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Designing Urban Spaces to Enhance Active and Sustainable Mobility: An Analysis of Physical and Symbolic Affordances in School Squares in the Metropolitan Area of Milan, Italy

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Abstract: As thresholds to cities, public spaces adjacent to schools play an important role in children's everyday mobilities, potentially shaping their future mobility habits and affective experiences. The purpose of this paper is to investigate the urban design conditions of such spaces, defined as "school squares", and, with the aid of affordance theory, to analyze spatial features and characteristics that might encourage or hinder active and sustainable mobility practices. In the first part of the paper, we define sustainable mobility, conduct a literature review on affective responses to the urban environment, and discuss active school travel (AST) in relation to the design of school squares. By focusing on 416 primary and lower secondary schools in the metropolitan area of Milan, we present an assessment method that is composed of on-desk and on-site surveys. In particular, Phase 1 defines the type of school squares, Phase 2 investigates physical affordances (spatial features and characteristics that directly influence active mobility practices, such as bicycle racks, protective barriers, benches, and parked cars), and Phase 3 discusses symbolic affordances (elements and characteristics that might induce different affective responses to a school square with regard to active mobility, such as bicycle racks, parked cars, greenery, and dustbins). The results indicate that in most cases school squares are characterized by typological confusion that has nothing to do with the school environment: narrow sidewalks, disorder, and low levels of safety. In order to promote active and sustainable mobility choices and enhance children's mobile experiences, it is necessary to address the aforementioned features. The ultimate goal of this paper is to provide insights for developing an urban regeneration framework that considers school squares a safe context and a starting point from which to perform sustainable mobility practices.

Keywords: active mobility; sustainable mobility; active school travel; urban regeneration; school squares; children

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1. Introduction

In recent years, research on sustainable, active mobility and walkability has gained significant momentum in the field of urban design and planning [1–3], with a particular focus on the associations between the built environment and individuals' walking intentions and behavior. This paper focuses on active mobility, a branch of sustainable mobility that refers to mobility that includes physical activity and non-motorized transport means, for example, cycling and walking, as well as recent human-powered variants (e.g., push scooter, roller skates/rollerblades, and skateboards [4–7]). Today, promoting active urban travel is an aim of growing importance to many cities in the European region [8] and beyond [9,10], since active mobility is associated with many positive impacts. One is related to the promotion of sustainability [11]: Active mobility contributes to 15 of the 17 UN Sustainable Development Goals [12], with particular reference to goals 3 (good health and well-being), 7 (affordable and clean energy), 9 (innovation and infrastructure), 11 (sustainable cities and communities), and 13 (climate action). Such overarching goals

are defined in a number of strategic and operative documents at the international and European level that highlight the strong link between the transport sector and climatic issues and stress the need for action towards more sustainable mobility models based on mitigation strategies that largely amplify the role of active mobility [13]. Alternatives to motorized means of transportation have been shown to bring positive environmental impacts, notably through reduced emissions of greenhouse gases and air pollutants [14]. Moreover, in urban areas, active mobility can contribute to improving the quality of life by alleviating traffic congestion and noise, as well as by reducing the need for parking spaces and intrusive road infrastructure [15]. In terms of the social sphere, active mobility is a viable way to increase daily physical activity and health across a wide swath of the population [10,16–18]. Finally, active mobility, and, more in general, green and healthy transport, can provide new jobs and economic benefits. As studied by Scotini et al. [4] (p. 1), "the number of cycling-related jobs in the pan-European Region could increase by 435,000 in selected major cities if they increased their cycling share to that of the Danish capital Copenhagen".

Recent literature on active mobility has tried to identify the main factors influencing individuals' modal choices. From an urban planning perspective, these factors can be categorized into three groups [19–21]. The first group includes all the determinants that can be directly influenced by planners, such as urban form, density, land use mix, and infrastructure for active mobility (infrastructure type such as on- or off-road cycling infrastructure, existing infrastructure for motorized traffic, and overall traffic organization) [22–25]. The second concerns the determinants that can be indirectly influenced by planners: socio-economic/socio-demographic mix in a city or neighborhood depicting age, gender, and income structures; predominant social and individual perceptions, such as social norms for or against active mobility; and the social milieu mix [20,26]. The third group gathers the determinants that cannot be influenced by planners: These are mostly geographical preconditions such as climate, weather, and topography, which either limit or encourage walking and cycling [27–29]. In a similar way, Soltani et al. [30] found two main categories of variables, defined as non-physical factors (such as age, gender, household vehicle ownership, driving license, educational status, or income) and physical factors, relating to the urban spaces and infrastructure for active mobility. In particular, several spatial features of the urban context can influence individuals' experience of active mobility [22,23], such as the presence (1) of dense, well-connected, safe, and comfortable infrastructure (e.g., bicycle lanes or paths and sidewalks); (2) of dense developments with a mixed land use, which usually concentrate a higher number of commercial facilities and services in the neighborhood and, consequently, by reducing distances, encourage active mobility; and (3) of buildings with appropriate proportions within the public space, as well as with historical elements, local attractions, and outdoor activities; and beyond (4) the design and quality of public spaces that are found to be positively associated with both walking and cycling.

