the physical environment and to include that in their pedagogical plans. They can collaborate with pedagogues, interior designers and architects to create an environment that is suited for children of different ages and that enables stimulation of the development of all children.

Limitations and directions for future research

A limitation of the cross-sectional study which was the core of the current dissertation is the relatively small sample size of 61 children in ten daycare centers. Moreover, additional information on the psychometric quality of the newly developed observation instrument is needed. However, the inter-rater reliability was satisfactory and the observed inter-correlations attest to the reliability and concurrent validity of the instrument. It is therefore important to replicate this study, using a larger sample of centers, to enable a comparison of outcomes at the center level. A third limitation is the relatively short time children were observed. Future studies should therefore extend the observation time per child, to obtain more and reliable information about the breadth and depth of spatial exploration at the child level. Applying lag-sequential analyses could offer a better insight how children's acting upon affordances develops over time. Moreover, the observation instrument that was developed for this study should be extended to

include more complex, nested, affordances, in order to investigate how a specific spatial component, for instance a slide, triggers children's use of specific toys. Future research should also investigate how the layout of the playroom and the type of activity area relate to children's exploratory and social behavior. Outcomes presented in the narrative review (Chapter 2), indicate that such relations exist.

The current study pertained to age-heterogeneous groups and reported different outcomes for older and younger children, which might be related to the composition of the group. Research is needed on age-homogeneous groups, to investigate if a more homogeneous group composition leads, for instance, to more in-depth exploration of the space and to a different distribution of affordances acted upon.

This dissertation shows that indoor spatial characteristics are related to children's exploratory and social behavior, and thus should be included in instruments that are used to assess childcare quality. Widely used instruments for measuring quality, the ECERS-R and the version for care settings with younger children, the ITERS-R, indeed include subscales to assess quality of spaces and furnishings. However, the outcomes of the review reported in Chapter 2, suggest that many items in these scales are not based on evidence. Moreover, the assessment scales pool together the ratings of very different items such as amount of space, lighting, noise, hygiene and decorations, making it difficult to distinguish which specific physical components affect child outcomes. In addition, we found no relation between children's depth and breadth of exploration and the pooled ITERS-R/ECERS-R scores for environmental quality (Chapter 3). Thus, there is a clear need to develop an instrument that differentiates between items that are important because of health issues, such as ventilation and hygiene, and spatial characteristics that are related to children's social and cognitive development. This requires thorough, theory-informed research into this still largely unexplored constituent of childcare quality.

To summarize, the main conclusion of this dissertation is that children's exploratory and social behavior is related to the spatial components that comprise the indoor play environment of daycare centers. Employing an observation instrument based on the concept of affordances yielded new insights in the way children use spatial components during free play and can offer leads for policy and practice. The results reported in this dissertation suggest that the physical environment of daycare centers deserves a more prominent place in future studies into young children's behavior and development in center-based daycare, as well as in quality regulations and monitoring systems that aim to assure quality of care.

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Appendices

Appendix 1

Spatial Affordances in Childcare Interior Design (SACID)

Spatial component	Affords
Floor (flat, smooth surface)	walking (around) crawling sliding jumping, dancing riding with play material laying sitting / crouching standing falling running kneeling
Activity centers (for dramatic play, construction, reading)	hiding / withdrawing climbing / sliding quiet movement (crawling, rolling) active movement (dancing, jumping) sitting walking (around) manipulating parts pulling oneself up, stabilizing standing
Table (child height)	putting something on / taking something off standing at sitting at crawling under sitting under to pull oneself up / stabilizing banging on
Big play object (play house, tunnel, car)	hiding / withdrawing climbing / sliding quiet movement (crawling, wobbling) active movement (jumping) sitting, kneeling walking around standing in/ on climbing/ crawling in/out manipulating parts
Chair (child height)	sitting on sitting while moving (wobbling) moving it (pushing, pulling) pulling oneself up, stabilizing climbing on / off standing on kneeling on crawling under knocking down retreating / withdrawing putting things on

Spatial Affordances in Childcare Interior Design (SACID) (Continued)

Spatial component	Affords
Bars (door, fence)	standing at opening / closing looking through pulling oneself up, stabilizing hiding behind
Cupboard	taking off / putting in things standing before playing at opening / closing door/drawer crawling / sitting inside pulling oneself up, stabilizing climbing on hiding behind
Carpet	sitting, squatting laying falling jumping/dancing standing walking crawling (re)moving it
Chair (adult height)	pulling oneself up, stabilizing climbing on/off moving it sitting retreating / withdrawing taking off/ putting on things
Window	looking through touching with mouth / hands standing / kneeling at looking at oneself
Table (adult height)	sitting / crawling under standing at sitting at taking off/ putting on things pulling up / stabilizing
Decorations (pictures, drawings)	looking at touching pointing at

Appendix 2

Affordances of Play Materials

No play material	Simple manipulation	Complex manipulation
	riding (with or on car)	stacking
	throwing	compiling (puzzles, lego, cup/saucer)
	mouthing	hiding (in or behind)
	carrying	standing/sitting on (e.g. car, stacked blocks)
	shaking, ticking, banging	combining (two or more objects)
	looking	giving to someone
	(re)moving / pushing	
	seizing	
	putting down	
	kicking	

Appendix 3

Multilevel Analysis for Social Play with Age and Spatial Components as Predictors.

