



Affordances in a simple playscape: Are children attracted to challenging affordances?

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ABSTRACT

Environmental psychologists have used Gibson's concept of affordances to understand the playing behavior of children. This concept refers to the action possibilities the environment offers the animal. The present study examined whether children are attracted to challenging affordances in a simple playscape. Thirty children aged between 7 and 10 years old played freely in a playscape consisting of blocks that varied in height and were placed at different distances from each other. After the playing, several perceived and actual action boundaries of the children were measured. The further the child can jump, the wider the gaps jumped across. Yet, overall the children tended to actualize affordances that were not challenging for them. Moreover, especially in going down and in crossing gaps of certain widths, children preferred to jump even when stepping was possible. The implications of these findings are explored for both theories of playing and the design of playgrounds.

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1. Introduction

Over the last decades, many environmental psychologists have found inspiration in the concept of affordances (e.g., Clark & Uzzell, 2002; Cosco, Moore, & Islam, 2010; Jansson, 2010; Sandseter, 2009; Storli & Hagen, 2010; Ward Thompson, 2013). In the 1960s and 1970s, the ecological psychologist Gibson developed this concept to refer to the action possibilities of the environment. "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or for ill" (Gibson, 1979/1986, p. 127; emphases in original). Gibson argued that the environment consists of affordances and that these action possibilities are the primary objects of perception. That is, we perceive the environment in terms of what behavior it affords (i.e. the floor affords walking, a chair affords sitting, etc.).

Developing an ecological approach to the behavior of children, Heft (1988), following Gibson, suggested that we need to describe their environments not in terms of forms but in terms of affordances. After all, for the playing child it is not the form of the environmental furniture that counts, but its functional significance, that is, what behaviors it affords. Drawing largely upon Barker and

Wright's (1951) detailed observational study of the activities of a seven years old boy on an ordinary day, Heft provided a preliminary taxonomy of affordances in children's outdoor environments. Over the years this taxonomy has been used and extended by environmental psychologists who study children's playing behavior (e.g., Sandseter, 2009; Storli & Hagen, 2010). Kyttä (2002), for example, used an extended version of the taxonomy to evaluate the differences in playing possibilities in urban and rural settings in Finland and Belarus (see also Kyttä, 2004). Similarly, Fjørtoft and Sageie (2000) used the concept of affordances to describe the natural environment "as a playground for children" (p. 83). And recently, Broberg, Kyttä, and Fagerholm (2013) defined the child-friendliness of environments in terms of independent mobility and the actualization of affordances. In the present study we aim at extending this work in the context of playgrounds, focusing on the invitational character of affordances, an aspect that has recently been brought to the fore in the ecological literature.

1.1. Affordances as invitations

Over the last few years, it has been suggested that affordances can have the potential to invite behavior (e.g., Heft, 2010; Withagen, de Poel, Araujo, & Pepping, 2012). That is, the environment is not a manifold of neutral action possibilities the acting animal intentionally chooses from; rather, affordances can attract or repel an animal and thus have an impact on which behavior is performed.

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This conception of affordances as invitations differs from the traditional notion of affordances that Gibson laid out in the 1960s and 1970s. Trying to make room for the idea that animals have agency, Gibson defined affordances in term of *possibilities for action* (see e.g., Reed, 1996; Withagen, de Poel, Araújo, & Pepping, 2012). Indeed, by arguing that affordances are not the *causes of behavior* but the *possibilities for behavior*, Gibson (1982) put the idea of agency and self-control central to his ecological approach. Thus, the environment does not push the animal around; rather, the environment affords a myriad of behaviors and the animal is in charge of which affordances will be actualized.

However, as any architect knows, environmental interventions can have an impact on what behavior is performed in a certain setting. Although they do not cause behavior, the interventions can solicit certain actions and thus make them more likely to occur. Architects create not mere possibilities for action but also “inviting forms” (Hertzberger, 1991; see also Rietveld & Rietveld, 2011; Ward Thompson, 2013). Interestingly, we often unreflectively respond to these invitations (Rietveld, 2008). As the phenomenologists Dreyfus and Kelly (2007) put it,

We sense the world's solicitations and respond to their call all the time. In backing away from the ‘close talker,’ in stepping skillfully over the obstacle, in reaching ‘automatically’ for the proffered handshake, we found ourselves acting in definite ways without *ever having decided to do so*. In responding to the environment this way we feel ourselves giving in to its demands. (p. 52; emphases added).

Although affordances can invite behavior, it is important to emphasize that the vast majority of them generally do not. As Gibson (1979/1986) recognized, even a single object generally affords a myriad of behaviors: “The fact that a stone is a missile does not imply that it cannot be other things as well. It can be a paperweight, a bookend, a hammer, or a pendulum bob. It can be piled on another rock to make a cairn or a stone wall” (p. 134). Yet only a selection of all the available affordances in a certain setting will attract or repel an individual.

A better understanding of when affordances invite is pivotal in the study of playgrounds (e.g., Cosco et al., 2010; Ward Thompson, 2013). First, it might help us to understand the attractiveness of playgrounds. In the second half of the previous century, several authors have noticed that many playgrounds were hardly appealing to children and were thus poorly visited (see Jansson, 2010; Solomon, 2005). A theory of whether and when affordances solicit playing behavior might elucidate the differential attractiveness of playgrounds for children. Second, this knowledge might be used to develop playgrounds that are frequently visited and encourage activities that contribute to the development of the children. And third, a theory of inviting affordances can help us to understand the behavior of children in playgrounds. Why are some affordances in a playground more frequently actualized than others?

Although authors from different academic disciplines have recognized the fact that the environment can solicit actions (e.g., Dreyfus & Kelly, 2007; Hertzberger, 1991; Rietveld, 2008; Withagen et al., 2012), at present the conditions under which affordances attract or repel an animal are still poorly understood (e.g., Ward Thompson, 2013). Withagen et al. (2012) suggested that invitations probably depend on the animal–environment relationship in multiple ways, and provided a tentative list of possible factors included. In the present study we will focus on one of the factors they suggested: the action capabilities of the body. More precisely, we will examine whether children are attracted to challenging affordances in a playscape.

