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A Playscapes Perspective

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Design Strategies for Promoting Young Children's Physical Activity: *A Playscapes Perspective*

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This paper develops a set of design strategies for promoting young children's physical activity. These strategies are developed by taking the design perspective of Playscapes as a starting point. Playscapes suggests that three play qualities are key in promoting young children's physical activity: *free, bodily*, and *dispersed* play. We present two field studies in a pediatric oncology center, in which we observed how these play qualities were reflected in children's interactions with two Playscape designs: *Stickz*, a collection of branch-shaped objects, were placed in a semi-public waiting area; *Fizzy*, a self-propelled robotic ball, was introduced to patient rooms. Free play was analyzed according to the diversity of play activities, bodily play according to the diversity and exertion level of bodily movements, and dispersed play according to the floor area covered. Based on the findings, we discuss how Fizzy and Stickz contributed to each play quality, and derive a set of design strategies that can be applied in different contexts to stimulate young children's physical activity. With these strategies, Playscapes offers a concrete alternative to existing approaches, supporting designers in directing interactions towards physical activity while leaving room for children's unstructured and spontaneous play.

Keywords – Childhood Cancer, Exergames, Intermediate-Level Knowledge, Open-Ended Play, Pediatric Healthcare, Research through Design.

Relevance to Design Practice – This paper suggests designers to take a Playscapes perspective when designing for young children's physical activity, and presents a set of design strategies that make this perspective actionable.

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Introduction

During early childhood, children develop a set of motor skills that form the basis of their future physical activity, health, and competences (Frost, Wortham, & Reifel, 2012; Maude, 2010). This development is largely dependent on the interactions that children have with their physical environments. Some environments are more likely to elicit physical activity than others and some might stimulate particular kinds of gross motor movements. For example, children are more active in outdoor environments than in indoor environments (Gray et al., 2015; Raustorp et al., 2012). Not only the higher amount of available space explains this difference (Ridgers, Fairclough, & Stratton, 2010), it also depends on what specific opportunities for play are available. For example, the simple presence of a ball can restructure an environment into a playful and activating setting (Csikszentmihalyi & Bennet, 1971). Studies have also shown how natural features, such as grass, shrubs, trees, and cliffs have a stimulating effect on children and invite particular bodily movements (Dyment & Bell, 2008; Fjørtoft, 2004).

The above examples illustrate that characteristics of products and environments affect whether and how children play and move. Furthermore, they make apparent the potential of design to make a valuable contribution; designers can create environments that stimulate young children's physical activity and, ultimately, support them in becoming healthy and physically competent individuals. For this, designers need an accurate understanding of what stimulates young children's physical activity, as well as guidance to design according to this understanding.

Designing for Children's Physical Activity and Play

In the field of interaction design research, several design approaches have been proposed for stimulating children's physical activity and play. Some approaches are more oriented towards games, which involves structured, rule-bound, and goal-directed play, while other approaches are directed at unstructured and spontaneous play.

Much effort in interaction design research is directed at the development of exergames—i.e., games that lead to a certain level of exertion of the player (e.g., Sinclair, Hingston, & Masek, 2007). These games are generally screen-based and occur in a single

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location (with exceptions; e.g., see Landry et al., 2013). Through the use of game elements such as rules, goals, and rewards, designers can create stimulating experiences that activate children. Exergames have received interest in pediatric healthcare, as they can give therapists control over certain parameters, which allows them to challenge patients at the right level of physical performance (e.g., see Janssen et al., 2017). There is a growing body of literature on exergames that offers designers concrete guidance with respect to stimulating physical activity (e.g., see Hernandez, Ye, Graham, Fehlings, & Switzer, 2013; Landry et al., 2013; Sinclair et al., 2007). Other work on games for physical activity and play involves the integration of interactive technologies in traditional play activities or objects. Karoff, Elbæk, and Hansen (2012), for example, integrated sensor technologies in trampolines, and emphasized how physical activity, social interaction and safety affect one another. Soute and colleagues developed the concept of *Head Up Games*, referring to traditional games enhanced with interactive technology while avoiding the use of screens (Soute, Markopoulos, & Magielse, 2010).

While existing research on games provides a valuable resource for promoting children's physical activity, games are mainly applicable to children that are able to play rule-based games or doing structured exercises. This makes exergames and other game-oriented approaches less suitable when designing for young children, in particular below the age of 6. Children below this age find it difficult to follow structured activities, or simply are not yet able to do so. Instead, they tend to be mostly active by engaging in unstructured and spontaneous play, characterized by short bouts of activity (Pellegrini & Smith, 1998). A design approach that takes such unstructured play as its starting point was developed by de Valk, Bekker, and Eggen (2013, 2014, 2015), centered on the concept of *open-ended play*. Their approach supports designers in creating interactive play objects that allow children to make their own rules and set their own goals. While some design cases described by de Valk and colleagues concern children's physical activity, the overall approach is focused on rulemaking in play, thereby giving designers little guidance with respect to stimulating physical activity. A similar focus on open-ended play is present in research by Back and others (e.g., Back et al., 2016; Back, Turmo Vidal, Waern, Paget, & Sallnäs, 2018). Their focus is on enhancing outdoor environments with embedded interactive technologies in order to offer rich and varying play activities to children.

In earlier work we proposed to combine the merits of exergames and open-ended play, and introduced *Playscapes*—a design perspective on young children's physical activity and play (see Boon, Rozendaal, van den Heuvel-Eibrink, van der Net, & Stappers, 2016). On the one hand, Playscapes is similar to exergames in terms of its aim to direct behavior towards physical activity. On the other hand, Playscapes is similar to open-ended play in terms of leaving things open—i.e., it aims to create space for children's self-directed play (also see Boon, Rozendaal, & Stappers, 2018).

Aim of This Paper

The aim of this paper is to generate a set of design strategies for promoting young children's physical activity and play, taking the Playscapes perspective as a starting point. With the term *design strategies* we refer to *ways to achieve a goal*, similar to how others use the term in interaction design research (e.g., Marshall, Dancu, & Mueller, 2016; Sengers & Gaver, 2006). We consider design strategies as a generative form of intermediate-level knowledge (Höök & Löwgren, 2012; Löwgren, 2013). They are *generative* in that they support designers in the creation of new designs and they are *intermediate-level* because they are "more abstracted than particular instances, yet [do] not aspire to the generality of a theory" (Höök & Löwgren, 2012, p. 23).

Intermediate-level knowledge can reside on different levels of abstraction. In Figure 1 we show how the Playscapes perspective resides at relatively high level of abstraction; it offers designers an understanding of what stimulates children's physical activity and suggests three play qualities that are valuable to pursue. Located at the most concrete level of the knowledge spectrum are Fizzy and Stickz, two concrete *instantiations* of Playscapes. Both were designed to elicit the three play qualities in a particular context. The design strategies that we aim to generate in this paper are intended to reside on an abstraction level in between Playscapes and its instantiations. Where Playscapes proposes

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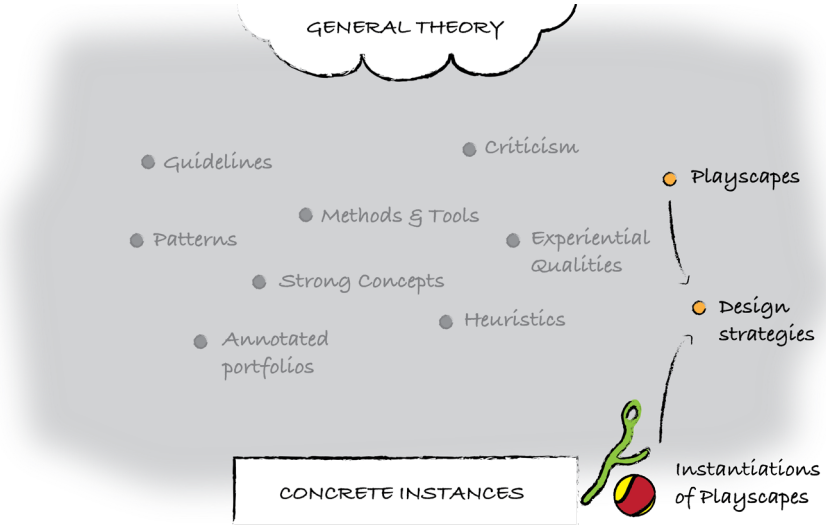

Figure 1. Taking Playscapes and its instantiations as the starting point, this paper develops design strategies that are concrete enough to be actionable for designers and generic enough to be used in different ways and in different contexts.
Figure adapted from Höök & Löwgren (2012).

generic qualities for designers to pursue, the design strategies can serve as concrete ways to achieve these qualities. Compared to Fizzy and Stickz, the design strategies will be at a higher level of abstraction, being generic enough to be used in different ways and in different contexts.