	Model 1: random intercept	Model 2: fixed effects: level 1 predictor		Model 3: fixed effects: level 1 + 2 predictors		Model 4: random slopes		Model 5: random slope + cross level interactions	
	Parameter (SE)	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*
Fixed effects									
Intercept	2.574** (0.202)	3.252**(0.269)		3.607**(0.295)		3.575**(0.306)		3.578**(0.348)	
Age (1 = older group)		1.352**(0.349)	3.865	1.287**(0.339)	3.622	1.324**(0.354)	3.758	1.337**(0.429)	3.808
Floor				0.318(0.172)	1.374	-0.116(0.291)	0.890	-0.323(0.458)	0.724
Activity center				0.791**(0.180)	2.206	0.317(0.342)	1.373	0.823(0.507)	2.277
Floor X Age								0.397(0.571)	1.487
Activ center X Age								-0.732(0.606)	0.481
Random effects									
Variance social	1.946** (0.498)	1.456**(0.381)		1.357**(0.357)		0.865*(0.348)		0.865*(0.336)	
Variance floor						1.865**(0.710)		1.873**(0.704)	
Variance activity center						2.009*(0.871)		1.714*(0.788)	
Likelihood	-1472.488	-1465.458		-1452.710		-1398.841		-1397.403	
Deviance	2944.976	2930.916		2905.420		2797.682		2794.806	
Diff Dev		14.060*	1	25.496*	2	107.738*	2	2.876	2
AIC	2948.975	2936.916		2915.420		2811.681		2812.806	
ICC	0.372								
Explained variance									
Explained variance		0.088		0.100					
Unexplained level 1		0.632		0.637					
Unexplained level 2		0.280		0.263					

Notes. $N = 4460$. *SE* = standard error. *OR* = odds ratio. ** = $p < .01$. * = $p < .05$.

Multilevel Analysis for Solitary Play with Age and Spatial Components as Predictors.

	Model 1: random intercept	Model 2: fixed effects: level 1 predictor		Model 3: fixed effects: level 1 + 2 predictors		Model 4: random slopes		Model 5: random slope + cross level interactions	
	Parameter (SE)	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*
Fixed effects									
Intercept	2.085**(0.147)	1.761** (0.195)		1.937**(0.234)		2.179**(0.179)		2.280**(0.183)	
Age (1 = older group)		-0.655*(0.284)	0.519	-0.768*(0.301)	0.464	-0.557(0.322)	0.573	-0.129(0.355)	0.879
Floor				0.025(0.138)	1.374	0.054(0.238)	1.055	0.516(0.302)	1.675
Activity center				0.745**(0.153)	2.206	0.198 (0.400)	1.219	0.471(0.546)	1.602
Floor X Age								-1.557**(0.474)	0.314
Activ center X Age								-0.714(0.758)	0.490
Random effects									
Variance solitary	1.072**(0.252)	1.005**(0.234)		1.143**(0.264)		1.445**(0.369)		1.319**(0.352)	
Variance floor						1.647**(0.519)		1.561**(0.481)	
Variance activity center						4.120**(1.603)		4.112**(1.604)	
Likelihood	-1732.919	-1730.266		-1710.325		-1628.703		-1625.694	
Deviance	3465.838	3460.532		3420.650		3257.406		3251.388	
Diff Dev		5.306*	1	39.882*	2	163.244*	2	6.018*	2
AIC	3469.838	3466.533		3430.649		3271.406		3269.388	
ICC	0.246								
Explained variance									
Explained variance		0.024		0.048					
Unexplained level 1		0.747		0.707					
Unexplained level 2		0.228		0.246					

Notes. $N = 4460$. *SE* = standard error. *OR* = odds ratio. ** = $p < .01$. * = $p < .05$.

Appendices

Multilevel Analysis for Parallel Play with Age and Spatial Components as Predictors.

	Model 1: random intercept	Model 2: fixed effects: level 1 predictor		Model 3: fixed effects: level 1 + 2 predictors		Model 4: random slopes		Model 5: random slope + cross level interactions	
	Parameter (SE)	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*
Fixed effects									
Intercept	1.600**(0.143)	1.447** (0.199)		0.549*(0.212)		0.624**(0.193)		0.619**(0.197)	
Age (1 = older group)		-0.294(0.281)	0.745	-0.355(0.279)	0.701	-0.591*(0.272)	0.554	-0.634*(0.295)	0.530
Floor				1.427**(0.115)	0.240	-1.534**(0.203)	0.216	-1.477**(0.267)	0.228
Activity center				-0.536**(0.125)	0.585	-0.779*(0.321)	0.459	-1.221**(0.474)	0.295
Floor X Age								-0.107(0.405)	0.899
Activ center X Age								0.811(0.625)	2.250
Random effects									
Variance parallel	1.064**(0.245)	1.052**(0.244)		1.027**(0.237))		0.965**(0.263)		0.985**(0.268)	
Variance floor						1.188**(0.424)		1.194**(0.439)	
Variance activity center						3.189**(1.023)		3.086*(0.988)	
Likelihood	-2132.914	-2132.406		-2043.601		-1973.246		-1972.267	
Deviance	4265.828	4264.812		4087.202		3946.492		3944.534	
Diff Dev		1.016	1	177.610*	2	140.710*	2	1.958	2
AIC	4269.828	4270.813		4097.203		3960.491		3962.535	
ICC	0.244								
Explained variance									
Explained variance		0.005		0.077					
Unexplained level 1		0.754		0.704					
Unexplained level 2		0.241		0.220					

Notes. N = 4460. *SE* = standard error. *OR* = odds ratio. ** = p <.01. * = p < .05.

Appendix 4

Multilevel Analysis for Social Play with Age and Spatial Components* Play Materials as Predictors

