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Stand(ing)still?! Exploring Motion Affordances in Learning Environments as a Lever for Better Motor Skills in Youngsters

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Abstract. Designing learning environments is challenging due to the dichotomy of the slow pace in which the discipline of architecture and the built environment evolve, and the fast-changing society in which youngsters are educated. However, the challenge posed by youngsters' exacerbated sedentary life style (i.e. due to usage of digital devices and the passive covid-period) urges us to reflect upon the role that the environment can play in their physical fitness and wellbeing, more specifically by looking at how the environment affords youngsters to be in motion. We hypothesize that reimagining schools in order to boost a physically active life could translate into better motor skills. A first question to be answered therein is: how do youngsters 'read' and pick up various types of motion affordances in the environment? This current blind spot is our focal point. In this paper we report on the findings of an experiment in which 14 pupils (aged 8-14) visited a university campus. They were asked in three different scenarios to perform motor activities in a specific room driven by what that room had to offer spatially (ranging from its structural elements to interior equipment/detailing). The exercise was repeated in three typical university spaces: cafeteria, auditorium and agora. The youngsters were recorded on film; using the Test of Gross Motor Development-3, their movements were analyzed on (1) uniqueness of motor activities performed, (2) type of motor activities, (3) notion of competence. Preliminary results showcase that youngsters are creative in their movement behavior and use different spatial elements present, but mainly perform locomotor actions. They display little stability/balance, and object control actions. This explorative study hints at a deeper attention to the two latter aspects of motor skills, as these are also crucial in the transitioning process from basic to specific motor skills, occurring at that age.

Keywords. Architectural design, learning environments, motion affordances, motor skills, youngsters

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1. Introduction

The first years of the 2020s have put stress on the spatial and organizational structure of schools in Flanders. Pressing issues in the field of education further magnified such as the difficulty of engaging pupils during periods of home-schooling [e.g. 1], pupil and teacher wellbeing, and the relation between achievement and engagement [e.g. 2]. Since the health crisis has moved into calmer waters, other issues started to reveal themselves, such as the influence of digital home-schooling on the physical activity and thus motor competence of pupils, and the growing problem of obesity [3, 4], These aspects all concern both the physical and psychological wellbeing of pupils, and have a strong connection to the spatial, architectural environment in which the education takes place (whether this is the school site, the home office or another out-of-class learning space). It has been pointed out that design has the power to change perspectives and facilitate access to another lifestyle [5], in this context, a more energetic and engaged school life. However, related to design in school environments, two wicked problems can be identified: the design methodological realization of 'optimal' school environments and the 'sedentary' character of school, campus life and the people therein.

Tackling the intricate challenge of realizing optimal school environments for more wellbeing poses a significant dilemma within architectural discourse, marked by complexities both in conceptualization and execution. Despite an extensive body of research [e.g. 6, 7], a robust knowledge foundation enabling designers to create evidence-based educational spaces remains elusive. Studies in the physical, social and academic conditions of the environment have grown in recent years and the built environment in this context has also been seen as a didactical agent for positively influencing learning and teaching processes [8, 9, 10, 11]. Notably, studies too often overlook the crucial integration of pedagogical practices into spatial design [12], impeding designers' ability to align educational strategies with architectural configurations. Notwithstanding, paradigms such as 'Design for Human Flourishing' [13, 14], and 'embodied cognition' [15] have shown that the environment can contain and be designed to 'afford' certain behavior. In terms of implementation, the inertia ingrained within architectural landscapes often perpetuates stasis within school environments, despite the dynamic evolution of curricula in response to societal shifts [12, 16]. This is in part due to the 'slowness' of the architectural domain in general and school typology in particular. Indeed, the patrimonial state of education in Flanders remains rather problematic, as more than 50% of the schools are still located in the same type of buildings or have the same interior as during the second part of the 20th century, and are facing deferred maintenance [17, 18, 19]. A recent endeavor to assimilate emerging trends and harmonize educational fabrics resulted in a building wave of mostly newly built projects [17, 20], but focusing mostly on the level of the masterplan (e.g. a school program with non-school programmatic elements, such as a nursery) and on a more active relation with the urban/rural fabric [18], but not on an individual, wellbeing-level. Thus, a dearth of nuanced insights prevails regarding the intricate interplay between pedagogical imperatives and spatial wellbeing. Moreover, a detailed take on the not-yet-refurbished patrimony and its challenges and potentials is missing. Hence, there exists a pressing need to galvanize actionable insights that can inform the design trajectory. Such insights would foster a more symbiotic alignment between pedagogical principles and spatial considerations within educational environments.

