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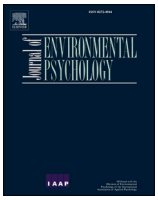

A comparison of children's play and non-play behavior before and after schoolyard greening monitored by video observations

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ABSTRACT

This paper investigates the impact of greening schoolyards on children's (age 7-11) play and non-play behavior during recess. Five primary schools in The Netherlands took part in a longitudinal prospective intervention study using a pre-post design with a baseline and two-year follow-up. At baseline, all schoolyards were paved. Between baseline and follow-up all schools greened their schoolyards. During recess at baseline and follow-up, the play behavior of children in grades 4, 5 and 6 in different target areas was videotaped with multiple cameras and afterwards coded using the cognitive play categories and non-play categories of the Play Observation Scale (Rubin, 2001). Video recordings of 352 children at baseline, and 325 children in 66 target areas at follow-up, were divided in equal time frames of 30 seconds. Each child's behavior was coded at the 30th second of the time frame, yielding a dataset of 17046 observations. Results show an increase in observed play, as compared to non-play, behavior, after greening. Furthermore, there was an increase in games-with-rules, a small increase in constructive and explorative play behavior, and a decrease in passive non-play behaviors. This impact of greening was stronger for girls compared to boys. These findings strengthen the empirical basis for greening schoolyards by providing data from a large scale quantitative study with a controlled, longitudinal pre-post design.

1. Introduction

Over the past decades a growing number of primary schools across many countries have taken the initiative to re-design their schoolyard with natural features such as trees, flowers, sand, water, grass, hills and bushes to create a more attractive 'green schoolyard' (Bell & Dyment, 2008; Van Dijk-Wesselius et al., 2018). This green schoolyards movement is inspired by research indicating multiple benefits of greening schoolyards for children, schools and communities (Lamar & Jordan, 2016). One of the benefits that is frequently cited in the literature is that green schoolyards offer more varied play opportunities that meet the interests of all children and support children's healthy development (Root et al., 2017). In particular, a green, compared to a paved, schoolyard, is thought to encourage more creative and exploratory play (Lucas & Dyment, 2010; Zamani, 2016). However, there is a lack of direct, quantitative evidence for the idea that greening a schoolyard encourages more varied play behavior among school-aged children. The present study aimed to fill this gap.

1.1. Children's play behavior

For the purpose of the current study we adopt a broad definition of play as a voluntary, intrinsically motivated behavior, that is self-chosen and self-directed, and allows children to quit if they are not having fun (Gray, 2017). Play is generally considered an essential and critical part of children's healthy development (Graham & Burghardt, 2010; Nijhof et al., 2018). From this perspective, schoolyards and other play areas can be considered of higher quality when children display more play behavior as compared to non-play behavior like being unoccupied, talking or moving from one place to another (Luchs & Fikus, 2013; Stanley, 2011). In line with Piaget (1962) and Smilansky (1968) play behavior can be categorized in terms of a variety of physical/locomotor, social, and cognitive skills that children can practice in play. In this study, the focus is on play behavior that supports the development of cognitive skills. Following a widely used classification scheme, these cognitive play behaviors can be subdivided into five broad categories (Rubin, 2001): (1) Functional play – use of objects as they are intended,

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(2) Games-with-rules – the acceptance of explicit rules that are agreed upon and provide boundaries for competition, (3) Constructive play – manipulation of objects to construct or 'create' something, (4) Dramatic or pretend play – engage in imaginary situations, (5) Exploratory play - a focused examination of objects (or other people or situations) in the environment. Within this spectrum of cognitive play behaviors, more creative play behaviors (i.e., constructive and dramatic play) have traditionally been valued for their contribution to the development of cognitive and social skills (Burriss & Tsao, 2002). As already pointed out by Piaget (1962), creative play, among other things, provides children with opportunities to reproduce real-life conflicts, to work out ideal resolutions for their own pleasure, and to ameliorate negative feelings. Additionally, exploratory play behavior is also valued for its supportive role in causal learning and inductive reasoning (Schulz et al., 2008), which are central to the working of intelligence (Perret, 2015). Moreover, in natural environments, exploratory behavior can foster children's connection to nature by acquiring direct 'hands-on' sensory and physical knowledge of their natural surroundings (Gurholt & Sanderud, 2016).

1.2. Theoretical background: Affordances and loose parts

Gibson's (1979) Affordance Theory provides a framework for understanding how the physical environment can influence play behavior. This theory states that the physical environment affords different actions and behaviors that correspond with an individual's body size, strength, skills, fears and other needs and abilities. For instance, a tree only affords climbing if a child can reach to the lowest branch or something is only grabbable if it fits in the hand of the child. As such, affordances can be defined as functionally significant properties of the environment that are delineated by the relationship between the environment and an organism. Heft (1988, p. 33) elaborated Gibson's theory by proposing a taxonomy of affordances in children's environments, such as a "climb-on-able feature" and a "swing-on-able feature." Kyttä (2004) further extended this work by distinguishing between potential and actualized affordances, the latter of which constitute the subset of the potential affordances that a child actually perceives, utilizes, or shapes.

The theory of affordances emphasizes the importance of designing schoolyards that provide opportunities for children to immerse in different types of play behavior, and that suit individual needs and abilities of all children (Tranter & Malone, 2004; Wilson, 1997). However, traditional, paved schoolyards are in general considered one-dimensional and restricted in the forms of play behaviors they afford (Woolley & Lowe, 2013). Studies highlight that traditional schoolyards mostly appeal to boys' interests, who dominate the schoolyard with competitive and rule-bound games (Brez & Sheets, 2017; Sharma-Brymer & Bland, 2016). Furthermore, the presence of non-natural play equipment made from artificial materials tends to promote competitive physical behavior, which can foster uncomfortable power relations that may negatively influence participation in play behaviors (Dyment & O'Connell, 2013; Lucas and Dyment, 2010). In contrast, green schoolyards with natural features are assumed to be more open and flexible in the potential affordances children can actualize in interaction with the environment (Heft, 1988) and stimulate more varied, creative and physically active play behavior (Drown et al., 2014; Fjørtoft et al., 2009).