Social play	Model 1: random intercept	Model 2: fixed effects level 1predictor		Model 3: fixed effects level 1+ 2 predictors		Model 4: random slopes / fixed effects		Model 5: random slope predictors + cross-level interactions	
	Parameter (SE)	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*
Fixed effects									
threshold	2.574**(0.202)	3.252**(0.269)		3.037**(0.348)		3.017**(0.310)		2.903**(0.273)	
age (1 = older group)	(0((0.202).202	1.352**(0.349)	3.865	1.327**(0.351)	3.770	1.209*(0.428)	3.350	1.085*(0.459)	2.959
tab1				-0.533(0.319)	0.587	-0.341(0.390)	0.711	-0.402(0.339)	0.669
tab2				-1.801**(0.486)	0.165	-1.685**(0.528)	0.185	-1.731**(0.500)	0.177
floor0				0.002(0.260)	1.002	-0.968*(0.451)	0.380	-1.533*(0.602)	0.216
floor1				-0.636*(0.265)	0.529	-0.933*(0.435)	0.393	-0.946**(0.364)	0.388
floor2				-0.106(0.309)	0.899	-0.006(0.430)	0.994	-0.045(0.374)	0.956
activ0				0.424(0.283)	1.528	0.330(0.400)	1.391	0.204(0.353)	1.226
activ1				0.326(0.267)	1.385	-0.203(0.495)	0.816	0.620(0.520)	1.859
activ2				-0.470(0.323)	0.625	-0.132(0.423)	0.876	-0.200(0.354)	0.819
floor0 *age								0.856(0.672)	2.354
activ1 * age								-1.174*(0.537)	0.309
Random effects									
VAR Social	1.946**(0.498)	1.456**(0.381)		1.471**(0.388)		0.973(0.590)		0.889(0.500)	
VAR floor0						2.974**(1.107)		2.868*(1.111)	
VAR floor1						1.523(0.841)		1.357(0.738)	
VAR activ0						0.827(0.500)		0.949(0.530)	
VAR activ1						2.054*(1.018)		1.266(0.749)	
FIT (par)									
Likelihood	-1472.488	-1465.458		-1428.048		-1348.285		-1346.572	
Deviance	2944.976	2930.916		2856.096		2696.570		2693.144	
Diff Dev		14.060*	1	74.820*	8	159.526*	4	3.426	2
AIC	2948.975	2936.916		2878.096		2726.570		2727.144	
ICC	0.372								
Explained variance		0.088		0.137					
Unexpl level 1		0.632		0.596					
Unexpl level 2		0.280		0.267					

Notes. N = 4460. Slopes model with MonteCarlo integration. Table 0 is reference category. p^{**}=<.01. p^{*} = < .05

Multilevel Analysis for Solitary Play with Age and Spatial Components* Play Materials as Predictors

Solitary play	Model 1: random intercept	Model 2: fixed effects level 1 predictor age		Model3: fixed effects level 1+ 2 predictors		Model4: random slopes / fixed effects		Model 5: random slope predictors + cross-level interactions	
	Parameter (SE)	*Parameter(SE)*	*OR*	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*	*Parameter (SE)*	*OR*
Fixed effects									
threshold	2.085**(0.147)	1.761**(0.195)		2.849**(0.348)		3.039**(0.380)		3.088**(0.313)	
age (1 = older group)		-0.655* (0.284)	0.519	-0.832*(0.320)	0.435	-0.678(0.354)	0.508	-0.464(0.341)	0.629
tab1				0.682*(0.333)	1.978	0.710*(0.325)	2.034	0.667*(0.292)	1.948
tab2				1.641**(0.319)	5.160	1.791**(0.312)	5.995	1.750**(0.278)	5.755
floor0				-0.121(0.314)	0.886	-0.419(0.411)	0.658	-0.268(0.461)	0.765
floor1				1.204**(0.289)	3.333	1.206**(0.316)	3.340	1.427**(0.328)	4.166
floor2				2.210**(0.323)	9.116	2.274**(0.323)	9.718	2.229**(0.278)	9.291
activ0				1.674**(0.316)	5.333	1.625**(0.290)	5.078	1.556**(0.263)	4.740
activ1				1.202**(0.306)	3.327	1.032**(0.366)	2.807	1.130**(0.449)	3.096
activ2				2.534**(0.328)	12.604	2.589**(0.325)	13.316	2.508**(0.290)	12.280
floor0 * age								-0.473(0.625)	0.623
floor1 * age								-0.609(0.402)	0.544
activ1 * age								-0.316(0.550)	0.729
Random effects									
VAR Solitary	1.072**(0.252)	1.005**(0.234)		1.306**(0.301)		1.807**(0.434)		1.699**(0.402)	
VAR floor0						2.294**(0.847)		2.315**(0.843)	
VAR floor1						1.151**(0.397)		1.064**(0.379)	
VAR activ1						1.451(0.761)		1.418(0.744)	
FIT (par)									
Likelihood	-1732.919	-1730.266		-1615.725		-1569.607		-1568.427	
Deviance	3465.838	3460.532		3231.450		3139.214		3136.854	
Diff Dev *		5.306*	1	229.082*	8	92.236*	3	2.360	3
AIC **	3469.838	3466.533		3253.450		3167.214		3170.855	
ICC	0.246			0.776					
Explained variance		0.024		0.144					
Unexpl level 1		0.747		0.612					
Unexpl level 2		0.228		0.243					

Notes. N = 4460. Slopes model with MonteCarlo integration. Table0 is reference category. p^{**}=<.01. p^{*} = < .05.

Multilevel Analysis for Parallel Play with Age and Spatial Components* Play Materials as Predictors