In related work, comparable forms of intermediate-level knowledge have been generated, although not necessarily described in such terms. Concepts such as *open-ended play* (de Valk et al., 2013) and *Head Up Games* (Soute et al., 2010) are contributions on a similar level of abstraction as Playscapes. These concepts form a broader framing that is supplemented with more concrete forms of intermediate-level knowledge, such as design tools, guidelines, implications, and interaction styles. As we already pointed out above, Playscapes is different from these related works, and we expect that the design strategies that we develop here will form a novel contribution. Some overlap may occur with work on open-ended play, since one of the play qualities of Playscapes, *free play*, is closely related to this concept. We return to this point in the *General Discussion* section.

Playscapes as a Design Perspective

As Playscapes and its instantiations form our starting point for developing design strategies, we now introduce these concepts in detail. The Playscapes perspective is centered on young children (2-6 years old), who generally engage in physical activity in the form of unstructured and spontaneous play. Playscapes directs designers towards the design of playthings and environments that create space for such physical activity and play. It builds on the view that children perceive their environments as landscapes full of possibilities for play—i.e., *playscapes* (Fjørtoft, 2004; Talbot & Frost, 1990). In a Gibsonian frame (Gibson, 1979; Heft, 1988), the perspective views playthings and environments as offering various *affordances*. During play, children learn to perceive and realize many of these affordances and through this process they develop their abilities and skills (see Gibson & Pick, 2000; Flôres, Rodrigues, Copetti, Lopes, & Cordovil, 2019).

The underlying motivation of Playscapes is to enable designers to contribute to children's physical development. Children's physical development is a dynamic process in which the child's motivation, physical competence and interaction with the environment play an important role (see Whitehead, 2010). An important question is how we can optimize children's environments to facilitate or enhance interactions that stimulate children's physical activity and foster children's physical development. Playscapes draws inspiration from outdoor environments to address this question. Children tend to be most active when playing outdoors and studies indicate that environments with natural elements are particularly activating. The physical activity and play that occurs in these environments contributes to children's physical development (Frost et al., 2012; Maude, 2010), and particular features of the physical environment can play an important role in this (Fjørtoft, 2004). By drawing on literature about outdoor play and so-called *natural playscapes*, we identified three play qualities that characterize children's physical activity in outdoor environments: *free*, *bodily*, and *dispersed play* (see Boon et al., 2016). Playscapes proposes that stimulating young children's physical activity is a matter of creating opportunities for these play qualities to emerge in children's interactions with their environment. Below we describe each play quality in detail, followed by a description of Fizzy and Stickz and their intended way to promote the play qualities.

Free Play

Free play is play that is unstructured, spontaneous and self-directed. It can be distinguished from more structured forms of playing, such as games and sports. Free play is the predominant form in which

young children engage in physical activity (Pellegrini & Smith, 1998). In free play, children improvise and use their imagination, resulting in a variety of play activities over time. Structure might arise temporarily, for example through rule-making or creating a leading narrative; but often new ideas or spontaneous actions will break down the structure and lead into a different play direction (e.g., see de Valk, 2015). Free play may involve the supervision or participation of parents or other caregivers, as long as they do not insist on predetermined intentions or rules (e.g., going to the beach to fly a kite). Furthermore, for safety and other reasons, caregivers will often set certain boundaries to free play (e.g., telling children not to cross the street).

How can designers create space for free play to emerge? In earlier work we suggested several general directions based on literature (Boon et al. 2016): Designers can leave things open for interpretation, leave room for multiple courses of action, make things unstable or erratic, provide many variables, allow things to be manipulated or rearranged, and avoid pre-defined goals and rules. The above suggestions all point towards the importance of creating a level of *openness* for children to self-direct their actions and to attach their own meaning to the playthings and situations.

Bodily Play

Bodily play is play that involves the full body, making use of the large muscles—i.e., the muscles that are required for gross motor movements. Bodily play does not only refer to the level of exertion (i.e., energy use) of bodily movements, but also to the diversity of movements. Bodily movements may occur as a play activity in itself (e.g., kicking a ball for the sake of kicking a ball) or in the form of operations that are part of a play activity (e.g., kicking a ball in in a game of soccer). While free play refers to the general form in which physical activity takes place, bodily play refers to the particular bodily movements that are involved.

Bodily play depends on the affordances in an environment in a very direct way; for example, climbing is only possible if there is a climb-able feature available to the child. Along these lines, designers can think of surfaces that are *run-on-able*, objects that are *lift-able*, or obstacles that are *jump-over-able* (see Heft, 1988). These affordances affect what parts of the body are likely to be used. Furthermore, these affordances can be shaped according to the level of exertion that is desirable. For example, making *lift-able* objects heavier or bulkier will require increased exertion of the child. Maude (2010) describes various movement categories, such as balance, locomotion, flight, manipulation, and projection, which can help as an orientation for designers to integrate a diversity of affordances for bodily play in their designs.

Dispersed Play

We define dispersed play as play that spans a wide area, potentially moving beyond the boundaries of a dedicated play area or other demarcated space. This quality increases children's radius of action, thereby allowing children to have exploratory experiences and to expand their play narratives (e.g., Kuh, Ponte, & Chau, 2013). Dispersion can work on different levels. Play may be more locally dispersed, for example, by occurring throughout a playground or schoolyard, as observed in Kuh et al.'s study. It might also span a wider area, covering multiple places or spaces.

Designing for dispersed play requires an understanding of interaction on a spatial level. It implies that there should be at least some ground surface available for play; designing for dispersed play on the couch or behind a stationary screen does not make much sense. In order to stimulate dispersion in play, children should be able to identify goals or affordances that require them to cover a distance. In earlier work we suggested *loose parts* (Nicholson, 1971) as a concept that is relevant for this purpose. Loose parts can be moved, manipulated, controlled, and changed in play (Daly & Beloglovsky, 2015), and they typically invite collecting and transporting over a wide area (Kuh et al., 2013). Another way to support dispersed play is to think of destinations to go to and pathways to follow across a landscape (e.g., Keeler, 2008).

Fizzy and Stickz: *Two Instantiations of Playscapes*

Playscapes, and the three play qualities that it puts forward, can be applied in various contexts. In this section we describe two instantiations of Playscapes, both of which were designed specifically for young children with cancer during periods of hospitalization. Children with cancer show very low levels of physical activity, in particular during hospitalization, which potentially hampers their physical development (Stam, Grootenhuis, & Last, 2005; Winter et al., 2009). Patients often have to pay long or frequent visits to the hospital. In response to children's low levels of physical activity in such settings, exercise programs are a common intervention. However, young children have difficulties to adhere to the rules and structure of such programs. Creating opportunities for more spontaneous forms of physical activity in the hospital can thus make a valuable contribution. Fizzy and Stickz were specifically designed for this purpose.

Fizzy (Figure 2) is a pro-active self-propelled ball designed to trigger young children in the patient room to engage with it and play in a physical way. Fizzy was designed to be *cheeky*, *playful*, and to have a *mind of its own*. This character is reflected in the behavioral repertoire that is designed into it, consisting of: i) wiggling to draw attention, ii) rolling away when being approached, iii) shaking wildly when getting stuck or being picked up, and iv) purring when it is caressed. Fizzy's embodiment, consisting of a robust and soft outer shell, allows for rough and physical play, just like any other ordinary ball.

Stickz (Figure 3) are large and soft, yet sturdy, branch-shaped objects, inspired by the sticks that children may find in a park or forest. Stickz were designed to enable children to engage in imaginative and constructive play, while inviting the use of the full body. Stickz achieve this by their ambiguous shape and the possibility to use them for construction purposes, in combination with their sheer size and weight.