1.2. The role of the body in which affordances are actualized

Although environmental psychologists have used the concept of affordances to understand humans' interactions with the environment, the role of the body has thus far received scant attention in their studies. However, as argued by Gibson (1979/1986) and other ecological psychologists (Chemero, 2009; Heft, 2001; Withagen & van Wermeskerken, 2010), affordances are relational properties—they exist by virtue of a relationship between the physical properties of the environment and the action capabilities of the body. As Gibson (1979/1986) put it, “[An affordance] is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer” (p. 129). Whether a gap affords stepping across for a child depends on the size of the gap *in relation to the maximum stepping distance of the child* (e.g., Chemero, Klein, & Cordeiro, 2003; Mark, Jiang, King, & Paasche, 1999). Hence, if we want to describe the affordances in a playground, we have to measure the physical properties of the objects and surfaces (e.g., height, width) relative to the action capabilities of the children. Moreover, action capabilities not only determine whether an action can be performed in a certain setting (i.e. whether an affordance exists) but also the effort that is needed to perform it (see e.g. Warren, 1984). Although a certain gap might be jump-across-able for two children, for one child it might be easy to jump across whereas for the other it can provide a real challenge. Accordingly, the effort that is needed to actualize an affordance is also a relational property depending on the physical properties of the environment *and* the action capabilities of the body.

There is reason to believe that the effort that is needed to actualize an affordance partly determines its attraction (Withagen et al., 2012), especially for children in playgrounds. Although not always available in (modern) playgrounds, it has been suggested that children are attracted to challenging and sometimes risky behavioral opportunities (e.g., Little & Eager, 2010; Morrongiello, 2004; Sandseter, 2009). And because challenges are relational this would mean that we have to take into account the action capabilities of the body to understand which affordances an individual child prefers to actualize. In the present study we aim to examine whether children are attracted to challenging affordances. To this end, we contrived a simple playscape consisting of blocks that varied in height, leading to different climbing opportunities. And by placing the blocks at different distances from each other we also created different gap widths that the children could cross. If children are allowed to play freely in this setting, which affordances will get actualized? And to what extent do the action capabilities of the child determine the preferences for the width of gaps crossed and the height of blocks climbed?

2. Methodology

2.1. Participants

Thirty children who had no experience with our contrived playscape participated in this study. One child was excluded from the data analyses because she fell in the beginning of the playing phase of the study. The age of the remaining children ranged between 7.33 and 9.73 years of age. There were eight boys and twenty-one girls. For safety concerns, we selected these children from various beginners classes of a circus club, ensuring that the participants had well-developed but not excessive motor skills. The study was approved by the local institution's ethics committee and parents gave permission for the participation of the children and for videotaping their children's behavior by giving their informed consent.

2.2. Design and procedure

The contrived playscape consisted of 24 blocks made out of extruded polystyrene foam (Roofmate, DOW, Netherlands). The length and width of the blocks was 50 cm and the blocks varied in height. The upper surface of the blocks was covered with corrugated rubber mats to prevent slipping. By placing the blocks at different distances from each other, we created a playscape with different affordances to be actualized. The selection of the heights of the blocks and the widths of the gaps was based on the predicted stepping capabilities of the children. In the literature, the affordances for stepping up a riser and stepping across a gap have been quantified as a percentage of leg length (e.g., Chemero et al., 2003; Warren, 1984). Hence, by using these findings in combination with anthropometric data of the leg length of children (TNO, 2010), we could predict their stepping capabilities. To test whether children are attracted to challenging affordances, we created blocks of different heights and gaps of different widths with the greatest height and the widest gap being close to the predicted maximum stepping-up riser height and maximum stepping-across gap width. The reason for basing the heights and the widths on the stepping capabilities of the children was two-fold. First, some of the blocks were rather high. Hence, if the gap width would be based on, say, the jumping capabilities instead of the stepping capabilities the gaps would have been wider, thereby increasing the risk on injuries. Second, basing the gap widths on the predicted stepping capabilities results in gap widths that can be found in playgrounds. For example, the stepping stones of Aldo van Eyck were placed in such a way that many of the children who played in them could step from one block to the other (see Fig. 12; see also the discussion). Hence, by creating gaps widths that were close to the ones that can be found in playgrounds we warranted the external validity of our study. Fig. 1 provides a detailed overview of the contrived playscape with information about the heights and the gap widths.

After the children expressed their willingness to participate in the study, we let them play freely in the playscape for 2 min. To awaken the children's interest, we asked them if they could inform

us afterwards whether they enjoyed playing in our playground. We videotaped the playing behavior with 2 cameras mounted approximately 3 m above the playscape.

After the playing phase, we measured standing height, leg length, and several perceived and actual action boundaries of the child. Following earlier studies on affordances (e.g., Konczak, Meeuwssen, & Cress, 1992; Warren, 1984) we determined leg length by subtracting the sitting height from the standing height. The children were first to stand against the wall and then to sit on the ground with their back against the wall and their legs straight. Leg length was computed by subtracting the child's height while sitting from the height while standing.

To measure the perceived and actual stepping- and jumping capability of the child, we used an apparatus similar to that of Chemero et al. (2003). We constructed a frame in which two extruded polystyrene foam platforms were placed: one of them was fixed, the other could be moved in the frame so that different gap distances could be created. Like the blocks, each platform had an upper surface of 50 cm × 50 cm and was covered with a rubber mat. For the stepping task, the experimenter first demonstrated what was meant with stepping—she stood with both feet at the edge of fixed platform and stepped to the other block, keeping one foot on either one of the blocks during the whole movement. Then the child had to stand on the fixed platform and the moveable platform was placed at a distance of 1 m from the child. The child was to judge whether she could cross this gap by stepping. If the child judged she could, we increased the gap distance with 5 cm; if the child judged the gap too wide, we decreased the distance with 5 cm. This procedure was repeated until the perceived maximum stepping distance was reached. After the perceptual judgment was made, the child was asked to step to the block at the perceived maximum, again starting with both feet at the edge of the fixed platform. Any time the stepping was performed successfully we increased the distance with 5 cm until the action could no longer be performed. If the child did not successfully step to the other block within two attempts, the gap size was reduced by 2.5 cm and the child was asked to try again. If the child had overestimated her maximum stepping distance in the perceptual task (i.e. the first