Parallel play	Model 1: random intercept	Model 2: fixed effects level 1predictor		Model 3: fixed effects level 1+ 2 predictors		Model 4: random slopes / fixed effects		Model 5: random slope predictors + cross-level interactions	
	Parameter(SE)	*Parameter(SE)*	*OR*	*Parameter(SE)*	*OR*	*Parameter(SE)*	*OR*	*Parameter(SE)*	*OR*
Fixed effects									
intercept	1.600**(0.143)	1.447**(0.199)		2.218**(0.282)		2.194**(0.267)		2.206**(0.254)	
age (1 = older group)		-0.294(0.281)	0.745	-0.395(0.255)	0.674	-0.483(0.252)	0.617	-0.453(0.273)	0.636
tab1				1.796**(0.260)	6.025	1.579**(0.403)	4.850	1.829**(0.496)	6.228
tab2				2.883**(0.275)	17.868	2.887**(0.274)	17.939	2.899**(0.272)	18.156
floor0				-1.006**(0.281)	0.366	-0.977**(0.268)	0.376	-0.970**(0.270)	0.379
floor1				0.623*(0.239)	1.865	0.405(0.272)	1.499	0.514(0.308)	1.672
floor2				1.179**(0.270)	3.251	1.377**(0.261)	3.963	1.381**(0.262)	3.979
activ0				0.859**(0.267)	2.361	0.660(0.395)	1.935	0.659(0.382)	1.933
activ1				0.064(0.254)	1.066	0.629(0.405)	1.876	0.156(0.511)	1.169
activ2				1.810**(0.276)	6.110	1.931**(0.267)	6.896	1.938**(0.275)	6.945
tab1 * age								-0.514(0.726)	0.598
floor1 * age								-0.255(0.373)	0.775
activ1 * age								0.906(0.569)	2.474
Random effects									
VAR Parallel	1.064**(0.245)	1.052**(0.244)		0.828**(0.196)		0.739**(0.192)		0.740**(0.202)	
VAR tab1						2.950*(1.304)		3.077*(1.262)	
VAR floor1						0.919**(0.347)		0.937**(0.358)	
VAR activ0						1.555(0.887)		1.592(0.834)	
VAR activ1						2.158*(1.019)		1.943*(0.870)	
FIT (par)									
Likelihood	-2132.914	-2132.406		-1900.173		-1842.912		-1841.634	
Deviance	4265.828	4264.812		3800.346		3685.824		3683.268	
Diff Dev *		1.016	1	464.466*	8	114.522*	4	2.556	3
AIC **	4269.828	4270.813		3822.347		3715.823		3719.269	
ICC	0.244			1.152					
Explained variance		0.005		0.219					
Unexpl level 1		0.754		0.624					
Unexpl level 2		0.241		0.157					

Note. N = 4460, Slopes model with MonteCarlo integration, Table0 is reference category, , p**=<.01, p* = < .05.

Appendices

Nederlandse samenvatting

(Summary in Dutch)

Een jong kind dat voor de eerste keer in een kinderdagverblijf komt, belandt in een omgeving die heel anders is dan thuis. De ruimte is groter, er staat ander meubilair, er zijn speciale speelplekken en er zijn onbekende kinderen en volwassenen. Het kinderdagverblijf is, in sociaal en ruimtelijk opzicht, een bijzondere omgeving, die het kind zowel nieuwe kansen als uitdagingen biedt: kansen voor interactie met leeftijdgenootjes en voor het verkennen van een nieuwe omgeving, en uitdagingen, omdat deze omgeving nog niet vertrouwd is én met anderen moet worden gedeeld.

Wereldwijd groeit het aantal jonge kinderen dat in de eerste levensjaren een kinderdagverblijf of voorschool bezoekt. Daarmee wordt de vraag steeds belangrijker of de kwaliteit van kinderopvangvoorzieningen voldoende is en bijdraagt aan het welzijn en de ontwikkeling van kinderen. Onderzoek naar de kwaliteit en effecten van kinderopvang op het gedrag en de ontwikkeling van kinderen richt zich meestal op de emotionele en educatieve kwaliteit van de interactie van kinderen met leeftijdgenoten en pedagogisch medewerkers, en op persoons gerelateerde structurele kenmerken zoals de beroepskracht-kind ratio, groepsgrootte en scholing van medewerkers. Onderzoek naar de relatie tussen de ruimtelijke omgeving van kindercentra en gedrag en ontwikkeling van kinderen is schaars. Hoewel de ruimtelijke indeling, het beschikbare oppervlak en de aanwezigheid van spelmateriaal vaak wel onderdeel uitmaken van meetinstrumenten die de algemene kinderopvangkwaliteit beoordelen, is het aantal studies dat specifiek onderzocht heeft hoe deze kenmerken van invloed zijn op het gedrag en de ontwikkeling van kinderen beperkt. Ondertussen groeit het bewustzijn dat de fysieke omgeving een cruciale rol speelt in de cognitieve en sociale ontwikkeling van kinderen. Volgens de theorie van embodied cognition (belichaamde kennis), is kennisverwerving geworteld in hier-en-nu ervaringen. Een kind leert en ontwikkelt nieuwe vaardigheden door zelf-geïnitieerde interacties met zijn of haar omgeving, interacties die herhaald, uitgebreid en verfijnd worden, en die we in dit onderzoek *exploratie* noemen.

Exploratie

Exploratie speelt een sleutelrol in de ontwikkeling van kinderen. Kinderen verzamelen informatie en leren nieuwe vaardigheden door middel van exploratie. Ze gebruiken hun sensomotorische competenties om hun sociale en fysieke omgeving waar te nemen en erop te reageren. Door de omgeving te onderzoeken en te ervaren hoe je objecten kunt manipuleren, ontdekt een kind nieuwe handelingsmogelijkheden en ontwikkelt complexere vaardigheden. Als kinderen zich zelfstandig gaan voortbewegen nemen hun exploratiemogelijkheden toe: hun actieradius vergroot zich, objecten die eerst nog ver weg of te hoog waren worden waarneembaar en komen binnen handbereik. Dat leidt ook tot meer sociale betrokkenheid: je kunt niet alleen zien wat een ander doet, maar ook naar de plek gaan waar die ander zich bevindt, een voorwerp bekijken vanuit het perspectief van de ander, de ander imiteren of samen de gebruiksmogelijkheden van het object onderzoeken.

Exploratie wordt vaak omschreven als een doelgerichte activiteit, waarbij het doel is om informatie te verzamelen over een voorwerp of situatie. Onderzoek laat zien dat exploratie bij jonge kinderen vaak 'per ongeluk' begint. Een baby raakt spontaan een voorwerp aan en veroorzaakt daarmee een geluid of een beweging. Dit effect zal het kind vervolgens opzettelijk proberen te herhalen, en als dat lukt, onderzoeken wat er nog meer mogelijk is. De bal, die na een zacht tikje wegrolde, rolt sneller en verder weg als je een hardere duw geeft, en nog sneller als je hem van een glijbaan laat rollen. Door te reageren op hun omgeving ontdekken kinderen dat er een relatie is tussen hun eigen gedrag en de veranderingen in de omgeving die door dit gedrag veroorzaakt worden. Andersom beïnvloeden veranderingen in de omgeving het gedrag. In een onderzoek waarbij jonge kinderen over een ongelijke vloer moesten lopen, bleken kinderen hun loopgedrag steeds zo aan te passen dat ze overeind bleven, wat erop duidt dat kinderen hun perceptie direct in actie omzetten. Door dergelijke ervaringen vergaren ze tegelijkertijd kennis over de ruimtelijke omgeving én over hun eigen competenties.