Moreover, scholars consider the act of moving slowly, by bike or on foot, a spatial process "in which intended or non-intended interaction with the material and social environment evokes physical and/or emotional responses" [31] (p. 102). Research on walkability leading to policy formulation puts the physical relationship of individuals with their immediate environment at high priority [32]. In sum, we might infer that the determinants of individuals' modal choices are a complex mix of spatial, infrastructural, social, and psychological factors. Infrastructures dedicated to active mobility need to be spatially designed together with respective public spaces, with the latter addressing both the quantity and quality of individual and social well-being.

The purpose of this paper is, firstly, to explore the way in which experience of the urban environment, intended both in a spatial and in a psychological sense, might influence mobility choices. Transdisciplinary research on this subject is gaining momentum, yet it still needs to overcome a fundamental weakness: Studies are often either too quantitative (for example, enumerating the physical determinant variables without addressing a broader

environmental quality or individuals' perceptions) or too qualitative (methodologically speaking, they yield descriptive results that do not entail clear implications for the planning practice). From this perspective, this paper tries to overcome the division between physical and non-physical determinants by proposing strategies in between that are directly and indirectly influenced by urban planning decisions. This proposal refers to the idea that creating a culture of active and sustainable mobility requires a change in the mindset of people; therefore, any city planning intervention should also incorporate social learning strategies [33]. This is the reason why the case study chosen in this paper focuses on the urban spaces in front of schools, a symbolic place of learning and changing.

The paper is structured as follows. The first part concerns the literature review on the two main theoretical pillars of the study, namely, the relation between affective experience and urban environment, and how this informs the practice of active school travel. These reflections introduce the case study, through which the paper proposes an urban planning strategy aiming to enhance active mobility choices. The case study focuses on the analysis of the urban public space in front of schools in the metropolitan area of Milan. Such urban areas are here intended both as potential spaces that have to be designed accordingly in order to be suitable for active mobility (physical determinants) and as symbolic places where children experience the city and learn sustainable values (non-physical determinants). Finally, the results of the analysis are discussed in order to provide insights for future urban design interventions aiming to promote active and sustainable mobility.

2. Literature Review

2.1. Affective Responses and Affordances in the Urban Environment

Research on mobility experiences is increasingly adopting a trans-disciplinary approach, combining inputs from the fields of traffic and transportation psychology, environmental psychology, and urban design and planning. However, due to the recentness of this approach, research on the subject often demonstrates a dissociation among the disciplines and a weakness in bridging theory with practice: Only a few studies have attempted to investigate the links between transport and children's well-being [34,35]. Furthermore, there exists no comprehensive framework that offers an overall understanding of the relationship between physical features (determinants) of the urban environment and individuals' subsequent emotional responses (non-physical determinants). In studying the interaction between people and their physical environment, it is important to consider that perceived features of the environment may foster or impede certain behaviors [36] (for an example from the case study, see Table 1). Aiming to clarify the process of the perception of space and human responses to the environment, Jacobs [37] stated that, regardless of disciplinary differences, approaches on the topic share three main assumptions: firstly, that the way individuals perceive space is influenced by but not entirely determined by physical characteristics; secondly, that the physical and psychological landscape is mediated through a complex mental process of receiving and processing information that fosters a process of incidental and informal learning; and thirdly, that biological, cultural, and individual factors affect this mental process. In other words, human responses to the environment are twofold: They reflect judgments of its physical characteristics on one hand and judgments of one's feelings about the environment on the other [38]. The first set of responses is called perceptual–cognitive judgements, referring primarily to characteristics of the environment, whereas the second is called evaluative responses and refers to the individual's emotional response to the environment [38]. It is important to note that there exists no linear order in which these responses occur: They instead complement each other simultaneously (Figure 1).