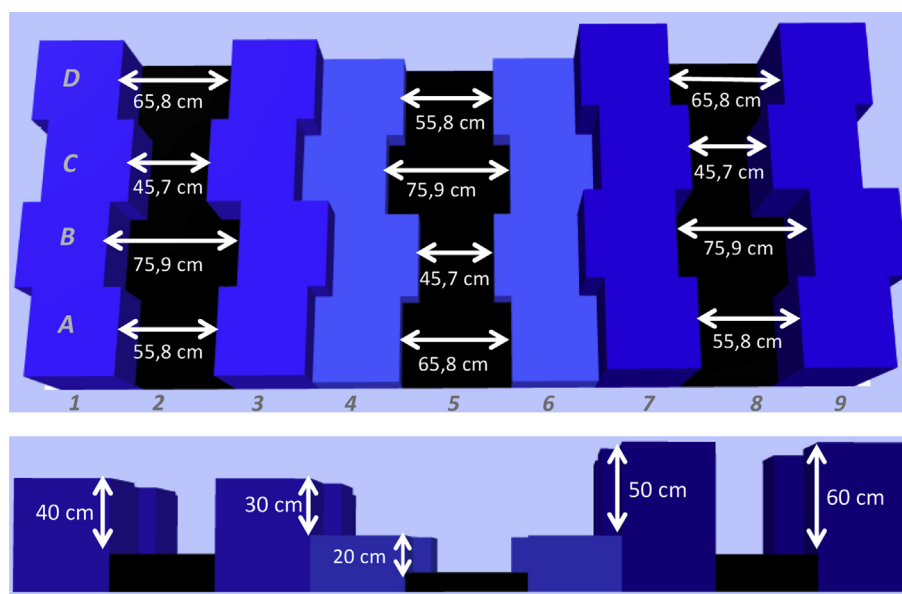


Fig. 1. The contrived playscape with the heights of the blocks and the widths of the gaps. Crossing the gap of 63 cm means that the child went, for example, from B1 to C3 or vice versa; and crossing the 72 cm gap means that the child stepped or jumped from, for example, A1 to B3 or vice versa. In computing these diagonals, an approximation of the general start- and end position of the gap crossing behaviors was made on the basis of the videotapes.

actual step could not be performed successfully) we followed the same procedure vice versa. We reduced the gap distance in steps of 5 cm until a successful step was performed and then increased the distance with 2.5 cm and asked the child again to step across the gap.

For the jumping task, the same procedure was followed. First, the experimenter demonstrated what we meant with jumping—she stood with both feet at the edge of the fixed platform and jumped to the other block, with both feet having no contact with either one of the blocks during a period of the movement. Then the moveable platform was placed at a distance of 1 m from the fixed block and the child was to judge whether she could jump to the other block. Again, the gap distance was increased or decreased in steps of 5 cm until the perceived maximum jumping distance was reached. In the actual jumping task, we adjusted the gap width in steps of 5 cm until we approached their maximum. Then, following the procedure of the stepping task, adjustments of 2.5 cm were made to have a more fine-grained measure of their actual maximum jumping distance.

A similar procedure was used to measure the children's perceived and actual boundaries of stepping up and stepping down. We had 11 slabs (50 cm × 50 cm) of extruded polystyrene foam: 8 of them were 10 cm thick, 3 of them were 3 cm thick. Five of the 10 cm thick slabs were piled up to form a block with a height of 50 cm. The experimenter first demonstrated what we meant with stepping up—she stood on the ground and stepped up the block without using hands and knees, and always having one foot on either the ground or the block. Then the child had to judge whether she could step up the created block. The height of the block was changed by adding or removing 10 cm thick slabs, depending on the judgment of the child. When the perceived maximum was approached the adjustments were made in steps of 3 cm to have a more precise measure of the child's perception of her ability. After the perceptual judgment was made, the child was to step up the just created block. Any time the behavior was performed successfully, we increased the height with 10 cm until the action could no longer be performed within two attempts. We then reduced the height using the 3 cm thick slabs to estimate the child's actual boundary of stepping up. In case the child overestimated her step-up capability (i.e. she could not successfully step up the block of the judged height), the height was decreased in steps of 10 cm until a successful step up was performed. We then increased the height in steps of 3 cm until the child could no longer step up the block within two attempts.

To measure the child's stepping down capabilities a similar procedure was followed. We demonstrated what we meant with this behavior by stepping from an 80 cm high block to a 30 cm high block that was placed against it. Performing this behavior, the experimenter did not use her hands and knees and always had contact with one foot on either one of the blocks. Then the child had to stand on the 80 cm block and she was to judge whether she could step down. The height of the “30 cm” block was then adjusted, by adding or removing slabs of 10 cm (and later of 3 cm). After the perceived stepping-down maximum has been reached, the child had to actually perform the behavior in which the height of the adjustable block was adjusted following the procedure of the stepping-up task.

2.3. Analyzing the playing behavior

The videotapes of the children's 2 min of free play were analyzed with The Observer XT Version 10.0 (Noldus Information Technology, Wageningen, Netherlands). The following behaviors of the children were coded: walking, running, standing still, stepping up, jumping up, climbing up, other going up, stepping down,

jumping down, climbing down, other going down, stepping across gaps, jumping across gaps, other crossing over gaps, and other. The criterion for coding behavior as stepping up, stepping across gaps, or stepping down were that the children had contact with one foot on the ground or blocks during the whole movement. For all three types of jumping behaviors, on the other hand, there should have been a period of time where the performer had no contact with the ground or blocks during the performance of the movement (Enoka, 2008). When children used knees or hands for going up or down from a block, this behavior has been coded as climbing up and climbing down, respectively (Warren, 1984). In walking the child had to have always one foot on the ground or blocks, whereas in running both feet should have no contact with the ground or blocks at some point during movement (Enoka, 2008). Every other way in which children went up or down a block or crossed a gap between the blocks was judged as one of the three other behaviors. Behavior that could not be classified in the above categories was coded as other. To determine the inter-rater reliability, two independent investigators coded the behaviors during the 2 min of free play of four participants (13.8% of the whole sample). The computed Cohen's kappa had a value of .890, indicating that the above behavioral criteria were sufficiently reliable.

To determine to which affordances the individual children were attracted, we conducted Friedman tests. This nonparametric test ranks the scores for each individual, and subsequently performs analyses on these ranks. A rank of 1 is assigned to the behavior that is least frequently performed by the individual child. The highest rank (which equals the number of used categories) is assigned to the behavior that is most frequently performed by the individual child. Hence, by converting the behavioral frequencies of each child to ranks and analyzing them, Friedman tests allow us to reveal which affordances the children prefer to actualize in the playscape. If the Friedman test revealed a significant effect, we conducted post hoc tests as described by Siegel and Castellan (1988, p. 180–181).

3. Results

3.1. Overall behavior in the playscape

Although the contrived playscape was relatively simple, it accommodated a wide variety of behaviors. Hence, we first examined which affordances were actualized during the 2 min of free play. To which affordances are the children attracted? For each child we ranked the behavioral frequencies during the play phase, thereby providing an overview of which behaviors each individual preferred to perform. The ranks averaged over participants are depicted in Fig. 2. A wide variety of behaviors occurred in the playscape. Children stepped, jumped and climbed up the blocks; they spent considerable time crossing the gaps between the blocks; they walked over the blocks; and when going down it seems that they had a preference for jumping. Not all of the performed behaviors could be coded in our movement classification scheme. Some children also spent time jumping on a plateau of blocks, stepping back and forth on a block, and one child even spent some time sitting on a block. In our analyses we will focus on both the gap-crossing behavior and the going-up and going-down behavior.