Studies naar exploratief gedrag bij jonge kinderen richten zich meestal op het gebruik van spelmateriaal. Het aantal studies naar exploratie van de ruimte is beperkt, en ze vonden meestal plaats in laboratoria of bij kinderen thuis. Hoe kinderen in kinderdagverblijven de speelruimte exploreren en gebruiken is nauwelijks onderzocht.

Deze dissertatie

Dit proefschrift beschrijft de resultaten van een onderzoek naar de relatie tussen ruimtelijke kenmerken van de binnenspeelruimte in het kinderdagverblijf en exploratief en sociaal gedrag van kinderen. Voor dit onderzoek is een nieuw observatie-instrument ontwikkeld, geïnspireerd door de theorie van embodied cognition en gebaseerd op het concept van affordanties. Het affordantie-concept, ontwikkeld door James en Eleanor Gibson, houdt in dat een object of een ruimte gebruiksmogelijkheden biedt die gerelateerd zijn aan de mogelijkheden van een persoon om ze waar te nemen en ze daadwerkelijk fysiek te gebruiken. Een stoel biedt bijvoorbeeld de mogelijkheid er op te zitten, hem te verplaatsen of eronder te kruipen, maar wat je ermee kunt doen hangt niet alleen af van de vorm, afmeting en gewicht van de stoel maar ook van de gebruiker. Een baby kan niet zelfstandig op de stoel gaan zitten, maar er wel onder kruipen, terwijl een volwassene juist dat laatste niet kan. In de hoofdstudie in dit proefschrift is het affordantie-concept gebruikt om het exploratiegedrag van kinderen in het kinderdagverblijf te onderzoeken. Met het nieuwe observatie-instrument is onderzocht welke gebruiksmogelijkheden (affordanties) jonge kinderen benutten die geboden worden door de verschillende elementen in de ruimte, zoals tafels, speelhoeken, kasten en het vrije vloeroppervlak. Door gedetailleerd te onderzoeken welke affordanties kinderen gebruiken tijdens vrij spel, is inzicht verkregen in hoe kinderen de ruimte exploreren, en welke elementen in de ruimte het meest gebruikt worden. Het onderzoek is uitgevoerd in tien verticale

groepen in tien kinderdagverblijven; de leeftijd van de geobserveerde kinderen varieerde van 11 tot 48 maanden.

Review van eerder onderzoek

Voorafgaand aan de hoofdstudie is een review uitgevoerd van internationale studies die de relatie tussen ruimtelijke kenmerken van de binnenruimte van kindercentra en de sociale en cognitieve ontwikkeling en gedrag van jonge kinderen hebben onderzocht. De resultaten van deze narratieve review worden in hoofdstuk 2 beschreven. Alleen peer-reviewed studies die betrekking hadden op kinderen in de leeftijd tussen zes maanden en zes jaar zijn opgenomen in de review. Over een periode van 30 jaar (1987-2017) werden slechts 19 artikelen gevonden die aan deze criteria voldeden. Zowel qua inhoud als qua methodologie verschillen de studies sterk van elkaar en een helder theoretisch kader ontbreekt. Ondanks deze verscheidenheid, zijn er enkele consistente bevindingen. Een interessante uitkomst van enkele studies is dat in een ruimtelijke indeling met herkenbare zones (speelplekken), waarbij jonge kinderen oogcontact kunnen houden met de volwassene, kinderen de ruimte vollediger benutten dan wanneer er geen duidelijke zones zijn of wanneer de afscheiding tussen die zones oogcontact met de volwassene belemmert. Zo'n 'open-zone-indeling' bevordert daarmee de ruimtelijke exploratie. Ook bleek dat verschillende plekken voor fantasiespel, bouwen, knutselen en lezen verschillende types sociale en cognitieve gedragingen uitlokten. Het aanbieden van een verscheidenheid aan activiteitenplekken kan dus verschillende vormen van cognitief en sociaal gedrag stimuleren, en daarmee een holistische ontwikkeling ondersteunen.

Onderzoek naar exploratie van de binnenruimte

In hoofdstukken 3 tot en met 5 worden resultaten beschreven van het onderzoek naar de exploratie van de binnenspeelruimte. Hoofdstuk 3 beschrijft de belangrijkste uitkomsten aangaande het gebruik van de ruimte gedurende vrij spel perioden. Kinderen gebruikten een breed scala aan ruimtelijke elementen. De vrije vloer (ruimte waar geen meubels staan en die geen onderdeel vormt van een activiteitenplek), werd het meest gebruikt, en liet de grootste verscheidenheid aan affordanties zien (o.a. rondlopen, springen, kruipen, rennen, stilstaan, vallen). Ook tafels en activiteitenplekken werden veelvuldig gebruikt. Om te onderzoeken hoe intensief kinderen een element in de ruimte exploreerden (diepte van exploratie), werd gemeten hoe lang tijdens een observatie-episode van 5 minuten het element gebruikt werd voor een specifieke affordantie. Deze intensieve exploratie kwam vooral voor in activiteitenplekken en aan tafels. Kinderen die door hun vaste pedagogisch medewerker werden beoordeeld als meer taakgericht, bleken elementen in de ruimte intensiever te exploreren.