Fizzy and Stickz were designed to elicit free, bodily and dispersed play in distinct ways. Fizzy aims to achieve free play by having no prescribed use designed into it. It is an interactive

and, to some extent, unpredictable agent with which children can improvise. Furthermore, its behavior can be interpreted in multiple ways. Stickz are designed for free play by allowing for multiple interpretations of their shape, and the making of various constructions. Bodily play with Fizzy is expected to occur mainly in following behavior (i.e., locomotion) and playing with Fizzy as a ball, involving throwing, kicking, and rolling. Stickz invite bodily play by their size and weight, requiring full body movements in order to play. For dispersed play, Fizzy rolls away from the child, hoping to invite the child to follow and play throughout the room and beyond. Stickz is intended to stimulate dispersed play by offering a set of loose parts that invite children to transport and collect, thereby covering a large area.

Approach

Having described Playscapes and the three play qualities together with two concept designs that instantiate the design perspective, we now turn to our approach for generating design strategies. The work that we present in this paper was part of a larger PhD project (Boon, 2020). In this project, design activities and prototypes played a central role in the generation of knowledge. This approach, commonly referred to as *research through design,* can take many forms (Stappers & Giaccardi 2017; Boon et al., 2020). The particular approach in this PhD project revolved around design activities on two levels. At one level, design activities were centered on the development of Playscapes, which served as a frame or foundation to structure the overall research (see Stappers, Keller, & Sleeswijk Visser, 2015). At another level, design activities were centered on the design of playthings and their implementation in real world settings. The design activities on these two different levels informed one another throughout the PhD trajectory. This process bears similarity to that of programmatic design research, in which a *design research program* is articulated, which is then substantiated or challenged through various *design experiments* (see Binder & Redström, 2006; Brandt, Redström, Eriksen, & Binder, 2011).

In this paper, we report on two field studies in which children's interactions with prototypes of Fizzy and Stickz were observed in real-world hospital settings. We used video recordings to analyze how the interactions reflected the qualities of free, bodily, and dispersed play and then identified how Fizzy and Stickz contributed to each quality. Based on these insights, we articulated a set of design strategies. The design strategies thus capture *what works well* in Fizzy and Stickz. In the subsections below we outline the details of our fieldwork and analysis.

Figure 2. Fizzy stimulates physical activity and play through its behavioral repertoire (e.g., rolling away or shaking) **and simply by being a ball.** Photos are used with permission from parents.

Figure 3. Stickz stimulate physical activity and play by inviting children to drag them around, make constructions, and use their imagination. Photos are used with permission from parents.

Prototypes and Setting

Prototypes of Fizzy and Stickz were implemented in the Princess Máxima Center for Pediatric Oncology in Utrecht, the Netherlands. Fizzy was tested in single and double bed patient rooms in an inpatient ward. Using a Wizard of Oz approach, the researcher controlled Fizzy's behavior without participants being aware of it (see Figure 4). The researcher in the field acted as a puppeteer, controlling Fizzy's behavior to reflect its key behaviors (see the description of Fizzy above). With this behavioral repertoire the researcher improvised according to the situation and in some cases decided to act divergently (e.g., rolling towards the child instead of only away). This improvisation allowed us to explore a wide range of ways in which to stimulate physical activity and play. The prototype consisted of a Sphero 2.0, a shell with an outer diameter of approximately 14 cm, and an Arduino-based Bluetooth controller that could connect to the Sphero. The shell was made out of soft polyethylene foam covered with sturdy artificial leather. These materials were chosen for safety and hygiene reasons, but also made the prototype robust enough to be throw-able, kick-able, etc. The Bluetooth controller included a joystick for directing Fizzy's rolling behavior and a three-button controller for purring, wiggling, and shaking behaviors.

Stickz were tested in a semi-public waiting area of an outpatient department of the PMC. More than 20 Stickz were present in the waiting area at all times, with lengths ranging from 50 to 160 cm. Each Stick had a unique shape while adhering to a single form language. The prototypes consisted of welded aluminum pipe frames covered in insulation foam, and a finish of colored duct tape. As in the case of Fizzy, this finishing afforded rough play, as well as meeting safety and hygiene requirements of the medical center.

Participants and Recruitment

All participating families received an information letter and informed consent form and were approached with help from the hospital staff. The study was designed together with oncologists, research nurses and legal staff to ensure the participants' safety and privacy. The Medical Research Ethics Committee of the University Medical Center Utrecht reviewed and approved the research proposal (METC protocol number 16-658/C).

The majority of children that participated in the fieldwork suffered from childhood cancer, mostly involving non-CNS solid tumors (i.e., tumors not affecting the central nervous system) and leukemia. With Fizzy we visited 8 inpatients between the age of 3 and 6 years old, including 5 boys and 3 girls. With Stickz we included 21 children (12 boys and 9 girls), including inpatients, outpatients and 4 siblings between the age of 2 and 8 years old. Most of the participants with Fizzy were connected to an IV pole (7 out of 8), whereas with Stickz this was more variable (7 out of 21 had an IV pole at some point of their visit). Although the fieldwork with Stickz was performed at a later stage than the sessions with Fizzy, 3 patients participated in both studies. Two patients were excluded for parts of our analysis. One was excluded from the dispersed and bodily play analysis, as he was not mobile at the time of the visit. Another child did not engage in any play at all, and is therefore only described as part of our general findings, but excluded from the free, bodily, and dispersed play analysis.

Data Collection, Processing, and Coding

Data was collected using GoPro cameras and audio recorders. The GoPro cameras offered a wide angle, which was useful in capturing the interactions in small patient room settings. Furthermore, their size minimized obtrusion. High quality audio recorders were used to capture the verbal expressions of children and others during play. Audio and video data were combined and synchronized into single video files. We then anonymized the data, using a *find edges* filter in Adobe Premiere (see Figure 5) and muting parts of the audio that contained personal data such as names.

The video material was coded and analyzed using Atlas.ti (see Figure 5). The coding was performed mainly by the lead researcher, and consisted of four steps. The first step laid the basis for the other steps: the researcher made *quotations* that indicated distinct activities with a particular timeframe. The end of one activity indicated the start of another. The start and end of a quotation was determined by a shift in the goal of the child (e.g., from trying to catch Fizzy to taking a sip of water). All activities of children were coded, including non-play activities such as eating or talking with parents. A research assistant independently made quotations in selected parts of the data, in order to check for consistency with the lead researcher (i.e., inter-coder agreement; Robson, 2002). The time frames of the quotations were largely aligned, with only minor inconsistencies. This provided a reliable basis for the subsequent coding steps.

Figure 4. During the fieldwork, Fizzy was controlled with a joystick and buttons that were concealed in the hands and by standing with the arms crossed or behind the back.

The second step consisted of coding the quotations with *activity codes* (see blue codes in Figure 5). These codes indicated the type of activity that children were engaged in within the timeframe of a quotation. We used *open coding* (Robson, 2002), yielding initial categories of children's activities and categorizing these further in later stages of the coding. We coded one activity code per quotation. Atlas.ti made navigating between ongoing and previous coding relatively easy, which allowed us to adjust codes for consistency. The resulting activity codes were grouped into larger categories, called *play activities*, while also identifying non-play activities to be left out for subsequent steps. The identified play activities were then clustered again into *play types.* The lead researcher performed the clustering by using printouts of the quotations. Through peer support (Robson, 2002) of two other researchers, final decisions were made about categories and labels. We analyzed free play by looking at the diversity of play types and their relative occurrence.

The third step was coding for bodily play (see green codes in Figure 5). We created a coding scheme that indicates which parts of the body are being used, with a basic indication of the level of exertion (see Figure 6). *Axial* (A) refers to movements or postures that require the use of *axial* muscles that keep the body upright (in particular trunk and neck muscles). Examples are sitting, standing, or any kind of locomotion. We use *upper* (U) and *lower* (L) to refer to movements that make use of the upper or lower extremities (i.e., arms and legs respectively). Examples are holding or carrying a light or small object within the body's support surface (U), walking (L), or crawling (U, L). We use the *plus* symbol (U+ or L+) to indicate movements with a relatively high exertion. Examples are carrying large or heavy objects outside the body's support surface or throwing an object (U+), and jumping, running or kicking an object (L+). A quotation may be coded with a variety of these codes (see Figure 5). Per play activity, each bodily movement was scored, leading up to a percentage that indicates the average occurrence of a bodily movement per play activity in a (given) time frame. For example, if *Activity A* occurred five times, and in three out of these five occurrences children used their arms, the U score would be 3/5 = 60%. A human movement scientist was involved in creating the coding scheme, as well as in the early stages of coding in order to ensure accuracy and thereby reliability.