The importance of natural features is further explained by the Theory of Loose Parts (Nicholson, 1972) that emphasizes the presence of open and unstructured features in an environment. The loose parts that can be found in natural environments, such as twigs, leaves, sand and water, tend to be less set and more fascinating than ready-to-use play equipment, like a climbing frame or a ball. Children love to interact with natural features that are flexible, capture and hold their attention and stimulate their senses (Chawla & Nasar, 2015; Dyment et al., 2013). As such, loose parts, which are naturally present in nature, create numerous opportunities for children to engage in constructive, imaginative and exploratory play behavior (Engelen et al., 2017).

1.3. Greening schoolyards: Empirical findings

The idea that green schoolyards afford more varied, creative and exploratory play opportunities than traditional non-natural, paved schoolyards is supported by a design evaluation study in the UK (Woolley and Lowe, 2013). In this study, ten playgrounds with varying degrees of naturalness were assessed using an evaluation tool that comprised dimensions of play value, physical characteristics and environmental characteristics. Play value was found to increase along a continuum, with more natural features leading to a higher play value in terms of more active, varied, creative, sensory and multidimensional play behavior. These findings are confirmed by an ethnographic study in Canada, which compared the affordances of a biodiverse schoolyard with complex vegetation and a relatively barren schoolyard, using drawings, surveys and interviews among children aged 6-13 (Samborski, 2010). Findings show that the biodiverse schoolyard afforded a richer play experience, with more varied play opportunities. Drawing on ethnographic observations and interviews, another study among children of primary schools with partially green schoolyards in the US found that children prefer to play in the green areas on schoolyards and that in these areas children expressed that they can choose activities they feel comfortable with and that suit their competence (Chawla et al., 2014). An observational study among Australian schoolchildren (aged 8-10) of five primary schools with schoolyards with differing degrees of naturalness found that two-fifths of the behavior during recess at the school with the most natural schoolyard were imaginative, constructive and exploratory activities, whereas the school with the least natural schoolyard had no observations in this category (Malone & Tranter, 2003).

Research also suggests that greening schoolyards can create an inclusive schoolyard that is more sensitive for the needs of both boys and girls than a traditional paved schoolyard (Dyment & Bell, 2008; Lucas and Dyment, 2010). For example, a study at two Swedish schools, one with little and one with substantial greening, among children aged 10-13, found that in paved areas girls were often hanging passively around soccer fields and were not engaged in play behavior. Whereas in green areas, girls were more actively engaged in play themselves (Mårtensson et al., 2014).

In sum, there is much indirect support from studies comparing green vs. paved playgrounds for the notion that greening schoolyards promotes play in general, and more varied and inclusive play in particular. However, few studies have directly examined changes in play behavior of school children after schoolyard greening. A survey study among 59 Canadian primary schools that greened their schoolyard provides some preliminary support that greening can affect children's behaviors (Dyment & Bell, 2007). In this study, teachers, parents and administrators confirmed that through greening, schoolyards appeal to a wider variety of children's interests and support a wider variety of play activities, like more imaginative and constructive play behavior. A study on the impact of greening as part of a 'lab schoolyard' of a university in the US found that greening promotes exploratory and investigative play in children aged 4-8 who were observed in the schoolyard before and after the experimental schoolyard was re-designed (Kuh et al., 2013). This change was attributed to the presence of loose parts, multiple pathways, and natural features.

1.4. The present research and hypotheses

The present study aimed to compare children's play and non-play behavior during recess before and after greening of the schoolyard across a variety of common schoolyard designs. Specifically we addressed the hypotheses that after greening:

H1. Children show an increase in observed cognitive play behavior

and a decrease in non-play behavior.

H2. Children show more varied cognitive play behavior.

H3. The increase and variation in observed cognitive play behavior is characterized by an increase in constructive, dramatic and exploratory play behavior.

In addition, we explored the impact of greening schoolyards on various types of non-play behavior, and whether the impact of greening differs between girls and boys.

2. Method

The data presented in this paper are part of a large, four-year research program investigating the impact of greening schoolyards of primary schools in moderate-to-high-urbanized areas in The Netherlands on several outcome measures (Van Dijk-Wesselius et al., 2018). The current paper discusses results of video observations of children's behavior in schoolyards of five intervention schools made at baseline in 2014 before greening and at follow-up in 2016 after greening.

2.1. Schools and participants

Two criteria were used to select the participating schools. Participating schools should have advanced plans for greening their schoolyard between 2014 and 2015 and should be located in urbanized areas with limited green play opportunities for children. For more details about the selection process see Van Dijk-Wesselius et al. (2018).

During recess, multiple video cameras captured the play and non-play behavior of all children from grades 4, 5 and 6 (age 7-11, comparable to grades 2-6 in the U.S.) present in the schoolyard. Table 1 gives an overview of characteristics of the children at baseline and follow-up, as obtained during classroom assignments on the same day the observations were made. There were 352 children at baseline, and 325 at follow-up. At follow-up, there were somewhat more children in the highest grade 6, and somewhat less children in the lower grades. However, this difference was not significant, $p > .24$, and samples at baseline and follow-up were comparable in mean age and gender distribution.

2.2. Study design

This study employs a non-experimental, pre-post design and is a within-school comparison of play and non-play before and after schoolyard greening. On the individual level, the study is (mostly) a between subjects comparison. Since play behavior varies strongly with age (Pellegrini, 2006) we considered it important that the samples at baseline and follow-up would be comparable in age range, which precluded a within-subjects comparison in this longitudinal study. Therefore, to control for age, we included children aged 7-11 (from grades 4, 5, and 6) at both baseline and at follow-up. This resulted in a design that was largely between-subjects. (There is a subset of children who were observed in grade 4 at baseline who were also observed at follow-up, when they were in grade 6; except for a few children who were not present at one of the two observation days, or children who changed schools in the meantime). Children who were in grades 5 and 6 at baseline were not included in the follow up. Instead, two 'new' groups of children in grades 5 and 6 entered the study at follow-up.

The Research Ethics Committee of the department of social- and organizational psychology from the Vrije Universiteit Amsterdam approved the study and affirmed that the study would not induce negative consequences above minimal risk for the participating children. The study and study protocol were also approved by the school boards. Furthermore, a passive consent procedure was conducted by sending a letter to the children's parents in which the aim of the study was explained and in which parents were informed how they could withdraw their child from participation. The parents of two children

Table 1
Characteristics of children at baseline and follow-up (Children in gray-shaded cells represent cohorts that participated in both measurements).