3.2. Gap-crossing behavior

We first tested whether the children had a preference for a type of gap-crossing behavior. For each child we counted how often the gaps were crossed by means of jumping, stepping, or other gap-crossing behaviors (e.g., using hands and knees). A Friedman test revealed a differential preference for gap-crossing behaviors ($X = 33.57$, $df = 2$, $p < .001$; see Fig. 3). Post hoc tests showed that

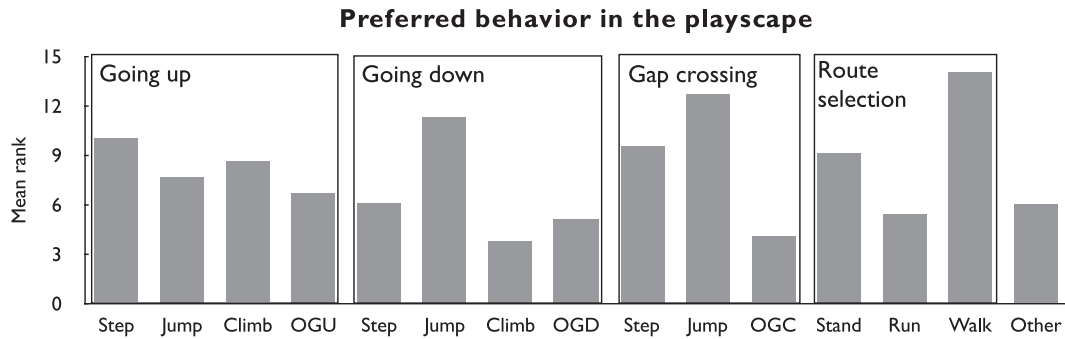


Fig. 2. The mean ranks of the performed behaviors: Going-up behavior (Going up), going-down behavior (Going down), gap-crossing behavior (Gap crossing), route-selection behavior (Route selection), and behavior that did not fit into our movement classification scheme (Other). OGU stands for other going-up behavior, OGD stands for other going-down behavior, and OGC stands for other gap-crossing behavior.

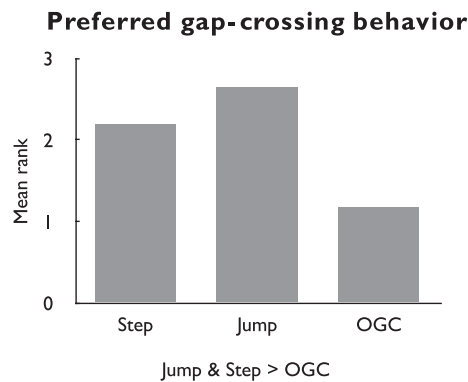


Fig. 3. The mean ranks of the gap-crossing behaviors: Stepping across gaps (Step), jumping across gaps (Jump), and other gap-crossing behaviors (OGC). Significant differences are mentioned below the figure.

children preferred jumping across gaps and stepping across gaps to other gap-crossing behaviors ($ps < .0083$).

The fact that children often jumped was not born out of necessity. Table 1 gives an overview of the perceived and actual stepping and jumping capability of each child. Even the widest gap (75.9 cm) afforded stepping across for all but one participant. Importantly, although the perceived maximum jumping distance was significantly smaller than the actual maximum jumping distance ($t = 9.17$, $df = 28$, $p < .001$), the perceived maximum stepping distance did not differ from the actual maximum ($t = 1.03$, $df = 28$, $p = .20$). Indeed, all the children that could step across the widest gap also perceived this gap as step-across-able. That is, children jumped across the gaps not because they could not step across them or perceived the gaps as such; rather, it seems that the children simply liked jumping.

To test whether certain gaps were more frequently crossed over than others, we counted how often each child crossed each gap, and subsequently ranked these frequencies for each child (see Fig. 4). As one can see in Fig. 1, crossing over the gaps of 45 cm, 55 cm, 65 cm, and 75 cm means that the child jumped or stepped to the opposite block; crossing over the gaps of 63 cm and 72 cm means that the child jumped or stepped diagonally. A Friedman test revealed a preference for gap width ($X^2 = 84.98$, $df = 5$, $p < .001$). Post hoc tests showed that children preferred the 45 cm gap to all the other gaps. Indeed, the mean rank of this gap is close to 6 (5.79), indicating that nearly all children crossed this gap more frequently than the other gaps. In addition, the gap of 55 cm was more frequently crossed over than the gaps of 63 cm, 65 cm, and 72 cm; and the gap of 75 cm was preferred to that of 63 cm ($ps < .0017$).

Table 1

The perceived and actual action boundaries for stepping and jumping across gaps of each participant.

Participant	Perceived max. stepping distance (cm)	Actual max. stepping distance (cm)	Perceived max. jumping distance (cm)	Actual max. jumping distance (cm)
1	95.0	97.5	105.0	160.0
2	80.0	102.5	105.0	137.5
3	90.0	100.0	100.0	105.0
4	95.0	90.0	105.0	107.5
5	95.0	92.5	95.0	120.0
6	75.0	87.5	105.0	130.0
7	90.0	92.5	100.0	127.5
8	90.0	92.5	115.0	140.0
9	90.0	95.0	100.0	115.0
10	100.0	92.5	105.0	147.5
11	85.0	95.0	105.0	127.5
12	95.0	97.5	105.0	117.5
13	75.0	60.0	80.0	85.0
14	90.0	92.5	110.0	145.0
15	105.0	87.5	95.0	107.5
16	100.0	90.0	105.0	152.5
17	100.0	105.0	105.0	130.0
18	85.0	97.5	105.0	122.5
19	95.0	90.0	105.0	115.0
20	85.0	92.5	105.0	122.5
21	100.0	105.0	115.0	162.5
22	105.0	112.5	117.5	170.0
23	90.0	110.0	100.0	155.0
24	90.0	90.0	100.0	125.0
25	100.0	100.0	105.0	145.0
26	95.0	87.5	115.0	152.5
27	100.0	95.0	110.0	117.5
28	85.0	87.5	105.0	140.0
29	80.0	87.5	110.0	125.0
Average (sd)	91.7 (8.16)	94.0 (9.39)	104.6 (7.26)	131.3 (19.7)

The fact that the gap of 45 cm was preferred to all the other gaps by nearly all children indicates that children frequently actualized affordances that were far from challenging. After all, for each child the 45 cm gap was easily step-across-able and jump-across-able (see Table 1).