The fourth step consisted of coding for dispersed play (see yellow codes in Figure 5), for which we used a coding scheme that reflects the floor area of the room used during a play activity, and whether the activity moved outside of the room (see Figure 7). Activities were coded either as occurring in one place (D0), occupying up to a quarter of the room (D1), half of the room (D2), or the entire room (D3). Each play activity was given a dispersion score between 0 and 3, which was the average dispersion of the occurrences of that play activity in a (given) time frame. For example, if *Activity B* occurred three times, of which one occupied quarter of the room (D1), and two occupied the entire room (D3), the dispersion score for this play activity was (1 + 3 + 3)/3 = 2,33. Activities that moved beyond the room (e.g., into the hallway) were coded and analyzed separately, using the code DX.

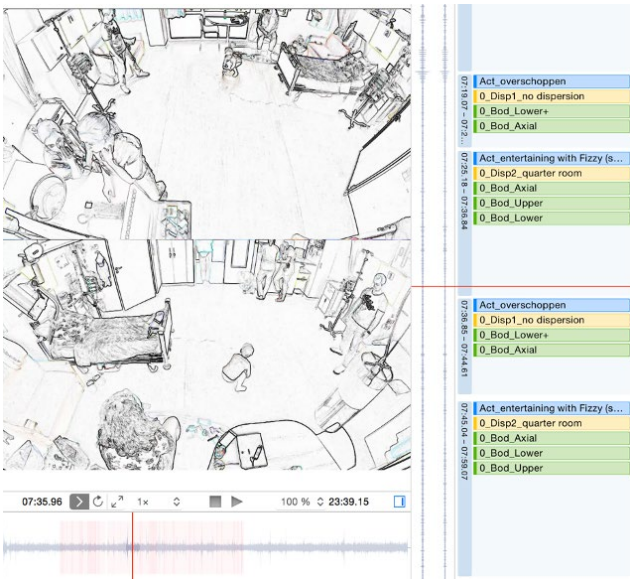

Figure 5. Video data of GoPro cameras was combined and anonymized. The resulting material was analyzed and coded in Atlas.ti, using quotations (horizontal blue bars with time indication) to indicate an activity and coding these with activity codes (in blue), dispersion codes (in yellow) and bodily movement codes (in green).

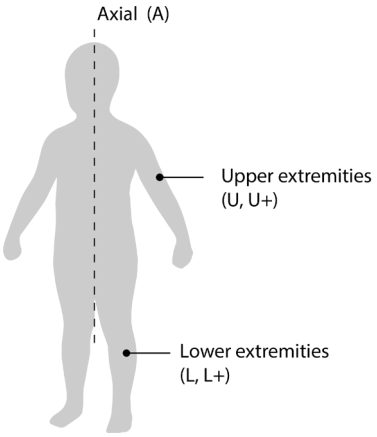

Figure 6. Bodily play was coded according to the use of axial muscles (A)**, arm muscles** (U, U+)**, or leg muscles** (L, L+)**.**

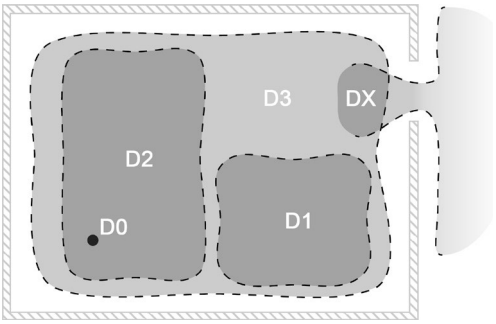

Figure 7. Dispersed play was scored according to the floor area covered in play in a particular room. Codes used for dispersed play ranged from no dispersion to dispersion throughout the room (D0, D1, D2, and D3 respectively) and dispersion beyond the room (DX).

Deriving Design Strategies

Based on the findings of our observations, we then identified how Fizzy and Stickz contributed to each of the play qualities. To do this accurately, parts of the video data were revisited and discussed among three of the researchers. The contributory roles of Fizzy and Stickz were then translated into design strategies. Each strategy was derived from only one of the designs. The following abstracted example illustrates the steps for deriving design strategies for free play based on our fieldwork with Fizzy: Based on our observations, interactions with Fizzy reflected free play in several ways: A, B and C. By returning to the data, particular characteristics of Fizzy were identified that the researchers considered to play a contributory role in these different expressions of free play: X contributed to A, Y contributed to B and Z contributed to C. Based on these insights, design strategies were formulated in sentences such as: *Integrate X in your design, in order to elicit A.*

Results

This section is structured as follows: First general findings are shared, followed by our observations of free, bodily and dispersed play. Each of the subsections presents the results of Fizzy and Stickz respectively, followed by an interim discussion of the contributory role of the designs in the interactions.

General Findings

Interactions with Fizzy gave rise to physical activity in almost a continuous stream of alternating play activities. Whereas we expected this alternation, we did not anticipate continuous engagement. We have a strong impression that Fizzy activated particularly younger participants; older participants (6 y/o) were curious, but not always challenged. Due to the relatively slow acceleration of Fizzy, it could not always get away from the older children. In two cases, children responded with some anxiety to Fizzy's presence. In the first case, the father managed to comfort his son, making his son more confident to interact and play with Fizzy, whereas in the second case a boy kept holding back while observing how another participant played for almost a full hour.

The interactions with Stickz were characterized by short bouts of physical activity and play, alternated with periods of more passive activities. The extent to which children engaged with Stickz in an active way differed strongly per child. Some children expressed enthusiasm and started playing with Stickz right away, whereas others scarcely engaged with Stickz although entering the room multiple times. There were short and long periods in which children did not play at all. Children were often occupied talking to parents or caregivers, or engaged in other activities like eating and drinking. Younger children were the least engaged with Stickz; for them, Stickz appeared quite challenging to handle due to their instability and size. We also observed that some patients withdrew from play or held back when another child (e.g., patient or sibling) was playing with Stickz at that moment.

Interactions with Fizzy resulted in a more continuous stream of play activities than interactions with Stickz; in the latter case, play activities alternated more with other activities. An explanation for this is that the sessions with Fizzy were planned, with Fizzy being the main reason for the visit. Contrastingly, Stickz were located in an open and shared space and, in many cases, they were not the primary reason for participants to be present. The waiting area was often an in between stop for families, when moving from one activity (e.g., the taking of blood samples) to another (e.g., a consult with the oncologist).

Free Play

For the interactions with Fizzy, 51 different activity codes were generated. After excluding non-play codes, the remaining activity codes clustered into 28 play activities. Through another step of clustering 11 different play types were identified (Figure 8, left). Total playtime with Fizzy was 3 hours and 2 minutes. All participating children engaged in creature play (7/7), ball play (7/7) and exploration (7/7), and the majority of children in games (4/7), transitory play (6/7), sensory play (6/7), functional play (4/7), and manipulative play (4/7). Fewer children engaged in dramatic play (3/7), sharing (2/7), and rough-and-tumble (1/7).