	Baseline (N=352)	Follow-Up (N=325)
Grade 4	122 (34.7%)	105 (32.3%)
Grade 5	125 (35.5%)	105 (32.3%)
Grade 6	105 (29.8%)	115 (35.4%)
Boys	170 (48.6%)	153 (47.1%)
Age (Mean/SD)*	8.47 (1.02)	8.62 (1.01)
7 years	69 (19.7%)	50 (15.6)
8 years	114 (32.6%)	90 (28.1%)
9 years	105 (30.0%)	117 (36.6%)
10 years	58 (16.6%)	58 (18.1%)
11 years	4 (1.1%)	5 (1.6%)

* *Data on age were incomplete for some children*

across all schools and measurements refused to let their child participate.

2.3. Schoolyard greening

The greening of the five schoolyards was a tailored process supported by a regional funding agency (Fonds1818). Funding was allocated based on the design, quality, shape and functionality of the schoolyard greening which schools had to describe in a detailed plan. When this plan was approved, the greening was carried out in a participatory process with input from parents, teachers, children and designers. Fig. 1 gives an impression of each schoolyard before and after greening. The greening only affected the design of the schoolyard, the sizes of the schoolyards remained the same at each school.

2.3.1. The designs of the schoolyards

Table 2 gives an overview of the changes in artificial and natural features at every school. At baseline, all schoolyards were entirely paved, with various types of artificial play equipment. At some schools, natural features such as a grassy area, trees, and shrubs were present as a

Fig. 1. Impressions of the schoolyards of the five intervention schools before greening at baseline (left) and after greening at second follow-up (right).

Table 2
Sizes of schoolyards and changes in artificial and natural features at each school (↑ = Feature added, ↓ = Feature removed, ~ = Feature remains, Blank = Feature not present before or after greening).

	School				
	A	B	C	D	E
Size	920m^2	795m^2	565m^2	698m^2	1660m^2
Artificial features					
Climbing feature	↓	~	↓		~
Bench/picnic table		↓	↓	~	~
Stony structure	↓	↓			~
Funkorf			↓	↓	~
Bars, roundabout			↓	~	~
Table tennis table	~		↓	~	
Swings and slides	↓	↑	~		~
Soccer area	~		↑	~	~
Running track		↓	↑		
Baseball court			↑		~
Sandpit	~				
Spring rope					~
Natural features					
Hills, bridges, paths and tunnels	↑	↑	↑	↑	↑
Vegetation (trees, shrubs)	~	↑	↑	↑	↑
Ground cover of wood chips	↑	↑	↑	↑	
Play structures made of wood	↑		↑	↑	
Amphitheater	↑	↑		↑	~
Natural grass			↑		↑
Huts and other structures made from willow branches		↑	↑		
Imitation grass	↑				
Wilderness/bushy area				↑	
Vegetable garden				↑	

fence or decoration, but they were typically not intended as play areas. Most schools removed some of the artificial play equipment as part of the greening process. Most frequently removed were climbing features, benches and picnic tables, stony structures (like relief sculptures on the pavement), and 'funkorfs' (multicolored baskets). At school E, all artificial features were kept in place. This is partly due to the fact that this schoolyard borders a communal playground that children use during recess. This communal playground, with a baseball and soccer court, was not part of the greening process.

All schools added at least one natural feature that promotes exploration and moving from one place to another, such as a grassy hill or tunnel, a stone path, or a rope bridge. As expected, most schools also added vegetation in the form of trees and shrubs. Only school A did not plant new vegetation, the design of this schoolyard only included imitation grass. Natural grass was added only at two schools, presumably because of difficulties with maintenance due to child erosion. Instead, ground cover of wood chips was a popular alternative for most schools. Three out of four designs also included wooden climbing structures and an amphitheater. These amphitheaters, where children can sit or watch performances, were typically made of stone and grass, and surrounded by bushes and flowers. More adventurous natural features, like wilderness areas, huts made of willow branches, and water and mud features were not very common in the green designs. The same applies to vegetable gardens, which were only included in the design of one schoolyard. None of the designs included an abundant presence of loose parts, like leaves and twigs. Notably, the design of school C included the addition or renovation of artificial features such as areas for running, soccer and baseball, and swings, along with natural features. This design was thus more mixed.

2.4. Observations and coding of play behavior

2.4.1. Video observations during recess

At each participating school, during the 15-min morning recess of the children in grades 4, 5 and 6 (as classified by the Dutch educational system) the schoolyards were monitored in their entirety by multiple video cameras that targeted different segments (target areas) of the schoolyard. Depending on the number of children and the size of the schoolyard, some schools had only one 15-min recess for all children, while at other schools there were two or three 15-min-recesses for children in different grades. During recess, children were allowed to play freely with the equipment and facilities present in the schoolyard, there were no rules in place regarding the use of the different areas, and there were no organized activities. At least two or more teachers were present in the schoolyard to keep an eye on the children. These teachers did not actively engage with the children, they only intervened in case of emergency, for example when children started a fight or when a child was hurt.

Video-observations were made on one day during baseline in 2014 and on one day during follow-up in 2016. Observation days were chosen such that they would fall in approximately the same period each year to avoid nuisance caused by for instance seasonal influences, weather conditions and holidays. The weather was generally dry and warm enough to play outside. The video cameras were placed so that they would not hinder children's activities in the schoolyard.

2.4.2. Target areas

Each schoolyard was divided into target areas by the researchers. Target areas were selected based on pragmatic criteria to facilitate the coding of videotapes. Each target area was identified to cover a specific feature of the schoolyard that facilitated a specific play situation, like for instance a soccer field or a climbing element. Target areas were chosen so that together the cameras placed in the area would cover the entire schoolyard. If needed, larger areas or features that were difficult to code from only one viewpoint were divided into more than one target area with multiple cameras to assure accurate coding. As the design of schoolyards changed between baseline and follow-up, the number of target areas differed between baseline and follow-up. At baseline 50 target areas were distinguished, while at follow-up 66 target areas were distinguished (see Table 3).