Regarding the 'sedentary' character of school life, in Flanders, the standard educational model heavily relies on traditional in-class learning [see 21], closely

associated with desk-bound instruction and frontal teaching methods [22, 2]. While these approaches have their merits, they can also hinder teachers from implementing innovative techniques [23]. Moreover, they may negatively impact students' motor skills, their inclination towards physical activity [24, 25] and their overall physical health [26]. Additionally, such methods can impede students' engagement and academic performance [27, 28]. Research indicates a positive correlation between active, dynamic learning approaches and increased engagement in the learning process [28, 29].

Unfortunately, the energy aspect remains largely untapped in educational settings. For example, in Flanders, a research study examining flexible learning approaches in primary and secondary schools [30] primarily focused on digital learning outside of school premises [e.g. 31], neglecting more dynamic in-class or out-of-class learning opportunities. However, some participants in the study highlighted the need for energetic learning methods. This aligns with international research emphasizing the benefits of connecting with the natural world [32, 33], which is linked to experiential learning and increased pupil engagement. Indeed, the sedentary behavior is already prevalent among primary school children and continues into secondary education, underscoring the importance of addressing this issue.

In concrete terms, youngsters must be consistently motivated and encouraged to engage in physical activity. During their formative years, they develop fundamental movement skills that will serve as building blocks for more complex movements later in life. This will also contribute to the adoption of a more active lifestyle and better overall health. It is assumed that combining an active lifestyle with academic education could positively impact better mental health outcomes [34]. It is important to recognize the interplay between physical activity throughout life and fundamental movement skills. This can be an essential factor in the overall promotion of physical activity for youth.

Thus, the prevailing inertia within school typology and the augmented sedentary lifestyle of children raises questions about the extent to which the environment can address pressing wellbeing and health concerns today. Is it feasible to unlock the latent spatial potential within existing school infrastructure to enhance overall pupil wellbeing? Can the environment ‘afford’ pupils to more active, and are these so-called ‘affordances for motion’ picked up by pupils? These questions prompt further exploration, considering studies that have underscored the potential benefits of leveraging spatial design to improve wellbeing aspects [see 35, 36].

What we have now, are for instance Flexible Learning Spaces (FLS), that offer some adaptability within school environments. However, these often limit themselves to indoor spaces and fail to explore the broader potential of the school environment or "stray spaces" [2]. Therefore, we take the unique perspective of researching the synergy between the architecture of school environments and the motivation to be physically active, increasing energy of pupils. Our working hypothesis then, is that enriching school environments with stimuli for motor competence can positively influence energy (physical wellbeing, motor competence) and eventually also engagement (psychological wellbeing, participation) and thus overall wellbeing of the pupils.

This can be translated into the following research question that we zoom in on, in this research paper: **How do youngsters ‘read’ and pick up various types of motion affordances in the environment?**

We focus on children between 8 and 14 years old, the period between primary and secondary school that marks the transition towards adolescence. This age group has been studied relating their physical activity [e.g. 37], but appears to form a hiatus in international literature on the link between motor competence and emotional,

psychological wellbeing [see 38, 39, 36]. In our discussion section, we will answer to our research question, and in the conclusion section, we will broaden the scope and reflect on how the field of architectural design can better support diverse motor activities in school environments.

2. Methodology

In order to answer to the research question, two instructors performed an exploratory study via a novel protocol in which 14 pupils (aged 8-14) visited the university campus of Hasselt University in Belgium. Youngsters were recruited via the concept of 'children university', a day on which the university launches various science activities in which children between 8 and 18 can enroll, in order to let them get in touch with science and the university work. University professors can develop activities linked to their research topics, which was the case for this study. We did cap the age limit at 14, due to aforementioned reasoning. The participation call was launched via the university's social media platforms and local television and media. In that way, children in the Flanders region could subscribe to come to Hasselt university.