For the interactions with Stickz, 50 activity codes were generated. After excluding non-play codes, the remaining activity codes were clustered into 17 play activities. Through another step of clustering, 6 different play types were identified (see Figure 8, right). Total playtime with Stickz was 3 hours and 32 minutes. The majority of participating children engaged in constructive play (18/21), landscape play (12/21) and loose play (12/21). Fewer children engaged in dramatic play (7/21), rough-and-tumble (2/21)

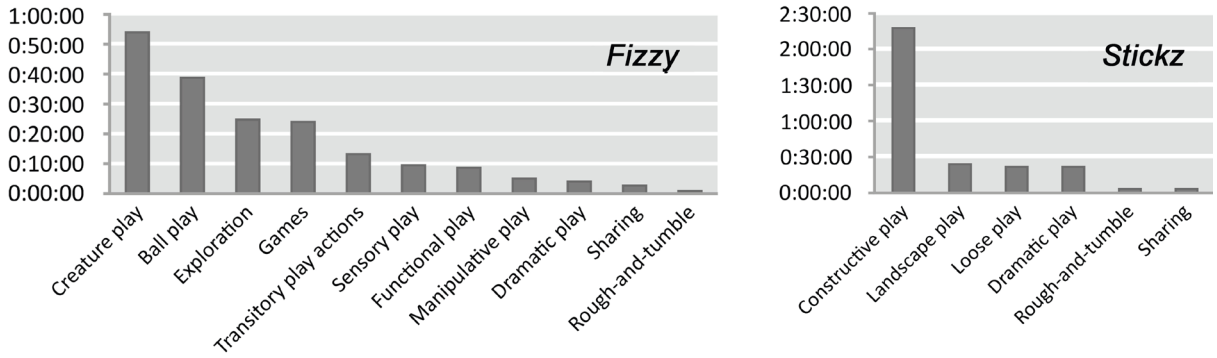

Figure 8. Dominant play types with Fizzy (left) **were creature play and ball play. With Stickz** (right) **children mainly engaged in constructive play.**

and sharing (4/21). For an overview and more detailed descriptions of the play activities and play types per field study, please view Appendix 1 (Fizzy) and 2 (Stickz). In the results below, we only describe play types with a total playtime of 15 minutes or more.

Interactions with Fizzy were predominantly in the form of *creature play* and *ball play*. These two play types occurred in various forms, such as following, luring, and caressing (creature play), and throwing, kicking, and rolling (ball play). *Exploration* occurred mostly during the first encounter with Fizzy; in these early stages, children seemed to be still making sense of what to do with Fizzy and they were exploring its possibilities. *Games* consisted of traditional games, such as tag and hide and seek, as well as newly improvised games, which sometimes emerged from other activities. In these games, Fizzy was either used as tool (e.g., object to hide) or viewed as participating player (e.g., tagger or hider). Whereas children generally tended to alternate quickly between activities (e.g., first kicking Fizzy around and then luring it), games often lasted longer.

Interactions with Stickz occurred largely in the form of *constructive play*, in which Stickz were used as building elements. Constructive play consisted of constructing, deconstructing, maintaining, manipulating, and stacking. Most play time went into constructing, which was either done for the sake of constructing itself or with a particular goal in mind (e.g., building a hut or an apple tree). Constructing was a relatively long-term activity, whereas deconstructing and manipulating were often short-lived. Other play activities occurred relatively less. *Landscape play* consisted of playing in and around piles or structures of Stickz. *Loose play* largely consisted of collecting Stickz and sorting them. Dramatic play consisted of using Stickz as pretend objects, such as a walking stick, giant spider, weapon, or vacuum cleaner.

Fizzy and Stickz enabled free play in distinct ways. Fizzy's ability to play different roles resulted in a wide variety of play activities to emerge. Two particular roles—that of a ball and a creature—opened up two different play directions. Fizzy's embodiment as a ball (including its size, robustness, softness, and spherical shape) contributed to various forms of ball play, including rolling, throwing, and kicking. In creature play, Fizzy's pro-active mobility led to various play activities, such as following it, catching it, playing hide and seek; it also allowed Fizzy to escape or break out of ongoing activities, creating the possibility for a new activity to start. Furthermore, Fizzy's behavior was interpreted in different ways; this ambiguity led to variety in responses, which in turn led play narratives into different directions.

In the interactions with Stickz, the predominant type of play was constructive play; this inherently open activity allowed children to use their creativity to build what they wanted (e.g., apple tree or hut). On a more general level, Stickz served as loose elements that were rearrange-able, allowing children to collect, sort, and construct. This loose quality, together with the sheer quantity of Stickz available to the child, formed a condition of various play activities (e.g., collecting, constructing, sorting). The shapes of Stickz allowed for multiple interpretations, leading to them being used as pretend objects (e.g., a walking stick, weapon, or giant spider). Finally, Stickz also played various functional roles, such as a stick for poking another person, or for hitting a structure of other Stickz.

Bodily Play

With Fizzy (see Figure 9), most play activities involved the use the axial muscles (trunk and neck). Also the use of the upper extremities was common, except in the case of ball play in the form of kicking. The arms were mainly used for picking up, holding, catching, and projecting Fizzy (i.e., rolling or throwing). The use of the lower extremities varied significantly between activities. The activities of balancing and caring did not involve the use of legs at all, and also experimenting, fiddling, manipulating, rolling, sensing, sharing, and throwing involved little use of the legs. Activities of collecting, following, traditional games and kicking did involve the lower extremities to a large extent, in particular in the form of locomotion and kicking. High exertion in the upper and lower extremities mainly occurred in the form of projecting Fizzy (i.e., kicking and throwing), and occasionally running.

When playing with Stickz, children were almost constantly using their full body. All play activities involved axial, upper and lower muscles in at least 80% of the occurrences (see Figure 10). In particular *playing in and around* and *transporting* stand out in this respect. The first mainly involved walking around and crawling underneath built structures; the second involved the dragging or carrying of Stickz. Axial muscles were mainly used in a standing or walking position, and sometimes while sitting or crawling

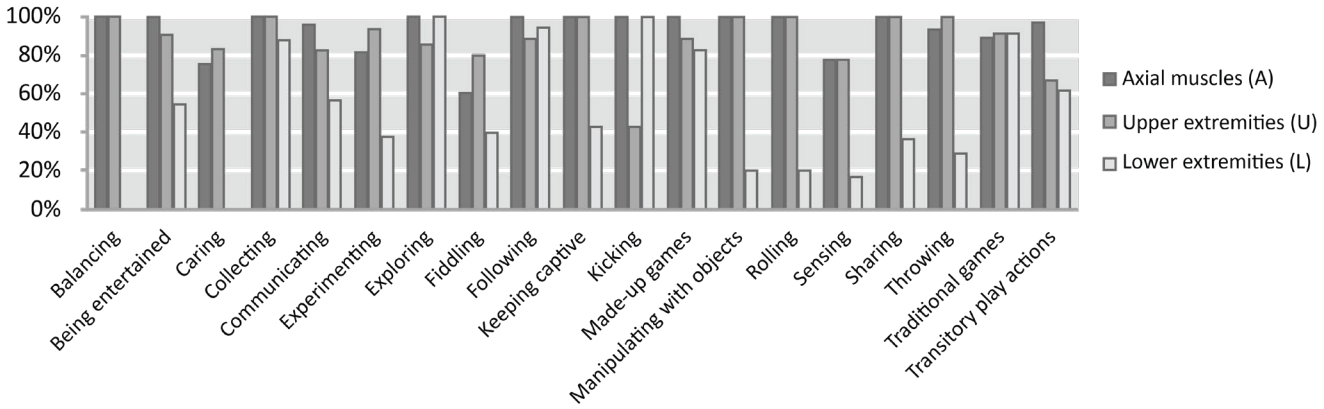

Figure 9. With Fizzy, children used their axial muscles (A) **and upper extremities** (U) f**requently, while using their lower extremities** (L) **more variably.**

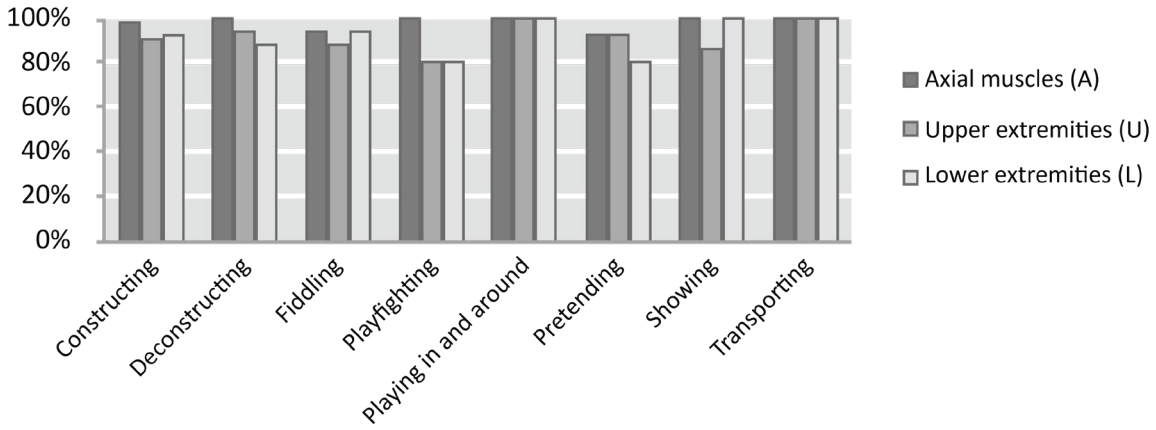

Figure 10. With Stickz, children frequently used their full body;
axial muscles (A) and upper- and lower extremities (U, L) were all used in at least 80% of the occurrences of each activity.

underneath a structure. The upper extremities were used mostly for picking up, holding, carrying, and placing Stickz, but also in the form of throwing, swinging, and crawling. Lower extremities were mainly used in the form of locomotion, which typically involved walking and sometimes crawling. High exertion of the upper extremities mainly occurred in the form of playfighting (i.e., using a large Stick to poke and swing with); high exertion of the lower extremities occurred sporadically in the form of running.