In hoofdstuk 4 is de relatie onderzocht tussen diepte van exploratie en spelgedrag. Spelgedrag werd gecodeerd als sociaal, parallel of solitair spel. Daarnaast werden andere,

niet-spel gedragingen gecodeerd, zoals transitie en toekijken. Niet-spelgedrag kwam voor in meer dan de helft van de geobserveerde tijd, met transitie als meest frequente gedrag. Transitiegedrag hing sterk negatief samen met intensieve exploratie van de ruimte, wat duidt op een lage betrokkenheid bij activiteiten tijdens transities. Tijdens transities waren kinderen veel in beweging, vooral op de vloer. We vonden geen significante verbanden tussen intensieve exploratie en solitair spel, en een beperkte samenhang met sociaal spel. Deze bevinding wijkt af van andere studies die lieten zien dat jonge kinderen tijdens solitair spel vaak intensief spelmateriaal exploreren. Mogelijk worden in een verticale groep de jongere kinderen, die het vaakst alleen speelden, eerder afgeleid of gestoord door de oudere kinderen. Het ontbreken van een sterke relatie tussen spelgedrag en intensieve exploratie kan ook samenhangen met de indeling en inrichting van de speelruimte in de verticale groepen. Knutselmaterialen, zoals verf en klei, en klein speelgoed stonden vaak buiten bereik en zicht, om risicovolle situaties voor de jongste kinderen te vermijden. Het beperkt voorhanden zijn van meer complexe spelmaterialen tijdens vrij spel kan een negatieve invloed hebben gehad op intensieve betrokkenheid bij exploratie.

In hoofdstuk 5 wordt verder ingezoomd op de relatie tussen sociaal, parallel en solitair spel en het gebruik van de drie meest gebruikte elementen in de ruimte: de vrije vloer, tafels en activiteitenplekken. De hypothese was dat de jongere kinderen, die minder goed de acties van andere kinderen kunnen inschatten of voorspellen, liever samenspelen met leeftijdgenoten in overzichtelijke en begrensde activiteitenplekken dan op de open vrije vloer. Onderzocht werd of het gebruik van spelmateriaal de relatie tussen het gebruik van ruimtelijke elementen en type spel modereerde. De hypothese werd deels ondersteund door de data: als jongere kinderen met anderen speelden en daarbij spelmateriaal gebruikten, deden ze dit significant vaker in de activiteitenplekken dan de oudere kinderen. Ook speelden de jongere kinderen vaker alleen dan de oudere kinderen en dit deden ze voornamelijk op de vrije vloer.

Gebruik van spelmateriaal werd gecodeerd als afwezig, eenvoudige manipulatie of complexe manipulatie. Complexe manipulatie van spelmaterialen vond vooral plaats tijdens parallel spel en solitair spel, ongeacht de leeftijd van het kind. Deze uitkomst sluit aan bij nieuwe inzichten, dat solitair en parallel spel niet zo zeer vroege stadia van spelontwikkeling zijn, maar mogelijk een belangrijke functie hebben in de cognitieve ontwikkeling. Een belangrijke uitkomst van deze studie is daarnaast dat gebruik van spelmateriaal een groot deel van de variantie in het gebruik van ruimtelijke elementen tijdens sociaal, parallel en solitair spel verklaart. Zo werd bijvoorbeeld de tafel vooral gebruikt voor complexe manipulatie van spelmateriaal tijdens parallel spel. In toekomstig onderzoek naar de relatie tussen ruimtelijke indeling en inrichting en gedrag van kinderen dient dan ook het gebruik van spelmateriaal betrokken te worden.

Naar een nieuwe speltheorie?

In dit proefschrift werden gedetailleerde gegevens verzameld over de wijze waarop kinderen de ruimte en spelmaterialen exploreren. De resultaten kunnen bijdragen aan een hernieuwde discussie of de huidige veel gebruikte speltheorieën niet moeten worden heroverwogen. In de klassieke speltheorie wordt spel beschouwd als een ontwikkelingssysteem waarin verschillende stadia worden doorlopen. Exploratie wordt beschouwd als een vroege en onrijpe vorm van spel. Recente studies suggereren echter dat exploratie, en daarmee het ontdekken van nieuwe strategieën voor het oplossen van problemen, een terugkerende activiteit is, die gaandeweg complexer wordt. In de huidige studie vonden we inderdaad dat exploratie van ruimte en spelmateriaal niet gerelateerd is aan leeftijd. De theorie van embodied cognition beschouwt gedrag dat bij jonge kinderen 'spel' genoemd wordt, zoals schijnbaar doelloos een blokkentoren omgooien, als exploratie. Bij jonge kinderen wordt exploratie vaak intrinsiek gemotiveerd door de handelingsmogelijkheden die de omgeving biedt. Door deze te onderzoeken, worden nieuwe vaardigheden ontwikkeld en kunnen steeds complexere acties worden uitgevoerd. Volgens deze gedachtegang, zouden klassieke cognitieve definities van spelstadia kunnen worden geherdefinieerd als niveaus van exploratie. Zo kan constructief spel, dat vaak wordt gedefinieerd als het manipuleren van objecten om iets te construeren, worden geherdefinieerd als het exploreren van affordanties om objecten te combineren of te construeren. Door gedrag te observeren met een open observatiemethode gebaseerd op affordanties, in plaats van gedrag vooraf te definiëren als constructief of functioneel spel, of als passend bij een bepaald ontwikkelingsstadium, kan een meer gedetailleerd inzicht ontstaan in wat er feitelijk gebeurt tijdens spel en hoe dit kan bijdragen aan de ontwikkeling van het kind. Zo'n nieuwe speltheorie kan een domein-specifieke benadering stimuleren, waarbij gekeken wordt naar wat en hoe kinderen in een specifieke omgeving exploreren en leren. Een dergelijke benadering geeft inzicht in de specifieke kennis en vaardigheden die kinderen verwerven in deze omgeving, zonder een claim te leggen met betrekking tot de kennis en vaardigheden op terreinen die kinderen misschien nog helemaal niet opgedaan hebben of die in een andere omgeving verkend moeten worden. Dit is in lijn met een recente aanbeveling van Siegler dat er behoefte is aan meer domein-specifieke ontwikkelingstheorieën in plaats van een algemene, en daarmee waarschijnlijk te globale, speltheorie.