In our study, the pupils were asked in three different scenarios to perform motor activities in a specific room driven by what that room afforded spatially (ranging from its structural elements to interior equipment/detailing). The exercise was repeated in three typical university spaces: cafeteria, auditorium and agora, as these stand for typical spatial educational settings in Flanders. Anticipating a diversity of participants and thus a variety of movement intentions stemming from different abilities, we presented the participating youth with an additional challenge. In each of the three designated rooms for physical activity, they were tasked with assuming both their own perspective and that of a designated other person: (i) an elderly person with diminished physical capabilities, such as their grandparents, (ii) a peer who had sustained an injury like a broken arm or leg, (iii) a youngster disinclined towards sports or physical activity.

At the conclusion of each session of movement exploration, we prompted the youth to individually depict through drawings their experience of movement, identifying the features that elicited their physical behavior and suggesting adaptations to the environment to facilitate a broader range of physical movements.

When welcoming the youngsters, we commenced by acquainting the youth with the (fictional) fact that the university building stood vacant and was earmarked for conversion into a facility tailored for children's physical activities. We articulated to them that they served as the focal point of our study, enabling us to gauge how the existing structural layout, furniture arrangements, and décor might already promote and facilitate physical movements. The objective we shared with the youngsters was to ascertain which structural components and furnishings within the edifice could be retained and repurposed for its prospective function. The latter could prompt our curiosity regarding the innovative ways in which the youth would engage with the architectural elements, furnishings, and materials commonly encountered in educational settings. It is also noteworthy that we refrained from disclosing the specific motor movements or motor skills to the children. Instead, we entrusted them with the task of employing their imaginations and freely utilizing the space to engage in physical activity.

The experiment spanned 90 minutes and adhered to the following structure:

- 20 minutes of instructional briefing
- 20 minutes allocated for activities in the cafeteria space

- 20 minutes allocated for activities in the auditorium space
- 20 minutes allocated for activities in the agora space
- 10 minutes designated for summarizing and a group photograph

Each 20-minute block spent in one of the three university spaces was structured as follows:

- 7 minutes dedicated to movement exploration from the youngster's personal perspectives
- 7 minutes allocated for movement exploration from the perspective of the designated other person (i.e. the elderly person, the peer with an injury, and a youngster disinclined to be physically active)
- 5 minutes allotted for sketching the features facilitating movement and identifying necessary physical adaptations.
- Throughout the execution, the two instructors meticulously observed the participants, via an overt, observer-approach. The researchers documented the childrens' movements through film, photographs, sketches, and field notes, see Figure 1.

3. Analysis of results

In In this paper, we will use the concept of objective motor competence, i.e., one's ability to perform motor action [40], as our leading definition to anchor physical activity of youngster to. Regarding the types of motor activities, fundamental movement skills are generally classified in academic literature into three overarching types [41, 39, 42].

(1) locomotor skills: e.g., running, hopping, jumping, gliding, galloping, leaping;
(2) object control/manipulative skills, e.g. hitting, dribbling, kicking, throwing, forearm rolling, catching;
(3) balance/non-locomotor skills, e.g., balancing, body rolling, bending, twisting.

In order to answer our research question and as we asked youngsters to execute all motor activities that came into their mind, we will firstly (1) map and describe the unique types of movements we could capture. Secondly, in analyzing our data, we will use the TGMD-3, Test Gross Motor Development 3 [see 43]. The TGMD-3 evaluates gross motor skills across two main categories: locomotor skills (e.g., running, hopping) and object control skills (e.g., catching, kicking), providing a comprehensive assessment of a child's gross motor abilities. It includes a variety of tasks that capture different types of movements, allowing for a more thorough examination of motor proficiency. The test is designed for children between 3 to 10 years old and uses a scoring system that evaluates the quality of movement performance based on predetermined criteria for each skill assessed. As our purpose was to use totally diverse motor actions and their competence within youngster, we found it better suited than for instance the KTK3+, Körperkoordinationstest für Kinder, test battery. While the KTK3+ assesses specific aspects of gross motor coordination such as walking backward, moving sideways, jumping sideways, and hand-eye coordination, it may not cover as wide a range of movement variety as the TGMD-3. The KTK3+ primarily focuses on coordination tasks and may not include as diverse a set of movement patterns as the TGMD-3. Therefore,

if the goal is to assess the diversity and range of movement skills in children, the TGMD-3 may be more suitable due to its broader scope and inclusion of various motor tasks.