Fizzy and Stickz stimulated bodily play in the hospital in distinct ways. Fizzy was a single object that invited bodily play through its role as a ball and a creature, and through its interactivity in general. These characteristics invited the use of upper extremities in the majority of activities (e.g., in the form of picking up, holding, carrying, throwing, rolling, crawling, etc.). The use of the lower extremities (e.g., crawling, walking, kicking) was more variable, possibly due the fact that several activities were enjoyable without having to move.

Stickz formed a collection of loose elements, which in many cases were used for construction. Almost every play activity involved the use of axial muscles and the upper and lower extremities. Carrying Stickz around required the use of the full body and was involved in most activities. Another way in which children used their full body, was by playing in and around structures of Stickz. Passive play did not occur, which can be explained by the fact that Stickz are static and bulky, and that they are not engaging for children when sitting or lying down. In both Fizzy and Stickz, high exertion of the upper and lower extremities occurred relatively little. Both the space available, as well as the vitality of the participants, may have played a role in this.

Dispersed Play

In general, children occupied a large area of the patient room when interacting with Fizzy. In Figure 11 we see that activities that tended to be most dispersed were traditional games (i.e., playing tag or hide and seek), exploration (i.e., interactions during first encounter with Fizzy), and following (i.e., seeing where Fizzy would go or chasing and catching Fizzy). In some cases, Fizzy invited the child to leave the room. One boy returned to the hallway several times, throwing Fizzy into the hallway to see if it would return to him when calling it. In most cases, however, Fizzy rolled out of the room itself; this created some excitement, and was often followed by the child bringing Fizzy back to the room. In one case, a child explicitly shut the door so Fizzy couldn't escape anymore. Another reason for leaving the room was the wish to go to a shared area called 'the living room'.

Dispersed play with Stickz occurred mainly in the form of transporting and pretending (see Figure 12). Transporting often happened in short bouts, followed by longer periods of play in the form of constructing. Pretending was particularly dispersed when Stickz were used as play guns. There were several instances in which play moved beyond the waiting area. For example, two children, who were building a tent for a particular nurse, came to the idea to use bed sheets to cover the construction. Together with the nurse, the children left the play area to collect these additional materials. In two other instances, Stickz were brought along into the hallway of the clinic and returned later on. Other reasons to leave the waiting area were to collect parents, for example, in order to show what had been built.

Stickz and Fizzy invited dispersed play in distinct ways. Fizzy proactively invited children to follow throughout the room through its rolling-away behavior. Its maneuverability and small size allowed it to cover almost the entire floor, resulting in play throughout the entire patient room. Also traditional games emerged, such as tag and hide and seek, in which the entire room was used. The ability of the researcher to allow Fizzy to play an intelligent role in these games was crucial for this purpose.

Stickz, on the other hand, had a more passive way of inviting children to move around, and this usually occurred in a relatively short time frame. In the activity of constructing, children tended to first collect Stickz, which often occupied the entire room, and then started constructing, which generally occupied a quarter of the room. Stickz afforded such play by being transportable and connectable. The dispersion of activities depended on the position of the Stickz in relation to the place where the family was seated at that moment. In pretend play, Stickz were sometimes used in a way that involved dispersion; their ability to represent weapons or a vacuum cleaner invited dispersed play narratives. The ability for Stickz to be brought along resulted in some dispersed play beyond the waiting area.

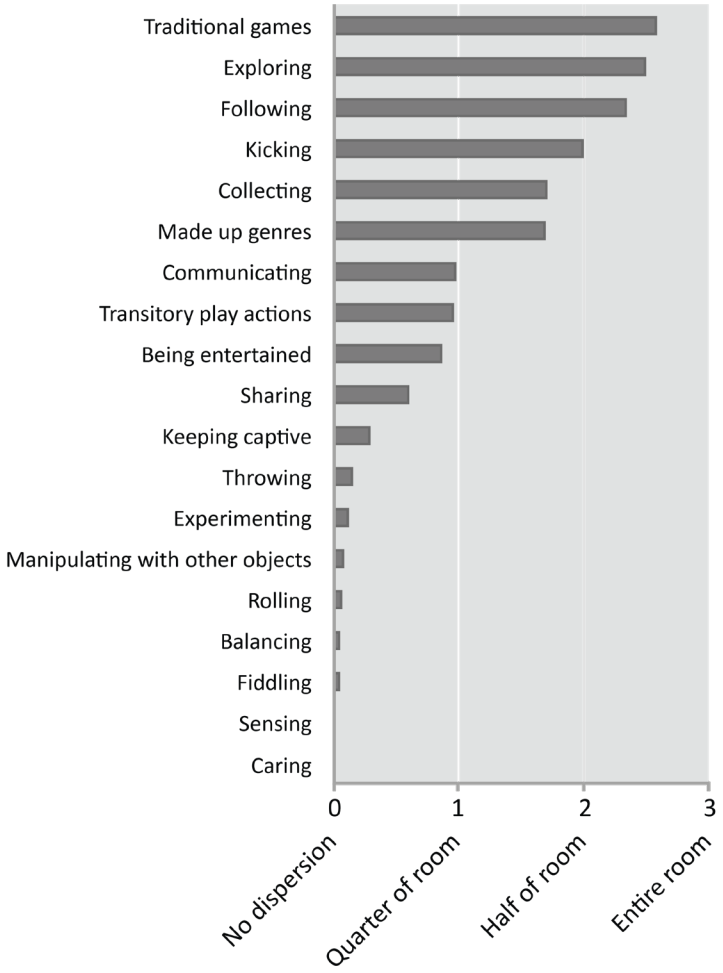

Figure 11. Dispersed play with Fizzy occurred mainly in the form of traditional games, exploring and following Fizzy around. In these activities, children generally occupied more than half of the patient room.

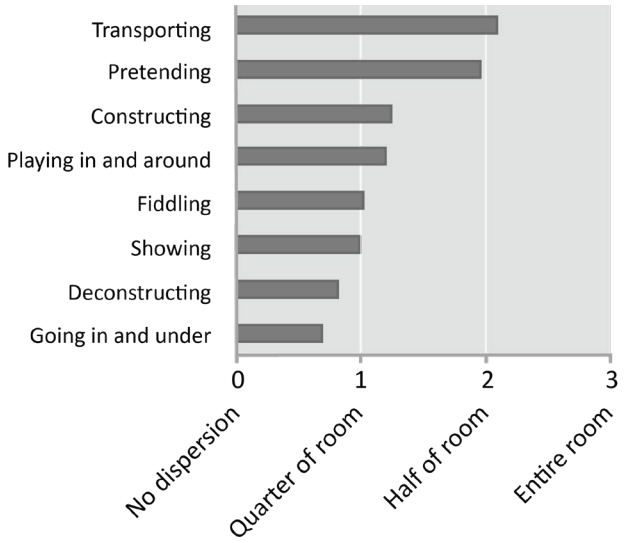

Figure 12. Dispersed play with Stickz occurred mainly in the form of transporting and pretending (i.e., using Stickz as pretend objects). In these activities, children generally occupied around half of the waiting area.