2.4.3. Coding of play behavior

Play behavior was coded using the Play Observation Scale (POS, Rubin, 2001). The POS was developed to assess social, cognitive play and non-play behaviors. For this study we only coded the cognitive play behavior and a selection of relevant non-play behaviors. Cognitive play behavior was divided into five categories of functional play, games -with-rules, and constructive, dramatic and exploratory play. Non-play behavior was divided into eight behaviors/activities: active conversation, onlooker, unoccupied, transition, rough-and-tumble, aggressive, interaction with teacher and interaction with camera. The latter was added to the original scale because our study used video observations. See Table 4 for a brief description and examples of each of the play and non-play categories. It should be noted that in the literature rough-and-tumble is sometimes considered play (instead of non-play) behavior, but for consistency we decided to keep to the POS-classification and list rough-and-tumble as non-play behavior. Originally the POS was developed for on-site observation and employs a methodology that requires the observer to sample the behavior of one single child during a fixed period. However, in this project we had the opportunity to make video observations, which can be paused, zoomed-in, and rewinded for as many times as needed. This made it possible to code behavior of all children playing at a certain time in a certain area, instead of the behavior of only one single child.

Videotapes of the play behavior were coded by research assistants who were unaware of the aim of the research. Assistants were instructed to closely watch the video in time frames of 30 s and to register the most observed type of behavior of each child that was present at the 30th second. Thus, for example, for a group of 10 children in a certain area, the assistant paused the video at the 30th second, and recorded the number of boys and girls present. Subsequently the assistant coded the

Table 3
Number of target areas, time frames and observations, and % boys at each time of measurement for both the total sample and for each school separately.

	Baseline				Follow-up			
	Target areas	Time frames	Obser-vations	% Boys	Target areas	Time frames	Obser-vations	% Boys
Total	50	3808	17046	55.78%	66	4428	13156	50.91%
school A	7	535	3721	54.47%	12	840	2085	53.81%
school B	11	591	3006	50.60%	12	777	2551	48.69%
school C	12	398	1744	45.47%	12	852	1468	31.00%
school D	7	458	3831	51.92%	13	871	3934	59.63%
school E	13	1826	4744	66.97%	17	1088	3118	49.42%

Table 4
Description of sub-categories of the play observation scale for the categories of cognitive play and non-play behavior.

Play behavior	
Functional	Simply repetitive muscle movements with or without objects – e.g. running, sliding, climbing.
Games-with-rules	Competitive game-type activities following established rules and limits, e.g. playing soccer or hide-and-seek.
Constructive	Activities to manipulate objects to construct or create something – e.g. creating a hut and shelters, playing with loose parts.
Dramatic	The substitution of reality with an imaginary situation – e.g. role play.
Exploratory	A focused examination of objects in the environment – e.g. detailed examination of snails.
Non-play behavior	
Active conversation	Communicating verbally with others.
Onlooker	Watching or listening to behaviors and activities of other children.
Unoccupied	Behavior with a lack of goal or focus – e.g., staring blankly into space, wandering with no specific purpose.
Transition	Preparing or setting out activity or moving from on activity to another.
Rough-and-tumble	Mock fighting or playful physical contact - e.g. tickling or wrestling.
Aggressive	Non playful agonistic interaction with another child – e.g. hitting, kicking, grabbing, etc.
Interaction with camera *	Children interacting with video cameras in the schoolyard
Interaction with teacher**	Children talking or otherwise engaged in interaction with teacher

Note: *added given that we use video-observations instead of real-life coding ** added based on experiences during coding.

predominant behavior that was observed for each of these boys and girls. When a child moved in and out of an area during a time frame, the assistant coded the most dominant behavior during the time the child was in the area. If necessary, the tape could be stopped, zoomed in or rewinded.

Within our coding scheme, the same play situation – let's say a soccer game – may have been sampled several times for each child in that situation. We did not control for this 'double-coding', because we wanted to get an indication of the relative frequencies with which different play and non-play behaviors occurred in the schoolyard, for the entire group of children present in all the different areas of the schoolyard. Unfortunately, it was not feasible to register the relative frequencies of play and non-play behaviors at individual child level. However, in most time frames children engaged in the same type behavior during the entire 30 s, thus the most observed behavior was in most cases the only type of behavior. In time frames with different types of behavior, these behaviors usually differed in length, which made it clear which was the predominant type of behavior. In the few cases where behavior was too mixed or the child stayed in the area for too short a time to establish a clear predominant type of behavior, the time frame was labeled 'uncodable'.

2.4.4. Reliability

The video data were coded by four pre-trained research assistants. Given the quantity of the recorded footage, it was not feasible to have all individual observations of play behavior coded by two independent observers. However, we took several steps to ensure inter-observer reliability. First, the coding scheme was tested together with students enrolled in an educational program to become primary school teachers. Each student coded 15 min of video data of a target area using the POS. Afterwards similarities, differences and possible difficulties in coding the video-materials were discussed. Based on these discussions the protocol was amended with suggestions for how to deal with difficulties and ambiguities. Second, the research assistants were trained and undertook practice scans to ensure that there were no considerable differences between the coding used by each research assistant. During coding, when confronted with a difficulty the research team watched the video together and decided on how to code the behavior. Last, during coding each research assistant made notes of the behavior they observed in children. For instance, that children were playing soccer or were talking with friends. These observations were used to control the data files as a final check to ensure that all categories were used in a similar manner by every observant.

2.5. Procedure

Each participating school was visited for one day at baseline and one day at follow-up. The chosen weekdays and sequence of visitation were equal for baseline and follow-up measurements. The research team visiting the schools consisted of three researchers, accompanied by ten students (with a background in teacher training, psychology, or health sciences). Prior to data collection, students were trained to ensure an adequate understanding of the method of data collection. A data collection protocol was developed to minimize nuisance due to differences in data collection and therewith increase the reliability and validity of the findings. This protocol contained detailed information about the placement of the cameras and accompanying instructions. During the 15-min morning recess each camera was guarded by a researcher or student, who put it in the right position, pressed the start and stop button to start recording, and while the camera was filming made sure that the children did not touch the equipment. At the end of each school visit the cameras were collected by one researcher who transferred the digital recordings to a secured hard-drive only accessible by researchers. Afterwards, the cameras were reset, brought back to the university and stored in a locked room.