3.1. Step 1_Mapping the unique types of movement

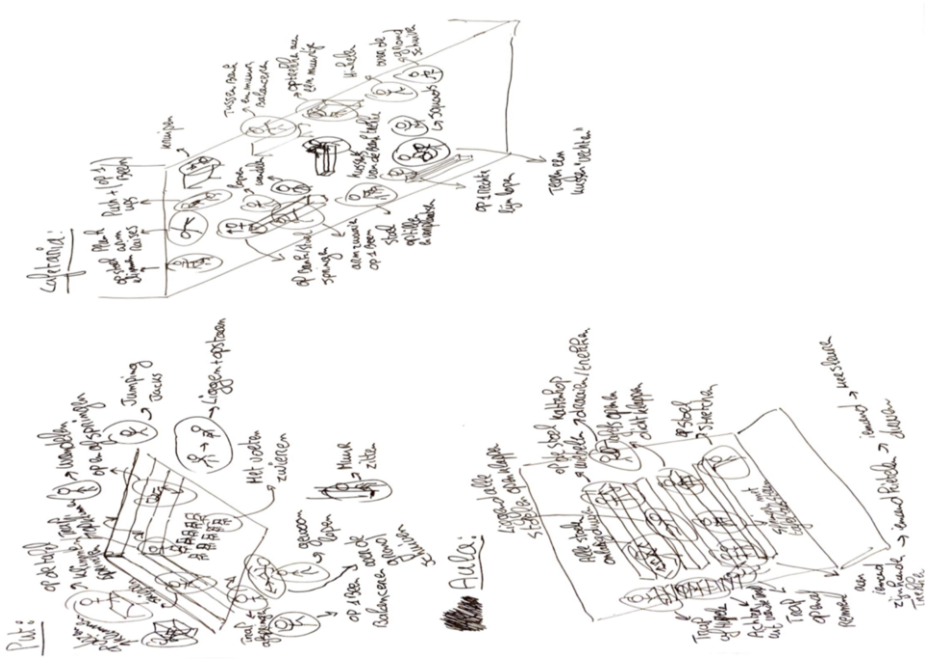

Figure 1. Field sketch of the instructors, capturing the unique motor actions performed by the youngsters in all three spaces.

Out of the observations, we noticed that youngsters did exhibit a propensity to "explore" the architectural structure and furniture within the space, demonstrating varying approaches to their use. While some children interacted with the furniture in conventional ways, such as unfolding chairs and tables in the auditorium or sitting on them (occasionally fidgeting with their feet), others engaged with the furniture in unconventional ways, such as using chairs for push-ups or soft seating elements as makeshift "punching bags", see Figures 2 and 3.

The children engaged in both sporting movements and exploratory activities. During exploration, they investigate how certain materials function, such as unfolding tables or lifting cushions. Sporting movements observed include wall-sitting, push-ups, running, and squats.

This indicates that children tend to utilize the furniture, objects, and structures within the space as aids for their actions, demonstrating a preference for not only performing actions on the ground but also on items, such as tables and chairs.

Primarily, boys were observed climbing various objects such as the red bench in the cafeteria or wooden structures in the agora (see Figure 3), whereas girls typically limited

their climbing to rather safe tables or chairs (see Figure 2). Additionally, boys were more likely to engage in playful activities such as pulling cushions off the couch, and engaging in "fights". However, regarding the activities that both boys and girls engaged in, girls often demonstrated a more graceful execution.