De hier gepresenteerde studie is een eerste voorzichtige stap in deze richting. Om een speltheorie gebaseerd op het concept van affordanties te ontwikkelen moet het in deze studie gehanteerde observatie-instrument verder worden uitgewerkt. Meer onderzoek is nodig om te onderzoeken of het observeren van kinderen door de lens van perceptie-actie affordanties, kan bijdragen tot een beter begrip van de wijze waarop exploratie van de ruimte en spelmaterialen evolueert en bijdraagt aan hun ontwikkeling.

Implicaties voor praktijk en beleid

Hoewel het hoofddoel van deze studie eerder theoretisch dan praktisch van aard was, leveren de resultaten ook aanbevelingen voor de praktijk op. De studie laat een duidelijk relatie zien tussen herkenbare activiteitenplekken (tafels, activiteitenhoeken) en intensieve ruimtelijke exploratie, ongeacht de leeftijd van de kinderen. Daarbij moet worden opgemerkt dat de tafels in de onderzochte kinderdagverblijven grotendeels op kindhoogte waren. Dit impliceert dat, als kinderdagverblijven intensieve exploratie willen stimuleren, het belangrijk is dat er specifieke (thematische) activiteitplekken zijn, met geschikte spelmaterialen binnen handbereik van de kinderen, en tafels op kindhoogte in plaats van op volwassenhoogte. De vrije vloerruimte bleek tijdens vrij spel de meest gebruikte ruimtelijke component. Wanneer kinderen op de vloer *speelden*, waren ze bijna de helft van de tijd niet in beweging, maar zaten of stonden ze, en gebruikten spelmateriaal. Dit geeft aan dat de vloer, behalve verkeersruimte, ook een belangrijke speelplek is. In dit onderzoek werd de vloer meestal gebruikt door de jongere kinderen om alleen of naast een ander te spelen. Wellicht omdat de oudere kinderen de opties voor de jongere kinderen om in de activiteitenhoeken te spelen beperkten (die werden bezet door de oudere kinderen), maar het kan ook zijn dat jongere kinderen de vrije vloer liever gebruikten omdat deze meer bewegingsvrijheid biedt en ze hier makkelijker oogcontact kunnen houden met de pedagogische medewerker dan in de, meer afgescheiden, activiteitenplekken. Pedagogisch medewerkers in verticale groepen zouden tijdens vrij spelmomenten extra mogelijkheden kunnen creëren voor solitair spel op de vloer, bijvoorbeeld door met een kleedje en spelmateriaal een tijdelijke speelplek te maken. Complexe manipulatie van spelmateriaal, belangrijk voor de cognitieve ontwikkeling van kinderen, vond vooral plaats aan (lage) tafels. Hoge tafels zijn voor jonge kinderen lastig zelfstandig te gebruiken. Vanuit het oogpunt van ontwikkelingsstimulering zouden kindercentra lage tafels moeten introduceren, met een verscheidenheid aan spelmaterialen op kindhoogte, zodat kinderen zelfstandig deze materialen kunnen pakken en gebruiken.

Uitkomsten van deze studie kunnen ook van belang zijn voor beleidsmakers. Nieuwe wetgeving die bij baby's een lagere kind-beroepskracht ratio vereist (3:1) dan de huidige (4:1), lijkt er in de praktijk toe te gaan leiden dat, om kosten te besparen, het aantal verticale groepen zal groeien ten koste van leeftijds-homogene groepen. Uitkomsten van deze studie suggereren dat aparte groepen voor baby's en peuters beter geschikt zijn om exploratief spel te stimuleren. We vonden dat betrokkenheid bij ruimtelijke exploratie in het algemeen laag was en dat kinderen tijdens vrij spel minder dan de helft van de tijd echt aan het spelen waren. Het feit dat kinderen in verschillende stadia van hun ontwikkeling dezelfde ruimte moesten delen, zou dit deels kunnen verklaren. De noodzaak om uit veiligheidsoverwegingen bepaald spelmateriaal op te bergen waardoor peuters daar niet zelfstandig mee aan de slag kunnen gaan, maar ook

de verschillen in fysieke kenmerken (lengte, beweeglijkheid, kracht) tussen baby's en peuters zorgt voor een onbalans in de manier waarop ruimtelijke elementen kunnen worden gebruikt tijdens vrij spel. Nederlandse pedagogisch medewerkers hanteren vaak het *rust, reinheid en regelmaat* principe, vooral waar het gaat om heel jonge kinderen. Op zich is dit een waardevol, of op zijn minst onschadelijk, principe. Maar als deze regels te strikt gehanteerd worden kan dit resulteren in routines, zoals het proberen om de ruimte permanent opgeruimd te houden. Dit gaat, vaak onbedoeld, ten koste van exploratieve activiteiten van de kinderen, die onderbroken worden of niet kunnen worden voortgezet na een pauze of op de volgende dag. Recent nationaal kinderopvang onderzoek (Landelijke Kwaliteitsmonitor Kinderopvang) laat zien dat medewerkers in babygroepen meer gefocust zijn op zorg en veiligheidsroutines dan op het stimuleren van (spel)activiteiten en interactie. Dit gold nog sterker in verticale groepen.