To test whether the children's preferred gap-crossing behavior depended on the width of the gap, we counted for each child how often she crossed each gap by means of jumping, stepping or other gap-crossing behavior. Fig. 5 depicts the mean ranks of the crossing-over-gap behaviors for each gap width. Friedman test with ensuing post hoc tests showed that for the gaps of 45 cm and 55 cm, jumping and stepping was preferred to other gap-crossing behaviors; for the 63 cm gap, children preferred jumping to other gap-crossing behaviors; and for the gaps of 65 cm and 75 cm,

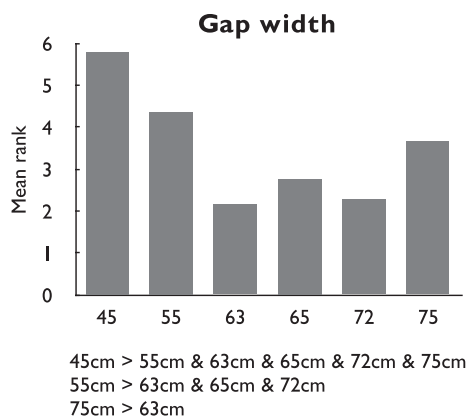


Fig. 4. The mean ranks of the different gap widths crossed over. Significant differences are mentioned below the figure.

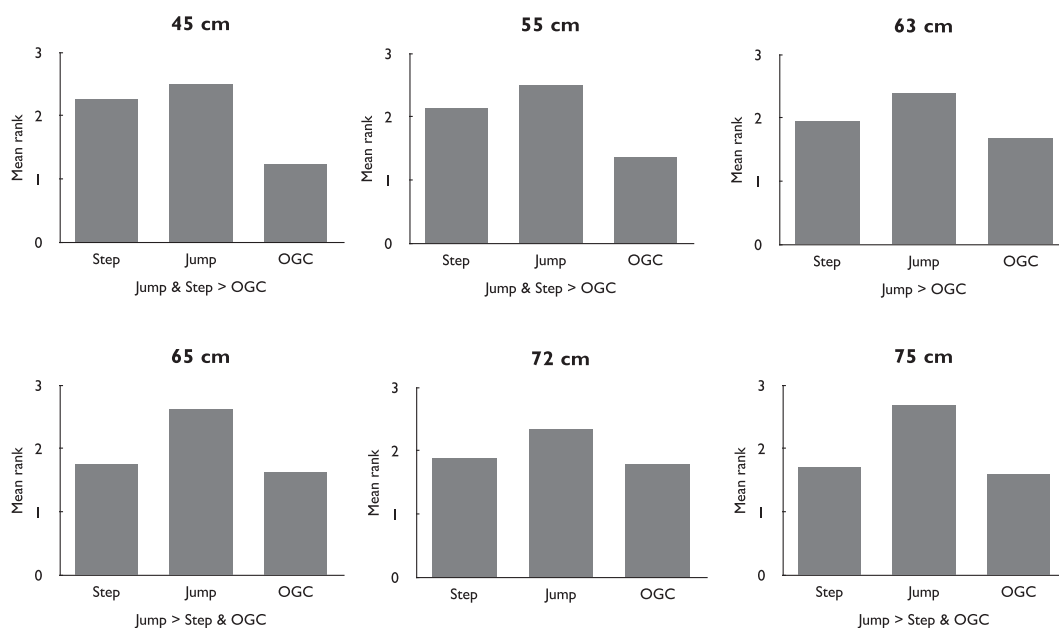


Fig. 5. The mean ranks of the gap-crossing behaviors for each gap width: Stepping across gaps (Step), jumping across gaps (Jump), and other gap-crossing behaviors (OGC). Significant differences are mentioned below the figures.

jumping was preferred to stepping and other gap-crossing behaviors ($ps < .0083$). Hence, the preferred gap crossing behavior depended on the width of the gap—when the width increased and stepping across the gap became more challenging, children turned to jumping. More notable, however, is the fact that even at the narrowest gaps (45 cm and 55 cm) children did not prefer stepping to jumping. That is, children often jumped over gaps, even if they could easily step across them.

However, as one can see in Table 1, the participants varied considerably in both their jumping and stepping capabilities. To what extent do these action capabilities of the child determine the selection of the gap widths jumped and stepped across? To answer this question, we computed the Pearson product moment correlation between the child's actual maximum jumping or stepping distance and the average gap width that the child jumped or stepped across during the 2 min of free play. We found no significant correlation for stepping ($r = .022$, $p = .91$) but we did for jumping ($r = .422$, $p < .05$). This indicates that the further the child can jump, the wider the gaps jumped across. Hence, although all

children crossed gaps of different widths, and there is a general preference for the narrowest gap, the jumping capabilities of the child do affect which gaps are jumped across.

3.3. Going-up behavior

In the contrived playground there were 5 different riser heights: 20 cm, 30 cm, 40 cm, 50 cm, and 60 cm (see Fig. 1). However, at the start of the 2 min of free play the children stood in front of the highest blocks (80 cm) and many children climbed one of them to enter the playscape. Importantly, during the play phase, children tended to stay within the field of blocks. Hence, in our analyses we limited ourselves to the riser heights that are depicted in Fig. 1. As one can see in Table 2, the riser height of 60 cm was not step-up-able for 2 of the 29 children. Moreover, children had a significant underestimation of their stepping-up capability ($t = 6.71$, $df = 28$, $p < .001$). In our playscape this meant that 13 of the 29 children who

could step up the riser height of 60 cm did not perceive this height as step-up-able (see Table 2).

To test whether children had a preference for a certain type of going-up behavior, we counted how often each child went up by means of stepping, jumping, climbing, or any other way (e.g., combining jumping and climbing by first placing their hands on the block and then jumping up). A Friedman test on these scores revealed a significant effect ($\chi^2 = 10.14$, $df = 3$, $p < .05$; see Fig. 6). Post-hoc tests showed that children preferred stepping up to other-going-up behaviors ($p < .004$). Children were also attracted to certain riser heights ($\chi^2 = 66.96$, $df = 4$, $p < .001$; see Fig. 7). Children preferred the riser heights of 20 cm, 30 cm, and 50 cm, to the riser heights of 40 cm and 60 cm ($ps < .0025$). This demonstrates that the children were not inclined to go up and down at the 40 cm and 60 cm riser heights at the sides of the playscape (see Fig. 1). Instead, they went up and down mainly in the middle of the landscape, suggesting that they performed this behavior primarily to go from one side of the playscape to the other.