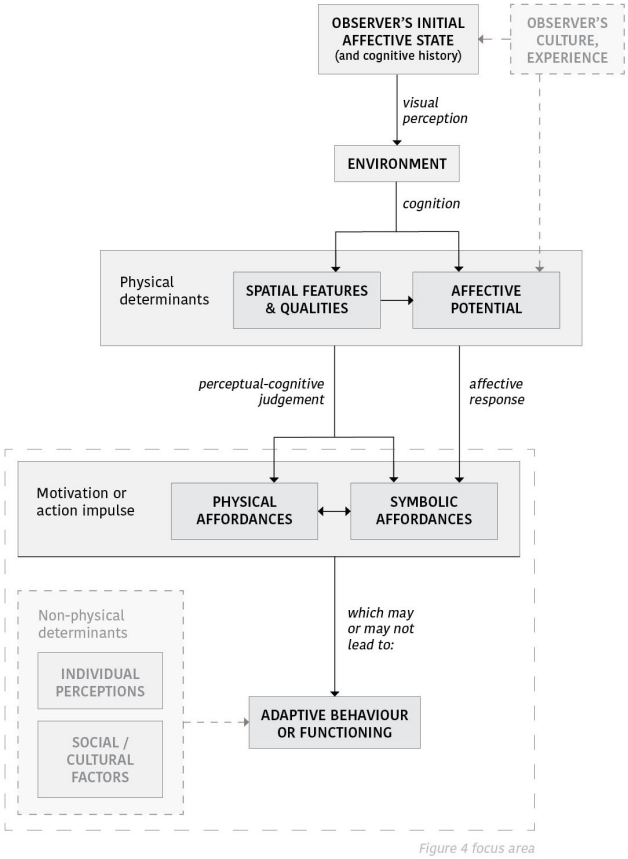

Figure 1. A theoretical conceptualization of the process of human responses to the environment. Source: elaboration by authors, based on [38,39].

Perceptual–cognitive judgements might be expressed through words such as "green", "tall", and "old", which describe objective and measurable features of the physical environment [40]. Conversely, evaluative responses occur when a person evaluates an environment and attributes to it an emotional—and therefore subjective—quality, such as being pleasant, interesting, exciting, stressful, and so on [40]. Rapoport argued that evaluative responses to an environment are "more a matter of overall affective response than of a detailed analysis of specific aspects" [39] (p. 13). Affective responses might be understood as emotional responses to an environment (although, in strict psychological terms, "affect" encompasses both emotions and feelings in terms of drive states, such as thirst or hunger); for the purpose of this paper, we use "affect" in its narrower sense and as synonymous to emotion [41]. Research concerning affective responses might provide significant insights into understanding the interaction between individuals and the environment, as they can potentially enrich more rigid quantitative studies on physical features [41]. Nevertheless, in measuring affective responses one always has to take into account their relativity: They do not only depend on the environment appraised but also on individual factors (age, gender, personality, attitudes, prior experiences that might affect habits and behavior) and sociocultural variables [27,36,40].

As far as mobility is concerned, scholars postulate that different forms of movement give rise to different affective responses and might influence overall experience [36]. For instance, perceived urban design qualities appear to be more important than measurable physical characteristics per se when it comes to walking experience [36,42], since such qualities may differ between routes and places and constantly trigger different affective responses. This aggregate of responses evokes an overall affective experience of mobility that might influence future behaviors and intentions. In sum, we might infer that perceived

urban design qualities evoke specific affective experiences, which, driven by individual factors, might guide an individual's mobility choices.

Affective responses related to active and sustainable mobility might be understood through the lens of affordance theory [43], which "provides a basis for understanding how the walking environment may influence how pleasant walking is, and how it adds to well-being" [31] (p. 103). Affordances are defined as material opportunities for an individual to take action within an environment in order to fulfil their own needs. As with physical and non-physical determinants that affect mobility choices, affordances can assume both physical and non-physical forms, and they operate on a smaller scale that is analogous to the human body. In the first case, physical affordances are objects or urban settings that directly invite the individual to some kind of action: a bench that allows elderly pedestrians to rest or a curb that invites skateboarders to perform tricks [31]. In the second case, non-physical affordances assume a symbolic nature: The presence of bicycle racks legitimizes and confirms cycling as a socially valuable practice that is taken into consideration by planners and policymakers, thus indirectly inviting more people to use bicycles.

2.2. Active School Travel

Active school travel (AST) has emerged as a sustainable mobility practice that is of particular interest to researchers and policymakers, as it demonstrates considerable potential to positively impact humans and the environment [34,44]. As a form of active mobility, AST includes travelling to and from school by non-motorized means. AST is considered to be instrumental for children from a developmental standpoint since they accumulate higher physical activity, develop greater alertness towards the environment, and learn about the legibility and navigability of their surroundings by negotiating obstacles and constraints [45–47]. Children's active journeys to and from school become experiences of an exploratory, an embodied, and a sociable nature and are part of a process of informal learning that shapes their spatial knowledge and safety perceptions [25,35,43,48–51]. It is believed that, perhaps unconsciously, children walk for the sensory experiences and activities that are embedded within the urban environment and are thus particularly drawn to spaces that offer an affective sense of enjoyment [48,49]. In this sense, planning environments to encourage AST does not only require inciting children's spatial skills but also presupposes a higher amount of quantity and quality of affordances along the journey to and from school that might foster overall affective responses.