Figure 2. Girls performing motor actions

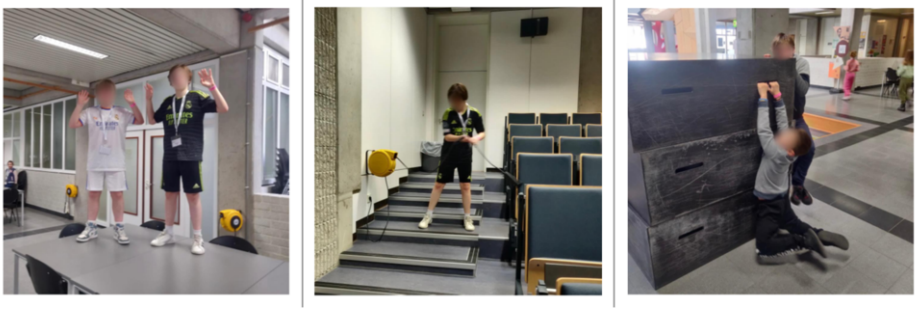

Figure 3. Boys performing motor actions

While certain movements recurred frequently, there is variability in their execution. For instance, some youngsters performed "regular" push-ups, while others opted for variations such as single-leg push-ups or using both legs on a chair. Similarly, in the auditorium, youngsters navigated the stairs in various ways, including walking normally, walking backwards, or jumping. The choice of surface for jumping also varies, with children jumping in place, off small steps, onto tables, or off chairs, tables, or benches.

3.2. Step 2_Classifying the types of movement in the motor competence spectrum

In order to see our data in the light of the motor competence definition, we sorted the motor actions that the youngsters executed per university space and per type of motor skill, see Table 1.

Table 1. Captured unique motor actions per university space and per type of motor activity.

	Locomotor skills	***Manipulative skills***	***Balance***
Cafeteria	-Climbing on a chair -Push-ups --regular	-Taking the cushions off the benches -Fighting	-Trying to walk on 1 straight line, balancing on the line

	--one leg --legs on a chair and the hands on the ground -Lying on the ground, moving with the arms -Crawling -Running around -Walking around -Standing on a chair/bench -Standing on it and jumping -Jumping on the spot -Sliding on the ground -Squads -Hopping -Lying on the table -Pulling oneself up to a wall	--with each other --with the soft seating element -Lifting and moving chairs	-Pulling oneself up using a wall and chair as an aid, and balancing in the air -Placing leg on chair/table
Auditorium	-Lying on the chairs -Jumping with the tables as an aid (support) -Hopping down the steps -Walking down the stairs backwards -Running up and down the stairs	-Unfolding the chairs - Opening and closing the tables -Twisting/pulling the extension cord	-Wobble when sitting on the chairs -Stretching with a chair as an aid
Agora	-Lying down and standing up -Jumping jacks -Running around -Walking around -Sliding on the ground -Jumping down the steps -Climbing the steps -Skipping a step	-Wall-sitting -Climbing on boxes -Standing on a table	-Sitting on a chair and swinging your legs -Balancing on one leg

What was notable in any of the three spaces, was that youngsters are predominantly engaged in locomotor movements, such as jumping, running, and lying, using the main structures that were available, such as the floor, the walls, the fixed furniture such as tables and chairs present in the auditorium, see Figure 4. Additionally, they often performed activities that were acquainted via their hobbies, such as stretching, wall-sitting, jumping jacks, and push-ups. There was no immediate distinction observed between boys and girls in these activities.

Comparing the movements to the TGMD-3, the locomotor skills tested therein incorporate the skills ‘run, gallop, hop, skip, jump and slide’. The youngsters showcased the entire spectrum incorporated in the TGMD-3.

Regarding the other two categories in the motor competence spectrum, of manipulative skills and balance skills, fewer types of movements were observed. That could be explained by the fact that there were little loose objects present in all three spaces, to manipulate. For the category of balance skills, the youngsters did seek intentions to train their balance upon, often combined with a locomotor activity, using fixed elements. Here, not all aspects from the TGMD-3 were observed, as the manipulative skills in the TGMD-3 contain ball-skills such as ‘one-hand strike, two-hand strike, dribble, catch, kick, overhand throw and lowerhand throw’. Here, the pupils had little to throw and catch, besides some cushions. The throw actions were observed, however the other actions were difficult to execute without a ball-like item present.