Design Strategies

Our findings and interim discussions show that Fizzy and Stickz contribute to free, bodily, and dispersed play in distinct ways. Based on these insights, Table 1 shows design strategies for each of the three play qualities. The design strategies are illustrated with examples from the fieldwork.

General Discussion

In this paper, we developed a set of design strategies for stimulating young children's physical activity. We did so by taking the Playscapes perspective and two of its instantiations—Fizzy and Stickz—as our starting point. Below we discuss the value of the design strategies, as well how the process of generating design strategies helped advance our general understanding of what it means to take a Playscapes perspective. We then describe several limitations of our work, followed by recommendations for future work.

Use and Value of the Design Strategies

The design strategies in Table 1, derived from the observed interactions with Fizzy & Stickz, can help designers in creating their own solutions for young children's physical activity and play. The strategies describe ways to achieve bodily, dispersed, or free play, which are concrete enough to be actionable, while being generic enough to be implemented in various ways. To illustrate, the strategy *Follow-able agent* can lead to solutions entirely different from Fizzy, for example, when integrated in interactive floor projection systems. Think of an agent that is projected on the floor (e.g., a fish or a simple dot), which moves away from approaching children. Similar to the effect of Fizzy, such an agent may invite children to try and catch it while using their locomotor and coordination skills. Note that the design strategies should not be seen as standalone solutions, but rather as parts of an integral effort to design stimulating playthings or environments. A Playscape design, as illustrated by Fizzy and Stickz, is likely to require multiple design strategies in order to elicit each of the three play qualities.

Table 1. Design strategies for promoting young children's physical activity, organized according to the qualities of free, bodily, and dispersed play.

Play quality	Design strategies	Examples from fieldwork
Free	*Building elements:* Offer a collection of loose elements that are stack-able and / or (dis)connect-able, allowing children to use their creativity in constructive play.	Children that were building with Stickz were making different structures, described, for example, as art, an apple tree, a tent, or a hut.
	Ambiguous shape: Make the shape of a plaything multi-interpretable in terms of purpose or function, allowing children to appropriate them in pretend play.	Children used Stickz as pretend objects, using and describing them as vacuum cleaner, giant spider, water gun or walking stick.
	Hybrid character: Embed intelligence/agency into a familiar plaything, opening up two play directions between which children can alternate.	Fizzy was interpreted as a ball and as a creature, which resulted in two entirely different sets of play activities.
	Ambiguous behavior: When developing a smart plaything, program its behavior to be multi-interpretable, allowing children to project different intentions or expressions onto it.	Fizzy's behaviors were interpreted in different ways. For example, rolling away was interpreted as wanting to be followed or trying to escape.
	Pro-active and unpredictable behavior: When designing a smart plaything, make it pro-active and unpredictable, thereby eliciting children's improvisation.	With Fizzy, children often had to improvise, for example, when it suddenly moved towards them or away from them.
Bodily	*Project-able embodiment:* Make it possible for a child to throw, kick, or roll a plaything, through its shape, robustness, and soft embodiment.	Fizzy's spherical shape and robust and soft embodiment invited ball play; it was rolled, thrown, and kicked.
	Large and heavy elements: Offer a collection of loose elements that are relatively large and/or heavy, so that play activities (e.g., collecting, constructing, play fighting) require use of the full body.	Most Stickz were large and relatively heavy, requiring children to use their full body when transporting them and when building constructions.
	Large obstacles: Offer large (stable) elements that can be stepped on, off or over, jumped on, off or over, crawled under, balanced on, walked around, etc.	As Stickz were lying around and were turned into constructions, this formed a landscape full of obstacles to move through (in, under, around, over).
	Follow-able agent: Make a plaything ambulatory and move away from children, thereby inviting different forms of locomotion (also see Dispersed).	Fizzy rolled away when it was approached, inviting children to crawl, shuffle, walk, or run after it.
Dispersed	*Multiple loose elements:* Offer a relatively large collection of loose elements that can be transported from one place to another.	Stickz were spread across the floor through play and gathered again when children started building something.
	Dispersed traditional games: Consider how a plaything can play a role in traditional games that are dispersed.	With Fizzy, children started playing hide and seek and tag, which occupied the entire patient room.
	Dispersed pretend play: Consider how a plaything can serve as pretend object that invites dispersed play narratives.	Stickz allowed children to use them as play guns, which involved running around the room and hiding behind different objects.
	Follow-able agent: Make your plaything ambulatory and able to navigate, inviting children to follow it throughout or beyond a particular room (also see Bodily).	Fizzy invited children to follow it throughout the patient room and sometimes into the hallway.

We suggest the design strategies provide a valuable contribution to the area of designing for children's physical activity and play. The strategies are attuned to young children's natural way of engaging in physical activity in an unstructured and spontaneous way. In this way, this paper offers concrete alternatives to the strategies and tools provided in scholarly work on exergames, which is more oriented towards children that are capable of playing according to a set of rules. As anticipated, the design strategies for free play show some overlap with work on open-ended play. For example, the quality of adaptability (Back et al., 2016) plays an important role in rearranging of and constructing with Stickz, perhaps best captured in the strategy *Building elements*. The strategies of *Ambiguous shape* and *Ambiguous behavior* can be seen as concrete means to *embrace a level of ambiguity* when designing for open-ended play (de Valk et al., 2014).

Taking a Playscapes Perspective

Besides the concrete findings and strategies that we generated in this work we also advanced our general understanding of what it means to take a Playscapes perspective. First, we experienced that the perspective is applicable in multi-purpose environments. Our design cases were situated in patient rooms and a waiting area in the hospital. We found that such environments can serve as *landscapes for play* while fulfilling other purposes as well, such as resting, receiving medical care, or having a meal.

Second, designing from a Playscapes perspective requires taking into account the social dynamics of play. The different actors around the child can have important roles in children's physical activity and play. Parents, in particular, were continuously present during the observations and were involved in various ways. Some played along, whereas others instructed or educated the child. In the case of Fizzy, parents often actively interpreted and narrated Fizzy's behavior, thereby directing the child's play. In earlier work, we give a more detailed account of the social dynamics of interactions with Fizzy, in which children's and parents' framing of Fizzy continuously shifted over time (Rozendaal, Boon, & Kaptelinin, 2019).

Finally, a *landscape for play* consists of more than just the elements introduced by the designer; there are various *situational affordances* that may play an important role as well. In our observations, the physical setting often enriched children's play. Examples are using bed sheets to make a tent with Stickz, or placing Fizzy on the bed while it is shaking, making it bounce. This *meshing* of affordances (Glenberg & Kaschak, 2002) offers a unique contribution to children's play and can be anticipated and integrated in the design process.

Limitations

There were several constraints to our research approach in terms of scope and validity. The first is that our findings and design strategies derive from two particular designs in two specific environments. Some of our findings might have depended on particular characteristics of the designs or environments that are not brought to the surface in this paper. This also means that the overview of strategies in Table 1 is not exhaustive. A broader range of design examples will allow us to formulate additional strategies, to eventually to reach a point of saturation. In our ongoing work with master students, we see several strategies reappearing already, such as the use of moving-away behavior, multi-interpretable shapes, and loose parts that get scattered.

A second limitation of our work is that we analyzed relatively short-term interactions between children and playthings. On the positive side, this allowed us to get a rich understanding of how in-the-moment dynamics contributed to free, bodily, and dispersed play. Such an understanding is key for getting a grasp on young children's physical activity and play, which is often very situated (de Valk, 2015). However, following from the goal to promote children's physical activity, our interest also goes to the long-term implications of Playscape designs. Do children remain engaged and physically active during long hospital stays or over the course of multiple hospital stays? And how do the three play qualities contribute to such long-term dynamics? Addressing questions like these is beyond the scope of this paper and remain open for future work (see subsection below).

A third limitation concerns our data analysis. We took several measures to strengthen the validity of our findings (see the *Approach* section). We could not make use of a previously validated approach, as our data analysis had to be specifically tailored to our research interests concerning Playscapes. This means that we cannot be entirely sure whether doing the same analysis over again will result in the exact same findings of our current study, in particular with respect to identifying and labeling play activities. However, with the measures we did take, we are confident that the findings of our inquiry consist of accurate descriptions that can be learned from, and that they form a reliable basis for the strategies that we formulated.