Table 2

The perceived and actual action boundaries for stepping up and stepping down of each participant.

Participant	Perceived max. stepping-up height (cm)	Actual max. stepping-up height (cm)	Perceived max. stepping-down height (cm)	Actual max. stepping-down height (cm)
1	53.0	76.0	37.0	61.0
2	59.0	66.0	44.0	57.0
3	53.0	63.0	44.0	57.0
4	56.0	66.0	51.0	57.0
5	60.0	63.0	44.0	51.0
6	63.0	66.0	50.0	64.0
7	56.0	63.0	47.0	54.0
8	63.0	66.0	40.0	54.0
9	50.0	66.0	44.0	61.0
10	56.0	70.0	47.0	64.0
11	60.0	63.0	50.0	54.0
12	56.0	66.0	40.0	54.0
13	33.0	40.0	27.0	31.0
14	60.0	66.0	44.0	57.0
15	49.0	63.0	40.0	51.0
16	63.0	63.0	50.0	57.0
17	60.0	66.0	50.0	61.0
18	43.0	70.0	50.0	64.0
19	70.0	63.0	47.0	57.0
20	56.0	70.0	37.0	57.0
21	60.0	73.0	50.0	64.0
22	60.0	76.0	60.0	67.0
23	53.0	70.0	40.0	57.0
24	50.0	59.0	37.0	60.0
25	60.0	66.0	40.0	60.0
26	63.0	66.0	60.0	54.0
27	60.0	66.0	37.0	57.0
28	53.0	66.0	50.0	60.0
29	63.0	63.0	47.0	60.0
Average (sd)	56.6 (7.13)	65.5 (6.28)	45.0 (7.04)	57.3 (6.46)

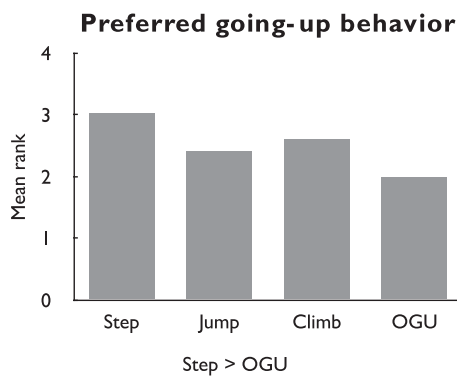


Fig. 6. The mean ranks of the going-up behaviors: Stepping-up (Step), jumping-up (Jump), climbing-up (Climb) and other going-up behaviors (OGU). Significant differences are mentioned below the figure.

To test whether the child's preferred going-up behavior depended on the height of the riser, we counted how often each child stepped up, jumped up, climbed up, or went up in another way at the different riser heights. The mean ranks of the going-up behaviors for each riser height are depicted in Fig. 8. Friedman tests with subsequent post hoc tests revealed that for the riser heights of 20 cm and 30 cm, children preferred stepping up and jumping up to climbing up and other going-up behavior; for the riser height of 40 cm, children preferred stepping up to jumping up; for the riser height of 50 cm, climbing up was preferred to jumping up; and for the 60 cm riser, children preferred climbing up to stepping up and jumping up ($p < .004$). Hence, the preferred going-up behavior depended on the riser height. When the riser height increased and

stepping up and jumping up became more challenging for the children (or even no longer possible), children started climbing up. However, again we observed that at riser heights that could easily be stepped up (20 cm and 30 cm), children did not prefer stepping to jumping. To determine whether the child's stepping-up capability is related to the height of the blocks stepped up, we computed the correlation between the child's average step-up height during the 2 min of free play and the child's maximum step-up height. The correlation was not significant ($r = -.010, p > .05$). Hence, we found no relationship between the selection of the heights stepped up and the capacity to do so.

3.4. Going-down behavior

We found different results for going-down behavior. We counted how often each child went down by means of stepping, jumping, climbing, and other going-down behavior (e.g. first going to sit on the block and then sliding down the block). The mean ranks of the different going-down behaviors are depicted in Fig. 9. A Friedman test with subsequent post-hoc tests revealed that jumping down was preferred to stepping down, climbing down and other going-down behaviors ($\chi^2 = 39.76, df = 3, p < .001$). Also, children preferred going down at the heights of 30 cm and 50 cm to descending the heights of 40 cm and 60 cm ($\chi^2 = 58.23, df = 4, p < .001$; see Fig. 10). Again, this indicates that children went up and down mainly at the center of the playscape, presumably to explore the whole field of blocks.

As one can see in Table 2, not all heights afforded stepping down for all children—17 of the 29 participants could not step down the 60 cm height. Moreover, the children had a considerable underestimation of their stepping-down ability ($t = 10.37, df = 28, p < .001$). Although all but one participant could step down the heights up to 50 cm, 19 of the 29 participants perceived the 50 cm height as not affording this behavior.

To test whether the preferred going-down behavior depended on the height of the blocks, we counted how often each child stepped down, jumped down, climbed down, or went down in another way at the different heights. As depicted in Fig. 11, Friedman tests with ensuing post-hoc tests showed that for the heights of 30 cm, 40 cm, and 50 cm, jumping down was preferred to stepping down, climbing down and other going down behaviors. For the height of 20 cm, there was no significant difference between jumping down and stepping down, although these behaviors were preferred to climbing down and other going-down behaviors. Hence, although the going-down behavior that is demonstrated in the playscape depended to some extent on the height to be descended, there was a general preference for jumping down, even

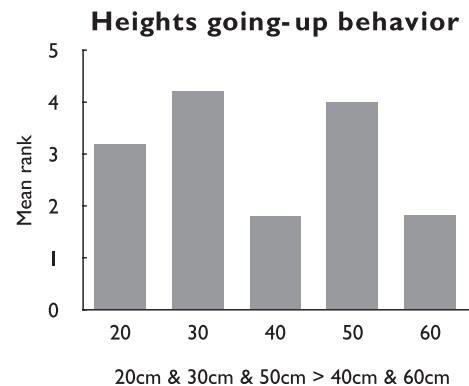


Fig. 7. The mean ranks of the different riser heights went up. Significant differences are mentioned below the figure.