2.6. Data analysis

Video recordings from each target area (with a total length of about 32 h at baseline, and 37 h at follow up) were divided in equal time frames of 30 s. As shown in Table 3, this yielded a dataset of 17046 observations of children in 50 target areas at baseline, and 13156 observations of children in 66 target areas at follow-up. Chi-square statistics were used to test the impact of greening schoolyards on observations of children's play and non-play behavior. Several

contingency tables were constructed with baseline and follow-up as rows and play and non-play behaviors as columns. We constructed a 2x2 table to test the impact of greening on play versus non-play behavior, a 2x5 table to test the impact of greening on the five cognitive play categories and a 2x8 table to test the impact of greening on the eight non-play categories. In addition, for each separate play and non-play category we constructed 2x2 tables to test the impact of greening on the specific category of behavior. All contingency tables and Chi-square statistics were calculated for the overall sample, as well as separately for boys and girls. From the contingency tables we derived percentages to describe the proportions of total observed play and non-play behavior, as well as the observed proportions within each subcategory, for the total sample and separate for boys and girls.

3. Results

Table 5 provides an overview of observed percentages of play and non-play behaviors at baseline and follow-up as well as a summary of tests results for the overall sample and for boys and girls separately.

3.1. Play versus non-play behavior

After greening, there was a significant increase of 6.9 percentage points in the observed play behavior in children from 53.0% at baseline, to 59.9% at follow-up. The impact of greening schoolyards differed for boys and girls and appeared to be larger for girls. As illustrated in Fig. 2, at baseline the percentage of observed play behavior was 15.8 percentage points higher in boys compared to girls, $Chi^2(1) = 423.25$, $p < .0001$. After greening, the observed percentage of play behavior in girls increased significantly with 13.8 percentage points, from 44.1% to 57.9%. Whereas the observed percentage of play behavior in boys slightly increased with 1.7 percentage points, from 60.0% to 61.7% As a result, after greening for both boys and girls the predominant behavior during recess in the schoolyard was play behavior. Although the difference between boys and girls decreased at follow-up, the percentage of observed play behavior was still 3.8% higher in boys compared to girls, $Chi^2(1) = 19.71$, $p < .0001$.

3.2. Changes in type of play behavior

After greening the distribution of observed behavior across categories of play behavior significantly changed, $Chi^2(4) = 412.49$, $p < .0001$. As illustrated in Fig. 3, at baseline the dominant play categories were functional play (21.3%) and games-with rules (30.1%). Constructive (0.5%), exploratory (0.1%) and dramatic (0.9%) play behavior was hardly observed. The overall increase in observed play behavior after greening is characterized by a significant increase of 5.5 percentage points in the observed games-with-rules, an increase of 1.6 percentage points in constructive play and an increase of 1.6 percentage points in exploratory play behavior. In addition, an increase of 2.0 percentage points in functional play behavior was observed. Greening had no impact on observed dramatic play behavior. Despite the increase in exploratory and constructive play behavior after greening, the dominant play categories at follow-up remain functional play (19.3%) and games-with-rules (35.6%).

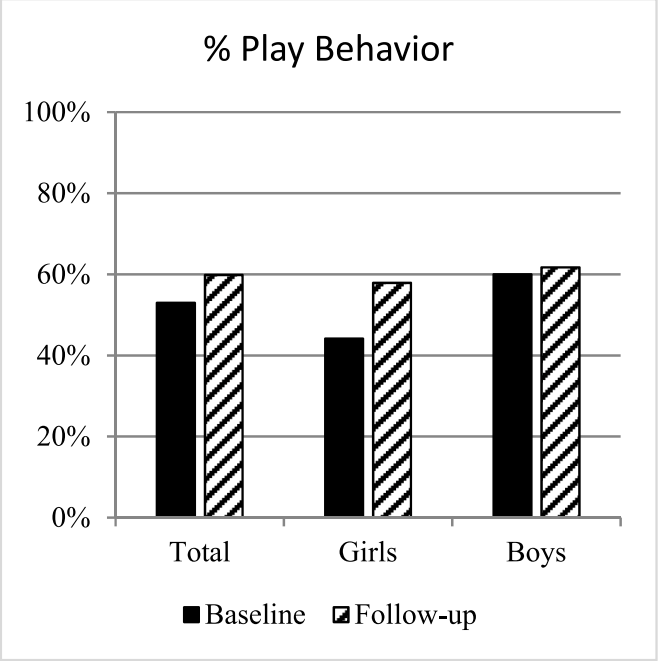

Fig. 2. Percentages of observed play behavior in the schoolyard for the total sample, and for girls and boys separately, at baseline and follow-up.

3.2.1. Gender differences in changes in play behavior

The distribution of observed behavior across categories of play

Table 5
Percentages of observed play behavior and non-play behavior at baseline and follow-up and the comparison of proportions (Chi2) between baseline and follow-up percentages for the total sample, and separate for girls and boys.

	Total				Girls				Boys			
	Baseline	Follow-up	Chi^2	*p*	Baseline	Follow-up	Chi^2	*p*	Baseline	Follow-up	Chi^2	*p*
Play												
Functional	21.34%	19.34%	18.20	<.001	25.35%	21.52%	28.28	<.001	18.17%	17.25%	0.13	*ns*
Games-with-rules	30.06%	35.58%	103.23	<.001	16.45%	32.67%	502.72	<.001	40.85%	38.39%	9.95	<.01
Constructive	0.53%	2.09%	151.80	<.001	0.85%	0.51%	5.78	<.05	0.27%	3.61%	269.49	<.001
Exploratory	0.10%	1.73%	246.18	<.001	0.19%	1.87%	103.73	<.001	0.03%	1.60%	142.95	<.001
Dramatic	0.93%	1.10%	0.14	*ns*	1.30%	1.35%	0.81	*ns*	0.64%	0.87%	0.10	*ns*
Total	52.96%	59.85%	142.97	<.001	44.13%	57.92%	264.58	<.001	59.97%	61.71%	5.03	<.05
Non-play												
Active conversation	15.10%	7.03%	472.01	<.001	22.06%	9.27%	419.68	<.001	9.58%	4.87%	123.86	<.001
Onlooker	10.94%	4.08%	477.21	<.001	11.42%	5.02%	184.13	<.001	10.56%	3.18%	308.08	<.001
Unoccupied	1.09%	6.95%	725.61	<.001	1.25%	8.00%	380.53	<.001	0.97%	5.93%	330.33	<.001
Transition	15.40%	18.12%	39.75	<.001	16.45%	16.75%	0.63	*ns*	14.57%	19.44%	67.46	<.001
Rough-and- tumble	0.99%	1.31%	6.94	<.01	0.60%	0.70%	0.46	*ns*	1.30%	1.91%	9.56	<.01
Aggressive	0.11%	0.07%	0.28	*ns*	0.05%	0.06%	0.83	*ns*	0.15%	0.07%	1.77	*ns*
Camera interaction	1.19%	1.19%	0.95	*ns*	1.23%	1.01%	0.20	*ns*	1.15%	1.37%	0.20	*ns*
Teacher interaction	2.22%	1.39%	28.17	<.001	2.81%	1.27%	40.25	<.001	1.76%	1.51%	0.22	*ns*
Total	47.04%	40.15%	–	–	55.87%	42.08%	–	–	40.03%	38.29%	–	–