4. Discussion of the results

4.1. How do youngers 'read' and pick up on various motion affordances in the environment?

These preliminary results showcase that youngsters are creative in their movement behavior and use different spatial elements present, especially items that belong to the fixed or flexible furniture, such as benches, chairs, etc. Often structural elements such as the walls, floors and staircases drew their attention as well, and afforded various active behaviour, mostly locomotor behaviour, and often combined with balancing activities. In fewer cases, youngster also used items that served decorational purposes, or items that are semi-flexible such as lighting fixtures or retractable sockets.

Speaking on an architectural level, the participants did not limit their quest to the classical furniture items, but kept an open mind to use larger structural items or smaller decorational items that were not designed to perform 'physical activity' on/with, see Figures 4-6.

It appeared evident that among all the architectural stimuli observed, the children primarily engaged in locomotor activities, such as jumping, running, hopping, pulling, and standing, see Figures 4-6, where locomotor actions are illustrated by personas wearing red jumpers. Notably, there was limited demonstration of stability/balance and object control actions. Frequently, balancing activities were intertwined with or driven by locomotor actions, as seen in the instance of a child attempting to balance while pulling themselves up on a chair or table, see Figure 6, personas dressed in red-and-blue jumpers, or while trying to maintain balance while rotating on a wobbling chair, see Figure 4. It is evident that maintaining balance was a focal point for the children. Regarding manipulative skills, it is important to acknowledge that the scarcity of small-scale loose items may have contributed to the relatively low occurrence of manipulative actions. However, some children demonstrated creative motor actions by removing cushions from chairs or utilizing furnishings in novel ways. In that respect we need to acknowledge that our school environment is often largely equipped with large-scaled furniture of non-moveable items.

4.2. What can be assigned to architectural design?

Thus, the results underscore firstly the need for heightened architectural consideration toward fostering manipulative and balance skills among children. The development of these skills is integral to the progression from foundational to specialized motor skills, particularly during the formative years. However, existing school designs often overlook these aspects, focusing primarily on providing functional spaces for instruction rather than facilitating diverse motor activities. To address this gap, there is a pressing need for architects to explore innovative spatial solutions that promote a wider range of motor activities among youngsters. By incorporating elements that encourage manipulative skills, such as loose items or interactive furnishings, and providing spaces conducive to balance practice, architects can create environments that support holistic development and enhance the overall educational experience. Secondly, there is a need to put equal designerly attention to all architectural layers: ranging from the structural elements such as the walls, ceilings, floors and fixed furniture (e.g. benches and chairs), over the furniture and flexible items, towards the decorational aspects such as cushions, or items with a different weight, shape and form, that can be lifted.