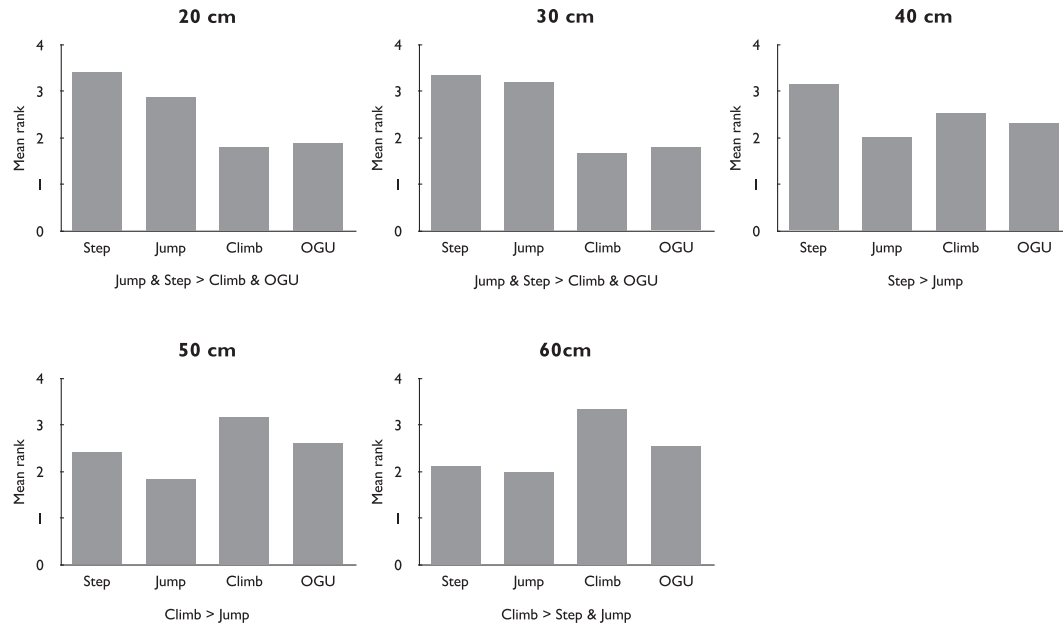


Fig. 8. The mean ranks of the going-up behaviors for each riser height: Stepping-up (Step), jumping-up (Jump), climbing-up (Climb) and other going-up behaviors (OGU). Significant differences are mentioned below the figures.

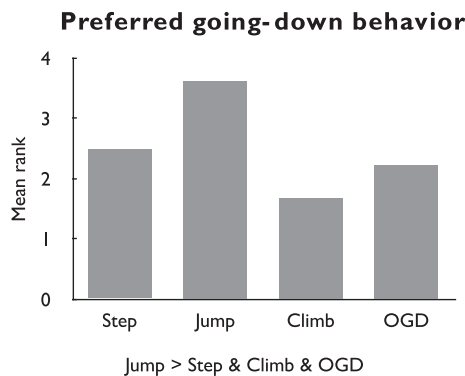


Fig. 9. The mean ranks of the going-downs behaviors: Stepping down (Step), jumping down (Jump), climbing down (Climb) and other going-down behaviors (OGD). Significant differences are mentioned below the figure.

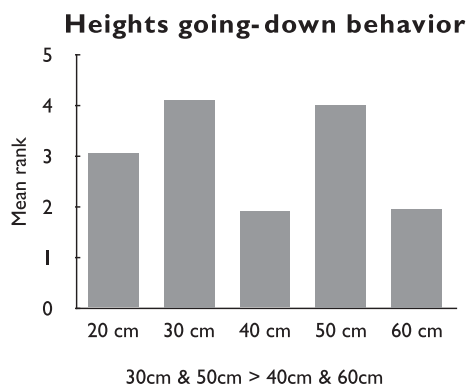


Fig. 10. The mean ranks of the different riser heights went down. Significant differences are mentioned below the figure.

at heights that afforded stepping down. Again, we found no significant correlation between the average height that the child

stepped down during the play phase and the child's actual stepping-down height ($r = .117, p > .05$). Thus, the child's selection of the heights stepped down seemed not related to the child's capacity to do so. All in all, this suggests that children jumped down not because stepping down was too demanding; rather, it seems that they simply preferred it.

4. Discussion

The present study examined whether children are attracted to challenging affordances in a playscape? To this end, we contrived a playscape consisting of blocks that varied in height and that were placed at different distances from each other. Children were allowed to play freely in this playscape for 2 min. We analyzed the behavior that occurred, focusing on gap-crossing behavior, and going-up and going-down behavior. We found that the selection of the gaps jumped across depended on the children's maximum jumping capabilities. Yet, overall children tended to cross over gaps that were not challenging for them. In addition, we found that the widths of the gaps and the heights of the blocks determined at least to some extent how the children crossed the gaps and went up and down the blocks (i.e. by means of stepping, jumping, or climbing). However, when it comes to going-down behavior and crossing gaps of certain widths, the children preferred to jump, even when stepping was possible. In the remainder of the discussion we aim at elucidating these findings and explore their implications.

4.1. Jumping as a “kinetic marker” of playing

In the contrived playscape, all but one child could cross the created gaps by means of stepping. Yet, the children often jumped, not only at the wider gaps of 65 cm and 75 cm but also at gaps that could be relatively easily stepped across (45 cm and 55 cm). Also in going-down behavior, this preference for jumping manifested itself. At all but the smallest and greatest height, jumping down was preferred to any other way of descending. And even at the height of 20 cm in which stepping down was easy, children frequently