Het is daarom raadzaam om voorzichtig te zijn met het, bedoeld of onbedoeld, stimuleren van de groei van het aantal verticale groepen. Bovendien zouden beleidsmakers zich bewust moeten worden van wenselijke verbeteringen in de binnenspeelruimte die kinderen van uiteenlopende leeftijden mogelijkheden moeten bieden om te exploreren, te socialiseren en te gedijen. Het is opvallend dat regels rond de hoeveelheid ruimte per kind hetzelfde zijn voor verticale groepen als voor homogene groepen, terwijl baby's duidelijk andere behoeften hebben dan peuters. Kijkend naar de uitkomsten van deze studie, is het opmerkelijk dat beroepskracht-kind ratio's heel precies zijn afgestemd op de leeftijd van kinderen, terwijl basale, aan leeftijd aangepaste, vereisten rond het indelen en inrichten van de speelruimte in wettelijke kwaliteitskaders ontbreken. Verticale groepen zouden verschillende plekken moeten hebben die geschikt zijn voor ofwel baby's ofwel peuters, maar dat vraagt om een groter oppervlak dan de wettelijke minimumeis, die geen onderscheid maakt naar leeftijden. Om kinderen in staat te stellen een variatie aan mogelijkheden te exploreren, met drukke, rustige, rommelige en fysieke activiteiten, zonder daarbij andere kinderen te storen of hinderen, heeft een verticale groep meer dan een ruimte nodig. Echter, de meeste groepen in Nederlandse kinderopvang beschikken maar over één eigen binnenspeelruimte. Een interessant voorbeeld van hoe het ook kan zagen we bij een van de centra in dit onderzoek. De onderzochte groep had een rustige speelruimte, die vooral gebruikt werd door de jongste kinderen, maar waar ook oudere kinderen rustig konden spelen. Daarnaast lag een kleinere ruimte, speciaal bestemd voor de driejarigen die er zelfstandig konden spelen. Een aangrenzende grote speelruimte, gedeeld met de naastgelegen groep, werd vooral door de oudere kinderen gebruikt voor knutsel- en 'drukke' beweegactiviteiten, maar ook om samen met de buren te eten. Dit voorbeeld van een zogenaamde open-deuren-aanpak laat zien dat het standaardmodel van één ruimte waar kinderen het grootste deel van de dag verblijven (behalve tijdens buitenspel of eventueel spel in een speelhal) heroverwogen zou moeten worden. Door vanuit het perspectief van exploratie te kijken naar gedrag van kinderen, kan onderzocht

worden hoe een indeling van ruimten en plekken kan worden gerealiseerd die de verschillende behoeften en mogelijkheden van kinderen van verschillende leeftijden ondersteunt. Kindercentra met verticale groepen zouden op basis hiervan een helder beleid rond de fysieke ruimte kunnen ontwikkelen en dit opnemen in hun pedagogisch plan. In samenwerking met pedagogen en ontwerpers kan dan een omgeving gecreëerd worden die geschikt is voor kinderen van verschillende leeftijden en die de ontwikkeling van *alle k*inderen stimuleert.

Toekomstig onderzoek

Deze studie onder verticale groepen rapporteert verschillende uitkomsten voor de jongere en de oudere kinderen, die kunnen samenhangen met de specifieke groepssamenstelling. Vergelijkbaar onderzoek is nodig naar horizontale groepen, om te onderzoeken of een meer homogene groepssamenstelling bijvoorbeeld leidt tot meer intensieve exploratie of tot andere affordanties die gebruikt worden.

Veel gebruikte kwaliteitsinstrumenten zoals de ITERS-R en de ECERS-R hebben weliswaar een subschaal die de kwaliteit van de binnenruimte beoordeelt, maar de uitkomsten van de reviewstudie (Hoofdstuk 2), suggereren dat veel items in deze schaal niet gebaseerd zijn op onderzoek in de praktijk. Bovendien worden in deze schaal uiteenlopende onderwerpen zoals verlichting, geluid, hygiëne en vierkante meters beoordeeld en samengevoegd in een eindoordeel, waardoor het lastig is om te bepalen welke specifieke elementen van invloed zijn op gedrag en ontwikkeling van kinderen. In dit onderzoek vonden we bovendien geen relatie tussen de ITERS-R/ECERS-R scores en diepte of breedte van exploratie. Er is behoefte aan de ontwikkeling van een instrument dat onderscheid maakt tussen zaken die van belang zijn vanwege bijvoorbeeld gezondheid, zoals ventilatie en hygiëne, en ruimtelijke kenmerken die samenhangen met de sociale en cognitieve ontwikkeling van kinderen. Daarvoor is grondig, theoretisch onderbouwd onderzoek nodig naar dit nog weinig onderzochte aspect van de kwaliteit van de kinderopvang.

Conclusie

De belangrijkste conclusie van dit proefschrift is dat exploratief en sociaal gedrag van kinderen gerelateerd is aan de ruimtelijke componenten van de binnenspeelruimte van kinderdagverblijven. Het gebruik van een observatie-instrument, gebaseerd op het concept van affordanties, heeft geleid tot nieuwe inzichten in de manier waarop kinderen ruimtelijke componenten gebruiken tijdens vrij spel. Deze inzichten kunnen richting geven aan beleid en praktijk. De resultaten die in dit proefschrift worden gerapporteerd maken duidelijk dat de ruimtelijke omgeving van kinderdagverblijven een meer prominente plaats verdient, niet alleen in toekomstig onderzoek naar gedrag en ontwikkeling van kinderen, maar ook in regelgeving en toezicht die de kwaliteit van de kinderopvang moeten waarborgen.

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About the author

Curriculum Vitae

Ine van Liempd was born on September 16 1953 in Liempde. She obtained her secondary school degree from the Jacob-Roelandslyceum in Boxtel in 1972. In 1976 she obtained her bachelor's degree in History at Utrecht University. After completing her bachelor degree she worked and volunteered in various positions in politics and childcare. In 1988 she obtained her master's degree in Ancient History, with a minor in Environmental Psychology. Since 1988 she is a partner in AKTA, research and consultancy firm for use of space. She wrote several books and articles on how to design and furnish buildings and outdoor play areas for childcare in a way that stimulates and fosters children's development and well-being. She was also involved in developing and teaching courses for pedagogues and caregivers, in consulting on building projects and in doing research. In 2013 she started as an external PhD student, first at the University of Amsterdam and since 2015 at the department of Social and Behavioral sciences at Utrecht University.