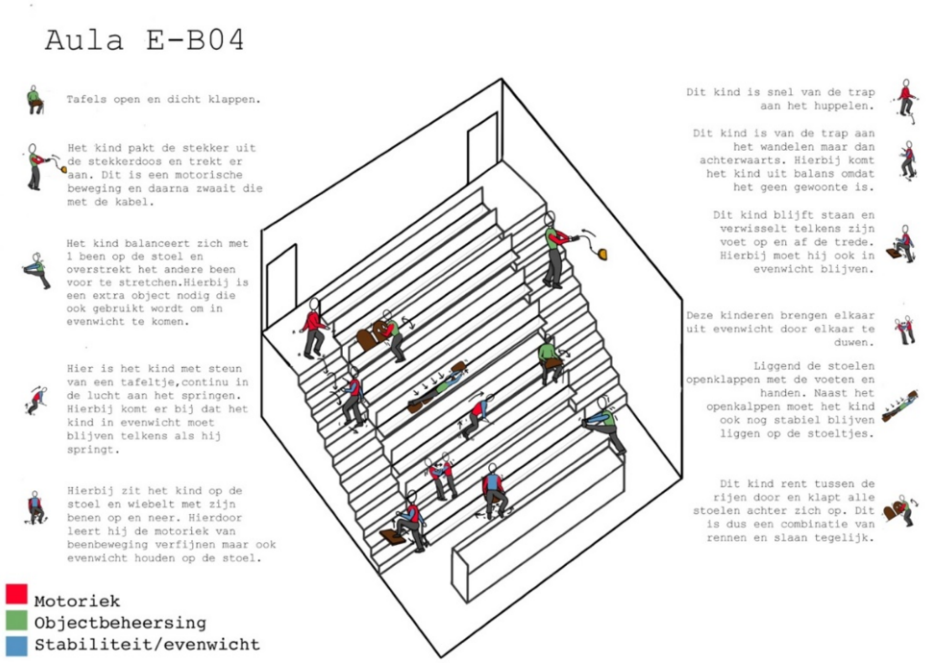

Figure 4. Visualization of the motor actions executed in the auditorium

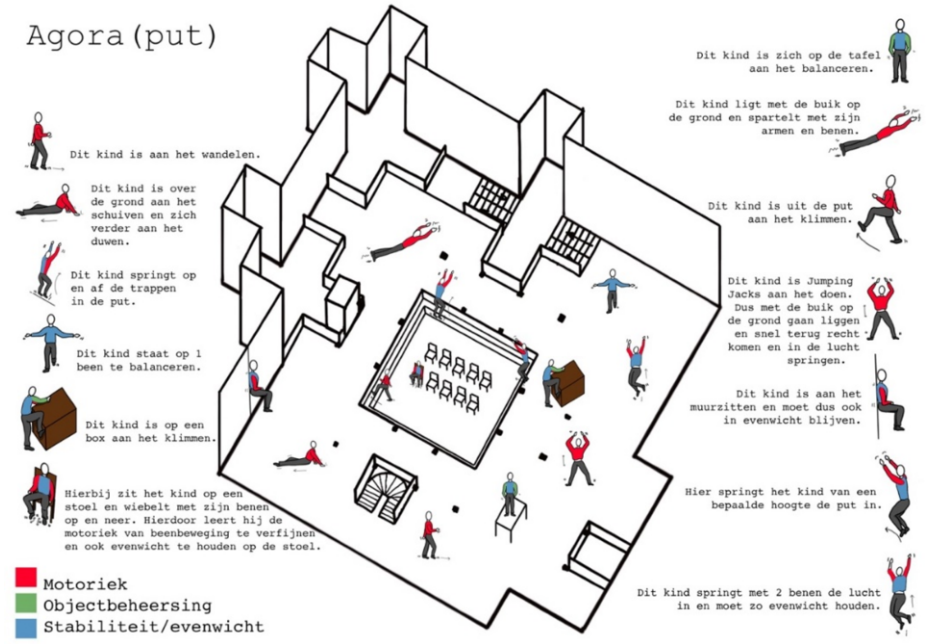

Figure 5. Visualization of the motor actions executed in the agora

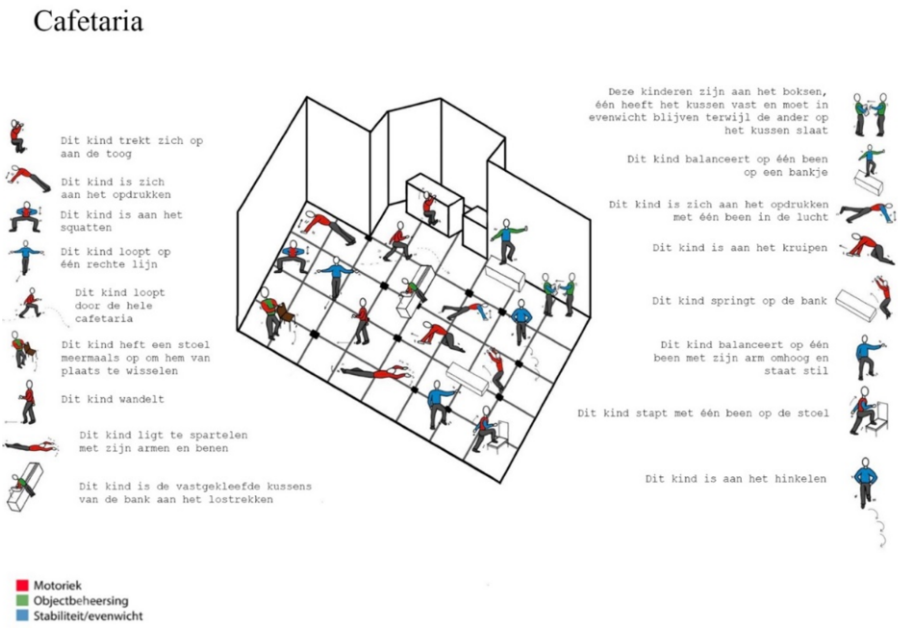

Figure 6. Visualization of the motor actions executed in the cafeteria

5. Conclusion & future research

Motor competence, or the mastery of what are called 'fundamental' or 'essential' movement skills during childhood, is suggested as the foundation of an active lifestyle during adolescence and into adult life [41, 39]. Poor motor coordination is also often associated with poor academic attainment and cognitive deficits [44]. The importance of children attaining motor competence is indicated by research findings demonstrating that children with high essential movement skills proficiency show little decline in physical activity when entering adolescence [45].

As designers, we need to acknowledge that our current school designs and the ones were are developing afford motor skill development up to a certain level, however, we could do a lot better. More effort needs to be placed into the creative design of not only pedagogical furniture, such as a standing desks, but in the entire environment, from the structural elements up to the lighting fixtures or decorative items. Observations of youngsters in this study highlight their recognition of affordances for motion within the environment. However, their tendency to primarily engage in locomotor skills underscores the need to explore how architectural design can enhance spatial affordances to encompass a broader spectrum of motor competencies, including manipulative and balance skills.

From a design perspective, we can broaden the scope and think beyond just seating furniture used during lessons. We contemplate our potential contributions to school environments beyond classroom hours, shifting our focus from standing desks and exercise balls to other types of furniture that also integrate with the fixed structure of the

school building or its decorative aspects. Moreover, collaborating with educational researchers can further enrich this process, allowing for the development of pedagogical strategies that leverage environmental affordances to support active learning and teaching styles, or vice versa. For example, approaches currently used in forest schools supports play, physical activity and hands-on exploration, while other types of learning approaches might limit physical activity, despite affordances of the environment. Therefore, the focus should be placed on educating tutors as well. By embracing this holistic approach, we can create school environments that foster the comprehensive development of children's motor competencies and contribute to their overall well-being.

Concretely, there are several avenues for future research that can contribute to advancing our understanding of how architectural design can better support diverse motor activities in school environments:

From a motor perspective:

- A quantitative study into the impact of environmental design on motor competence.
  Research could investigate the specific design elements and features within school environments that contribute to the development of motor competence in children. This includes examining the layout of spaces, the types of furniture and equipment available, and the overall architectural layout.
- Longitudinal studies on motor skill development [e.g. 43]. Longitudinal research studies could be enriched with a spatial perspective. That way, we could track the motor skill development of children over time within different school environments. This would provide valuable insights into how variations in environmental design influence the acquisition and progression of motor competencies from early childhood through adolescence.

From a design perspective:

- Effectiveness of Innovative Design Interventions [46].
  Studies could evaluate the effectiveness of innovative design interventions aimed at promoting diverse motor activities in schools. This could involve implementing and assessing the impact of interventions such as redesigned playgrounds, multipurpose indoor spaces, or interactive learning environments on children's motor skills development. These data could be compared between schools with varying architectural designs. By comparing traditional school layouts with those incorporating innovative design features, researchers can identify the most effective design strategies for promoting diverse motor activities.
- Integration of Technology in School Design.
  With the increasing integration of technology in educational settings, research could explore how digital technologies can be integrated into school designs to enhance opportunities for motor skill development. This could involve examining the use of augmented reality, interactive displays, or sensor-based equipment to create engaging and dynamic learning environments.

Foremost, we believe that collaborative research between designers and educators would be beneficial in this case. Collaborative research initiatives involving designers, educators, and researchers could be established to co-create and evaluate new school design approaches. By incorporating insights from both educational theory and

architectural practice, these interdisciplinary collaborations can lead to the development of more holistic and effective design solutions. Concretely, developing pedagogical and educational strategies using certain motion affordances in the environment, or the other way round, how the environment can help in developing more active learning and teaching styles.

To conclude, future research in these areas has the potential to inform the design of school environments that better support the diverse motor activities and developmental needs of children, ultimately promoting their overall health, well-being, and academic success. Concretely, we hope to come to strategies to design and 'use' spatial motion affordances to the fullest.

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