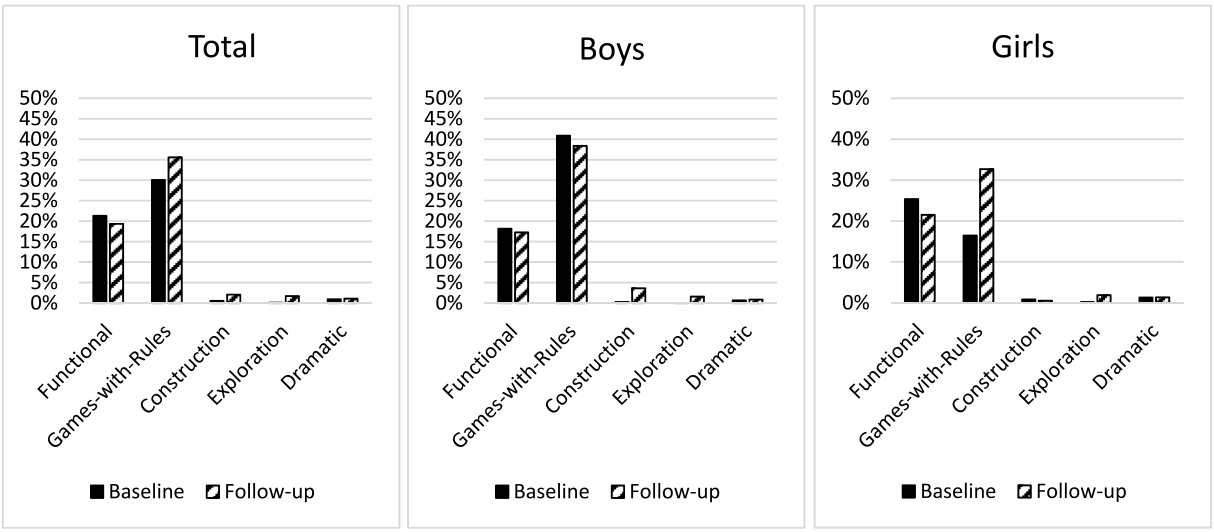

Fig. 3. Percentages of observed play behavior in the schoolyard for each of the individual play-categories, for the total sample, and for girls and boys separately, at baseline and follow-up.

behavior changed for both boys, $Chi^2(4) = 413.609$, $p < .0001$, and girls, $Chi^2(4) = 380.60$, $p < .0001$. However, changes were more noticeable in girls than in boys. As illustrated in Fig. 3, at baseline the most frequently observed play category for girls was functional play (25.4%) followed by games-with-rules (16.5%), whereas after greening this order changed with games-with-rules (32.7%) being the most frequently observed category. Games-with-rules were the most frequently observed play category for boys at both baseline (40.9%) and follow up (38.4%), although the relative frequency of both play behaviors compared to other behaviors was reduced at follow up. Furthermore, both girls (1.7%) and boys (1.6%) show a significant increase in observed exploratory play behavior from baseline to post-greening. In addition, boys show a 3.3 percentage point increase in constructive play, whereas girls show a small 0.3 percentage point decrease in constructive play behavior. As a result, after greening the dominant observed play behavior in both girls (32.7%) and boys (39.4%) was games-with rules. Greening had no significant impact on dramatic play behavior of boys or girls.

3.3. Changes in type of non-play behavior

After greening the distribution of observed behavior across categories of non-play behavior significantly changed, $Chi^2(7) = 1586.08$, $p < .0001$. As illustrated in Fig. 4, at baseline the most frequently observed non-play categories were active conversation (15.1%) and transition (15.4%), followed by onlooker behavior (10.9%). The decrease in observed non-play behavior after greening is characterized by a significant 8.1 percentage point decrease in observed active conversation, a 6.9 percentage point decrease in onlooker behavior, and a 0.8 percentage point decrease in teacher interaction. Furthermore, although the overall observed non-play behavior decreased, there was a significant 5.9 percentage point increase in observed unoccupied, a 2.7 percentage point increase in transition behavior, and a small 0.3 percentage point increase in rough-and-tumble non-play behavior after greening. As a result, at follow-up the most observed non-play category is transition (15.4%), followed by unoccupied behavior (7.0%) and active conversation (7.0%). Greening did not have a significant impact on observed aggression and interaction with camera.

3.3.1. Gender differences in changes in non-play behavior

The distribution of observed non-play behavior significantly changed after greening for both boys, $Chi^2(7) = 793.60$, $p < .0001$, and girls, $Chi^2(7) = 826.19$, $p < .0001$. As illustrated in Fig. 4, for girls the most

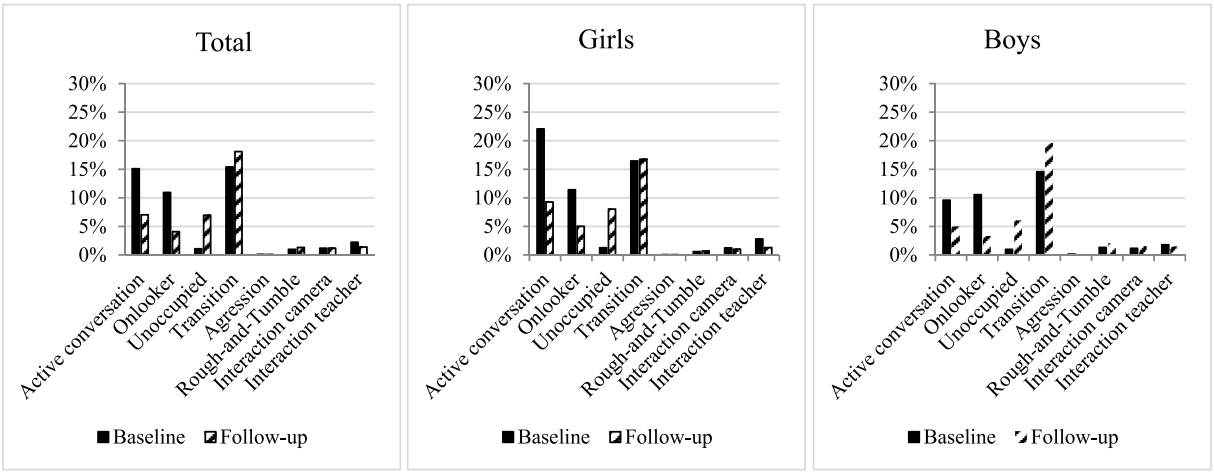

Fig. 4. Percentages of observed non-play behavior in the schoolyard for each of the non-play-categories, for the total sample, and for girls and boys separately, at baseline and follow-up.