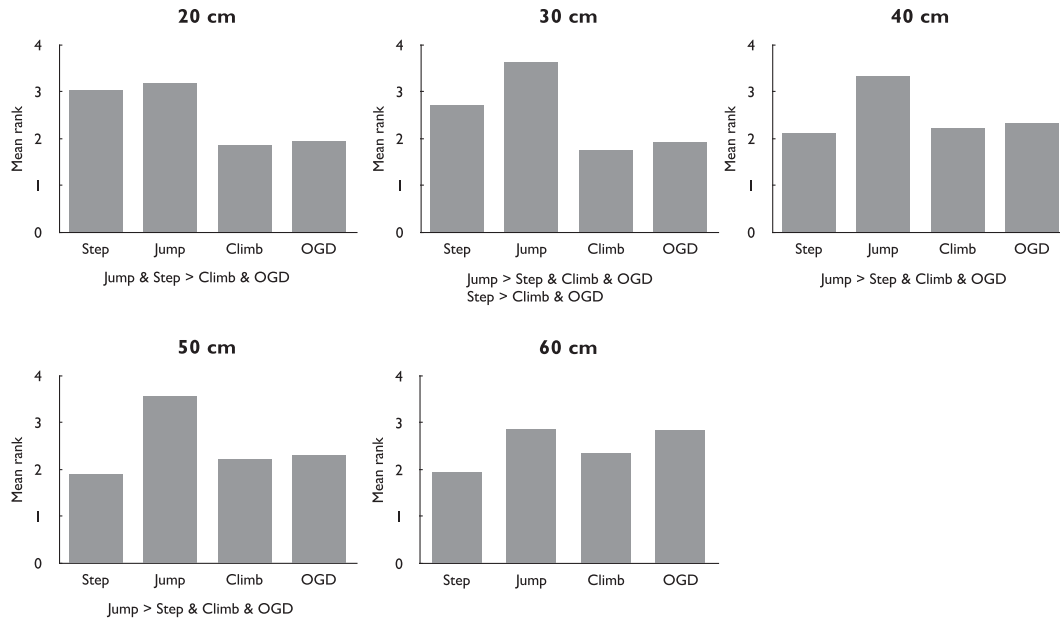


Fig. 11. The mean ranks of the going-downs behaviors for each riser height: Stepping down (Step), jumping down (Jump), climbing down (Climb) and other going-down behaviors (OGD). Significant differences are mentioned below the figures.

jumped. How to account for these findings? Why are children more attracted to jumping affordances than to stepping affordances?

One possible explanation comes from phenomenology. In her study of child's play, the philosopher [Sheets-Johnstone \(2003\)](#) discussed approaches that consider play to be purposeless or emphasize its developmental aspects and/or its evolutionary role. In her view, these approaches are misguided and provide a lopsided view on play at best. Indeed, they miss out on the experiential dimension that is key to playing. Drawing upon ethology, psychology and [Darwin's \(1872/1999\)](#) seminal work on emotions, Sheets-Johnstone argued that playing constitutes "a kinetic joyride" (p. 416) in which we learn our bodies and that of others (see also [Sheets-Johnstone, 1999](#)). "[M]ovement is in and of itself engaging, fun, and delightful, and it is engaging, fun, and delightful because it resonates in feelings of aliveness radiating dynamically through a kinetic/tactile-kinesthetic body" ([Sheets-Johnstone, 2003](#), p. 417).

That playing is a bodily event is arguably best demonstrated by the particular movement patterns that constitute it. While playing, human and nonhuman animals alike run, chase, flee, laugh, etc. (see e.g. [Blurton Jones, 1969](#)). [Sheets-Johnstone \(2003\)](#) called these movement patterns the "kinetic markers" (p. 410) of playing, and jumping is seen as one of them. Indeed, jumping expresses a liveliness that is part and parcel of playing. Whereas stepping articulates a weariness, jumping signifies joy. Hence, the fact that the children actualized jumping affordances in our playscape indicates that they were actually playing.

4.2. Children and challenging affordances

The aim of this study was to examine when affordances solicit actions (e.g. [Ward Thompson, 2013](#)). Based on earlier studies on playing behavior (e.g., [Little & Eager, 2010](#); [Morrongiello, 2004](#); [Sandseter, 2009](#)), we hypothesized that children will opt for challenging affordances in a playscape. And as argued in the introduction, challenges have to be understood relationally—whether actualizing an affordance is challenging depends on the physical properties of the environment *relative to* the action capabilities of the child.

Contrary to our hypothesis, we found that while playing in the contrived playscape children tended to actualize affordances that did not provide a serious challenge for them. Although the average gap width the child jumped across was positively related to the child's maximum jumping distance, nearly all children preferred to cross the narrowest gap to all the other gaps. Also in going-up and going-down behavior, we observed that the greatest height, which obviously provided the biggest challenge for the children, was not among the preferred ones. Apparently, children are attracted not to affordances that are challenging for them but to affordances that they could easily actualize.

However it is important to emphasize that the vast majority of children explored the whole playscape during the 2 min of free play. That is, they crossed gaps of different widths and went up and down risers of different heights, thereby actualizing affordances with different degrees of difficulty for them. Hence, although children often opted for affordances that were relatively easy to



Fig. 12. Zaanhof playground in Amsterdam designed by Aldo van Eyck. (Courtesy of the Amsterdam City Archive).

actualize, they sought more challenging ones occasionally. This brings us to the implications of our study for playground design.

4.3. Implications for playground design

Over the last decades several playgrounds have been designed with structures similar to the one we contrived. Consider for example the playscapes of Aldo van Eyck. This Dutch architect designed more than 700 playgrounds in Amsterdam after the Second World War, consisting mainly of neutral forms intending to stimulate the behavioral creativity of the children (van Eyck, 2008; Lefavre & Tzonis, 1999; Solomon, 2005). Among the central elements in his playgrounds are the jumping stones (see Fig. 12). These round, concrete blocks were often placed in a nice symmetrical form with a limited variety of distances between them.

Our study suggests that such configurations insufficiently reckon with the variation in motor skills among children. Indeed, children vary in their maximum jumping distance and, as mentioned earlier, we found that the further the child can jump, the wider the gaps jumped across. Hence, if we want to take this relation into account in our designs we should not place the blocks at equal distance from each other; rather we should create a variety of distances between the blocks. This would allow children to select gap widths that fit their action capabilities.

Such a configuration would also be in accordance with our observation that the vast majority of children, although attracted to the narrowest gap, tended to cross gaps of different widths. Children opted for variation. Moreover, creating variation in the distances between the blocks would be in line with the current knowledge on motor learning. Authors working from different theoretical approaches have suggested that motor skills do not so much improve by continuously replicating the same movement; rather, variability of practice facilitates the learning process (e.g., Chow, Davids, Hristovski, Araújo, & Passos, 2011; Schmidt, 1975; Schmidt & Lee, 2003; Schöllhorn, Beckmann, & Davids, 2010). That is, to develop and learn a skill it should be performed in different ways and in different contexts. Setting out the implications of his theory, Schmidt (1975), for example, argued that, “one of the important thrusts is that children should engage in activities stressing variety in movement patterns (e.g., jump over an object in as many ways as possible)” (p. 257). Interestingly, Nebelong (2004), a landscape architect who argued against common standardized playgrounds, gave a similar advice, based on related grounds.

I am convinced that ‘risk-free’, standardized playgrounds are dangerous – just in another way from those with obvious risks. When the distance between all the rungs in a climbing net or a ladder is exactly the same, the child has no need to concentrate on where he puts his feet. Standardization is dangerous because play becomes simplified and the child does not have to worry about his movements. This does not prepare him for all the knobby and asymmetrical forms he is likely to be confronted with outside the playground and throughout life. (p. 30).

Hence, the above considerations suggest that in designing playgrounds we need to create variation. By doing so, we would take into account the differences in action capabilities among children and also follow theories about how these capabilities can improve.

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