A final constraint concerns our Wizard of Oz set-up, which was key to our study with Fizzy. The use of human intelligence in steering Fizzy's behavior allowed us to respond to unanticipated behaviors of the child and to explore new ways of triggering the child beyond its defined behavioral repertoire. Despite these benefits, this approach has two implications. First, the approach was quite demanding for the design researcher in the field. We found it to be a balancing act between acting according to the character of Fizzy, keeping the goal of physical activity in mind, while also improvising and responding to the emerging behavior of the child and family. Second, some of our findings with Fizzy represent interactions not likely to be elicited in the near future with an autonomous plaything. For this reason, we made sure that the strategies in Table 1 do not rely on an artificial intelligence that is as sophisticated as played out by the researcher.

Recommendations for Future Work

Based on the above remarks, we have several recommendations for future work. First, we suggest a better understanding of the long-term interactions with Playscape designs is needed. One particular direction is to explore how children discover and actualize various affordances over time. For example, it would be useful to understand how the actualizing of one affordance may

lead to the disclosure of other affordances, and how this in turn may allow new play activities to emerge. Furthermore, affordances will change as a result of young children's body growth and their developing skills and abilities. How can Playscape designs remain engaging to a child that continually develops? In this regard, we are particularly interested in the *open* qualities of Playscape designs, such as their *ambiguous shape* or *ambiguous behavior.* We are curious to learn whether and how such qualities will allow children to continuously discover new affordances, or to integrate already familiar affordances in their play in novel ways.

A second recommendation concerns the social dynamics of young children's physical activity and play. These dynamics are important for designers to consider in their work, in particular with respect to the mediating role of parents. We expect these mediating roles can be anticipated to some degree. To include the role of parents in the scope of design and analysis, will require a more holistic perspective on children's physical activity and play—one that goes beyond the Gibsonian frame that was used in this paper. We suggest an *activity-centered* framing of children's physical activity and play would be fruitful, building on Activity Theory (e.g., Siyahhan, Barab, & Downton, 2010; Kaptelinin 2015; Kaptelinin & Nardi, 2012; Waern & Back, 2017; Rozendaal et al., 2019). Such a framing would help to better understand how the different mediating roles of people and playthings interact and shift over time, while different play activities alternate.

A final recommendation for future work is to better demarcate and explicate the solution space of Playscapes. Following the work presented in this paper, we have taken initial steps in this direction, by proposing broad categories that describe the basic functionality that playthings may offer to children (see Boon, 2020, ch. 6). Specifically, we suggest to distinguish between three different play elements: *landscape, loose*, and *animate elements*. To illustrate, Stickz provide structures to crawl under and obstacles to step or jump over (landscape elements), while also being transportable and used as building elements (loose elements). Fizzy is a ball that can be thrown, rolled and kicked (loose element), while also being a pro-active and lively agent that can followed and cared for (animate element). Taken together, the play elements (*landscape, loose,* and *animate*) and the play qualities (*free, bodily*, and *dispersed*) demarcate a clear solution space, representing means and ends respectively. In design practice, this solution space can support designers in coming up with their own design solutions and strategies, rather than depending solely on particular strategies generated in studies like the one in this paper. In research, the solution space may serve as a framework that can be further populated with design solutions and strategies, thereby expanding the body of knowledge to design for young children's physical activity and play.

Conclusion

Taking the Playscapes perspective as a starting point, this paper developed a set of design strategies for promoting young children's physical activity and play. The design strategies offer designers concrete directions for designing playthings and environments that stimulate young children's physical activity in the form of unstructured and spontaneous play. On a more general level, we have demonstrated that designers can make an important difference with respect to promoting young children's physical activity, even in environments that may initially seem inappropriate for such purposes. In an increasingly urbanized and densely populated world, in which sedentary behavior is more prominent than ever, Playscapes may serve as a useful tool to create the necessary space for children's physical activity and play.

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Appendix

Appendix 1. Different forms of play with Fizzy.

Play type	Play activities	Description of activity
Creature play *Activities in which Fizzy was interacted with as a creature*	Keeping captive	Enclosing Fizzy with legs or keeping it on the bed, not letting it escape.
	Following	Following Fizzy around, following and catching it, and wondering where Fizzy wants to go.
	Communicating	Luring, giving orders, or conversing with Fizzy.
	Collecting	Picking up Fizzy in order to bring him to a particular destination, or getting Fizzy out from under the bed.
	Caring	Stroking Fizzy, gently rocking it, or holding it quietly and close to the body.
Ball play *Activities in which Fizzy was interacted with as a ball*	Throwing	Throwing Fizzy towards one another, or throwing the ball up in the air or against something.
	Rolling	Rolling Fizzy towards one another.
	Kicking	Kicking Fizzy towards one another, or kicking it around.
	Ball play (mix)	Ball play in which throwing, rolling and kicking alternated in quick succession.
Exploration *Activities in which Fizzy is interacted with as an unfamiliar or technical object*	Exploring	Initial interactions with Fizzy, exploring what it is and does.
	Experimenting	Trying out various things to get responses from Fizzy and trying to understand how Fizzy works.
	Examining	Weighing Fizzy on a scale (one particular case).
Games *Activities in which Fizzy is interacted with as a tool for a game or as a co-player*	Traditional games	Playing tag or hide and seek.
	Improvised games	Playing games that spontaneously emerged from interactions, such as *take away ball* or *to whom will Fizzy come?*
Transitory play actions *Short actions that fall in between play activities*	Transitory play actions	Various actions that form transitions between other play activities.
	Observing	Moments in between play activities in which child holds back and observes Fizzy.
Sensory play *Activities in which Fizzy is used as a sensory stimulus*	Sensing	Attentively sensing Fizzy while it is purring, trying to move around or shaking
	Massaging	Using Fizzy as a massage tool while it is shaking
Functional play *Activities in which Fizzy is handled by hands or feet*	Balancing	Balancing Fizzy on one hand while it is shaking
	Fiddling	Playing around with Fizzy in the hands
	Lifting	Lifting Fizzy with legs and feet (one particular case)
Manipulative play *Activities in which the objects around Fizzy are manipulated*	Enclosing	Surrounding Fizzy with other objects
	Manipulating environment	Preparing or manipulating the environment for playing with Fizzy
	Manipulating with objects	Attaching or placing other objects on Fizzy
Dramatic play *Activities in which Fizzy is used as pretend object*	Being entertained	Watching parent acting silly in response to Fizzy's shaking
	Pretending	Pretending Fizzy is another object (e.g., helicopter)
Sharing *Actions of handing Fizzy over to others*	Sharing	Handing Fizzy over to another person
Rough-and-tumble *Activities in which Fizzy is used as tool for playfighting*	Throwing at someone	Using Fizzy as a projectile to hit one another

Appendix 2. Different forms of play with Stickz.

Play type	Play activities	Description of activity
Constructive play *Activities in which Stickz are used as building materials or as modifiable structure*	Constructing	Constructing with or without a clear goal, often including actions of collecting Stickz.
	Deconstructing	Disassembling or destructing a structure of Stickz.
	Maintaining	Keeping a structure of Stickz from falling over.
	Manipulating	Adjusting a structure of Stickz or placing an object on top of it.
	Stacking	Placing Stickz on top of each other.
Dramatic play *Activities in which Stickz are used as pretend objects*	Pretending	Pretending a Stick is a water gun, vacuum cleaner, etc.
	Storytelling	Telling a story about Stickz.
Landscape play *Activities in which Stickz form a landscape to move through*	Going around	Moving around constructions with a kart (particular case).
	Going underneath	Sitting inside a structure, crawling in and out.
	Overcoming	Jumping or climbing a pile or construction of Stickz.
	Playing in and around	Various actions in and around a structure of Stickz.
Loose play *Activities in which Stickz are played with as loose elements*	Fiddling	Playing around with a single Stick in the hands.
	Sorting	Organizing Stickz in separate piles or naming them according to color.
	Transporting	Dragging or carrying Stickz or a collection of Stickz, often in order to collect them.
Rough-and-tumble *Activities in which Stickz are used as tools for playfighting*	Playfighting	Poking or swing Stickz at one another.
Sharing *Activities in which Stickz are shared with others*	Sharing	Sharing Stickz with another person.
	Showing	Demonstrating Stickz or showing a construction to another person.