observed non-play category before greening was active conversation (22.1%), followed by transition (16.5%) and onlooker (11.4%) behavior. For boys, before greening, the most observed non-play category was transition (14.6%), followed by onlooker (10.6%) and active conversation (9.6%) behavior. After greening, active conversation was decreased in both girls (12.8 percentage points) and boys (4.7 percentage points), and onlooker behavior was also decreased in both girls (6.4 percentage points) and boys (7.4 percentage points). In addition, girls showed a significant 1.5 percentage point decrease in observed teacher interaction after greening. Although overall the observed non-play behavior decreased for both girls (6.8 percentage points) as well as boys (5.0 percentage points), girls showed a significant increase in the percentage of unoccupied behavior after greening. Furthermore, boys showed a significant 4.9 percentage point increase in observed transition behavior after greening, and a small 0.6 percentage point increase in rough-and-tumble behavior. As a result, after greening the dominant observed non-play behavior in both boys and girls was transition, followed by active conversation and unoccupied non-play behavior.

4. Discussion

In this large-scale study we used video observations of children at five schools to compare play and non-play behavior during recess before and after the greening of the schoolyard. In line with predictions, it was found that greening schoolyards stimulates more play, as compared to non-play, behavior. Children's play behavior also became more varied after the greening, with more observations of constructive and exploratory play behavior. Contrary to predictions, the greening did not lead to an increase in dramatic play behavior. By demonstrating that greening schoolyards promotes play in general, and more varied play in particular, the present research strengthens schools in taking the initiative to green their schoolyard.

The increase in play behavior after greening was mostly due to girls switching from non-play to play behavior. Before greening, girls mostly engaged in non-play behavior, like conversations and watching boys playing soccer, whereas boys mostly engaged in play activities like soccer and other games-with-rules. After the schoolyards were greened, the dominant behavior of both boys and girls was play behavior, mostly games-with-rules. So, after greening both girls and boys spent most of their time during recess in play behavior. These findings support the expectations, as drawn from Affordance Theory (Gibson, 1979), that greening creates a multi-dimensional schoolyard that hold numerous affordances and is better accommodated to the interests, abilities and needs of all children. The findings are also in line with previous studies, which describe green areas in schoolyards to be more sensitive to the needs of both girls and boys (Dyment and Bell, 2008; Lucas and Dyment, 2010). Green schoolyards tend to be designed with diverse infrastructures that afford girls to be less passive and more actively engaged in play behavior themselves (Coen et al., 2018; Mårtensson et al., 2014). In paved schoolyards girls can be systematically excluded from space and play opportunities by boys who dominate the schoolyard with their games (Pawlowski et al., 2016; Sharma-Brymer and Bland, 2016).

For boys, the most notable effect of the greening was that they showed an increase in transition non-play behavior after the schoolyards were greened. The increase in transition behavior could indicate that boys' play behavior became more interrupted after greening, shifting from one activity to another. This would contradict previous literature which suggests that playing in nature evokes a deep attention, which brings children in an endless flow of play (Chawla et al., 2014; Luchs and Fikus, 2013). However, it is also plausible that the increase in transition indicates that boys were transferring across the green schoolyard as a whole during their play activities. For instance, boys were observed running from one area in the schoolyard to another, to continue with their play behaviors. This explanation is in line with Kuh et al. (2013), who explored the impact of greening as part of a 'lab schoolyard' on children's play behavior. They observed that after the green intervention was implemented, children developed play scenarios that required them to move materials from one part of the schoolyard to another, and did not limit play themes to a particular area. In particular, frequently applied nature-based features like tunnels, bridge, hills and paths that connect different parts of the schoolyard could have afforded these types of transition behaviors. To a certain extent the label of transition as non-play may be misleading. During some transitions boys were observed setting up a game, negotiating and waiting for friends to join their game.

The finding that greening increased the prevalence of constructive and exploratory play, is in line with the assumption that greening schoolyards creates a more fascinating, unpredictable and flexible environment that affords more varied play behavior compared to paved schoolyards (Dyment and Bell, 2007; Kuh et al., 2013). However, the increase in constructive and exploratory behavior was small, and children still predominantly engaged in functional play and games-with-rules in their new green schoolyard. They also did not show more dramatic play behavior Although we expected to find a more substantial change in the variation of play behavior, our findings do coincide with previous studies. For instance, Mårtensson et al. (2014) also found that green schoolyards stimulate more varied and creative play behavior, but in particular more games-with-rules. They describe how children in their study enjoy to explore, run and play hide and seek and chasing games on different surfaces, structures and routes, which were created at each of the green schoolyards.

One explanation for why we did not find a more substantial increase in creative and exploratory play behavior could lie in the designs of the green schoolyards in this study. Based on the taxonomy of functional affordances of Heft (1988), the extent to which greening schoolyards rigorously altered the richness in affordances can be questioned. More specifically, loose parts were hardly present in the greened schoolyards. According to the theory of loose parts, it is especially parts like branches, twigs, sand, mud and leaves that stimulate creative play behavior (Nicholson, 1972). At a closer look, most natural features in the schoolyards of participating schools are constructed by landscape architects and are constructed of, but not rich in loose parts that allow children the opportunity to design, re-design and give meaning themselves.

An example is the presence of a treehouse. When asked beforehand what most children would prefer to have if their schoolyard is going to be greened, often children express the wish for a treehouse (Maas et al., 2014). So, on most green schoolyards architects design and build a treehouse. However, the question is whether this is actually what the children had in mind. Did they wish to have a treehouse or did they wish to build a treehouse themselves? In these situations one might say that children are 'trapped in the beauty of the design'. It is the architect who has all the fun of being creative and designing with natural loose parts and not the children. In this light, introducing more loose parts to the designs of green schoolyards would seem a promising intervention. This idea is supported by Engelen et al. (2017), who showed that loose parts, like natural and recycled materials stimulated an increase in constructive and creative play behavior in the schoolyard.

With respect to children's non-play behavior, the increase in unoccupied behavior could indicate that, in the green playground, children more often feel free to be on their own for a while, wandering around and relaxing. In the early years of environmental research, Hart (1979) already described how children were spending time alone, quietly resting in natural areas. In a similar vein, Chawla et al. (2014) show that children describe a green area in their schoolyard as a place where they feel at peace, do not feel worried and where they can be alone for a while. Furthermore, Dyment and Bell (2008) found that green schoolyards stimulate more freedom to wander around and lie down in contrast to only promoting physically active play. Woolley and Lowe (2013) found more children being on their own in green compared to paved playgrounds. Greening schoolyards thus seems to create an

environment that affords active play behaviors as well as greater opportunities to find some time to wander around and be on your own. In this light, being unoccupied could indicate that some children need to be alone for a while during recess and that greening schoolyard affords the opportunity for children to fulfill this need.

4.1. Limitations and suggestions for future research

The present study addresses many of the shortcomings of previous research on the impact of greening schoolyards on schoolchildren's play behavior by employing a within-school intervention-based design with pre- and post-measures of coded video observations of all children's behavior in the schoolyard, instead of interviews and questionnaires, or on-site observations with only pre-selected individual children. However, the research is not without limitations.

Among the limitations of this study are the absence of control (comparison) schools where no schoolyard greening occurred and lack of random assignment to intervention or control. The inclusion of control schools would shift the research design from a non-experimental case study to a quasi-experimental design and would allow us to more confidently rule out threats to internal validity (i.e., alternative explanations), such as a history bias due to the occurrence of unexpected events unrelated to the greening (Shadish et al., 2002). Inclusion of random assignment to treatment or control would further strengthen the study, making it a true experiment or 'randomized controlled trial' – the gold standard for research methods – most resilient against threats to internal validity. Unfortunately, in this study, it was not possible to include control schools and random assignment. However by including a large group of children in the same age groups from five different primary schools, the study was designed to average out influences of unexpected events and other possible biases.

A second limitation concerns the fact that our research examined children of similar age in the same grades at pre- and post-measurement (between-subjects design), instead of following children over time (within-subjects design). This may have introduced a selection bias, making it difficult to separate differences in play behavior from baseline to follow-up due to the greening, from differences due to socio-demographic differences (e.g., in age, gender, socio-economic status). However, the children who were observed at baseline and follow-up were part of the same schools in the same neighborhoods, making the study a within-school comparison. It is unlikely that the socio-demographic characteristics of the children coming from the same neighborhoods have changed much over a few years. Indeed, the data on age and gender suggest that the samples at baseline and follow-up were highly comparable. The reason for not choosing a within-subjects design is that children's play behavior changes over time, making it difficult to separate changes in play behavior due to the greening from naturally occurring changes due to maturation. Given that our study encompassed three years, children in the older grades at baseline would be in their early teens at follow-up, an age at which they would perhaps even have 'outgrown' playing during recess. After consulting relevant literature and experts, we estimated that the threat to internal validity caused by the bias due to maturation would – especially for the older children at baseline - be greater than the threat resulting from selection bias. Nevertheless, though unlikely given the large sample size and similar demographics, it is still possible that differences in the personality and background characteristics of the pre- and post-groups of children influenced the results.

Third, due to the enormous amount of footage and our limited resources, each video could only be coded by one observer. Reliability of the coding was ensured in a qualitative way, but we did not obtain quantitative measures of inter-observer reliability. This may have compromised the accuracy of the coding, especially when a target area was densely crowded with children.

Fourth, for similar reasons, we could only code children's cognitive play behavior and non-play behavior. It was not possible to test for impacts of schoolyard greening on social play behavior (alone, parallel or in a group), which have been reported in previous research (Dowdell et al., 2011; Seeland et al., 2009).

Fifth, data collection at baseline and follow-up was restricted to one short recess period one day a year at each school. This makes observations sensitive to the influence of weather conditions, novelty effects of being video-taped, or extra-ordinary events during recess or in the classroom. However, video-observations were carried out in approximately the same period at each school every year, cameras were placed so that they would not hinder children's activities in the schoolyard, and special events were avoided. By expanding data collection to more than one day a year and for longer periods of time (e.g., during lunchbreak) future research may obtain more robust results that allow examination of individual trajectories of changes in children's play behavior.

Last, a major limitation of the present research is that as researchers, we had no experimental control over the design of the greening. Although all intervention schools had plans to substantially green their schoolyards, the quality and quantity of natural features were modest in some cases and all green schoolyards still contained substantial paved areas. In particular, it is questionable whether the green schoolyards were designed with sufficient natural loose parts that afford children to engage in creative and exploratory play behavior. This may have influenced our results, possibly leading to an underestimation of the impact of greening schoolyards on children's play behavior. Future research could benefit from the development of a tool to indicate the greenness and play value of a green schoolyard. This tool could support the design of green schoolyards and the explanation of research findings.

4.2. Conclusion and implications

The present research strengthens the rationale for greening schoolyards by underpinning the positive impact of greening on children's play behavior with a large quantity of observational data obtained at different schools. At the same time, it highlights the challenge to design green schoolyards that foster opportunities for all children to engage in the type of behavior that suits their needs and abilities, whether it is being physically active, creative, talking to a friend, or wandering around and finding a place to relax. For optimal results of greening, we recommend researchers and schools to co-work in developing a tool to assess the play value and naturalness of green schoolyard designs. Overall, the findings underscore the potential of greening schoolyards for creating inclusive play environments where children can prosper and grow.

Author statement

Janke E. van Dijk-Wesselius: Conceptualization, Investigation, Methodology, Writing- Original draft preparation. **Jolanda Maas**: Conceptualization, Investigation, Resources, Writing- Review and editing. **Mark van Vugt**: Supervision, Writing- Review and editing. **Agnes van den Berg:** Supervision, Methodology, Writing-Original draft preparation.

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