Ward [52], in discussing the concept of incidental education, underlined the importance of considering the urban context as a place that stimulates children to establish autonomy, active participation, and engagement with their surroundings. As highlighted by Pooley et al. [21], children who travel independently are more likely to engage with their immediate environment. This sense of autonomy and environmental mastery achieved through walking has been found to contribute to the eudaimonic dimension of well-being [35] and "is fostered by maximizing one's virtue and realizing one's potential" [31] (p. 103). Walking might also entail a dimension of hedonic well-being, which is the experience of pleasant feelings and positive affects towards an environment [31] (p. 103).

Apart from placing children in urban space, the practice of walking to school inserts them in the social context of their local communities [50]. The image of children walking in their neighborhoods illustrates a place's identity, inclusiveness, and child-friendliness, since through walking children may "demonstrate agency, impart an air of normality, play a civic role and become a visible constituency and urban stakeholder" [45] (p. 378–379). If we consider walking not only as a type of transportation but also as "an informal and uncomplicated possibility for being present in the public environment" [53] (p. 133), then we might infer that AST plays a significant role in the collective well-being of whole communities and might constitute an important factor for urban and social regeneration. "Life takes place on foot" [53] (p. 71), in the sense that pedestrian activity encourages more observation, interaction, and engagement between and among children, adults,

and their surroundings: "after all, it is at a community level that children engage in mobility" [54] (p. 185).

Scholars highlight that efforts to improve walkability in the urban environment, and thus around schools, will help increase AST [21,51,55–57]. When it comes to urban design, Gehl urged planners to regard their client as being "a linear, frontal, horizontal, maximum 5 km/h human being" [58] (p. 32), that is, a child that should be able to walk and explore their surroundings freely; as Snyder asserted, "we learn a place and how to visualize spatial relationships, as children, on foot and with imagination" [59] (p. 153). Under these terms, research and policy in urban design and planning is increasingly adopting a more child-centered approach that considers children active social agents and takes into account the attributes, capabilities, potential, and limitations of the human body and its scale [49,50]. Rooted in the hypothesis that attending to the individual well-being of children encompasses benefits for collective well-being [34,35], the challenge is to develop urban spaces that account for the human scale of children and enable affective experiences of informal learning, regarding "city space as a meeting place that contributes toward the aims of social sustainability and an open and democratic society" [58] (p. 6).

3. Materials and Methods

The current paper presents an analysis carried out during the research project HABITAT@SCUOLA (HABITAT@SCHOOL) and contributes to the current state of knowledge by investigating the present condition of the urban public spaces in front of schools, defined as school squares [47] (The research project was conceived at the Politecnico di Milano through a collaboration between the Department of Electronics, Information and Bioengineering (DEIB), scientific responsible Prof. Renato Casagrandi, and the Department of Architecture and Urban Studies (DAStU), scientific responsible Prof. Paolo Pileri, and supported by Fondazione Cariplo in 2018–2020 [60]. The project investigated the relationship of school–city–environment through two complementary research paths: The first path focused on school entrances "outside schools" as symbolic places where children begin to experience the city; the second path aimed at deepening the role of courtyards "inside schools" for environmental education. The objective of the research was to bring attention to the need and the possibility of evaluating the role of schools in the city by acting on their open spaces, inside and outside the fence). We propose a method to analyze these places in order to consider two main aspects: their spatial features, as physical affordances (whether they are suitable for accommodating AST practices), and their affective potential, as symbolic affordances (whether they convey values and approaches to the children that can influence their mobility choices). This kind of study appears to be quite novel since the urban context is regarded as a driver to promote sustainable and active mobility for what concerns urban form, density, land use mix, or infrastructure (as mentioned in the introduction, we here refer to the first group of factors influencing an individual's modal choice). In this sense, urban space is seen not only in its physical characteristics but also in its capacity to encourage sustainable approaches. The school square is considered an emblematic urban space where children begin to relate to the city, and for this reason, it should be an inviolable, tidy, and safe place: Here, day by day, hundreds of children line up and learn from the surroundings. However, over time the space available to children has gradually shrunk, occupied by cars and elements that have nothing to do with school; similarly, the paths leading to the school square show an image of the city as less public and more at the service of private motorized mobility [21,35,61]. Such physical elements make walking to school a tiring and unpleasant experience for children, and, consequently, less practiced. In fact, children have to walk on narrow sidewalks along congested streets, being careful not to trip over uneven pavements and dodging foreign objects. In the long term, the ones who are not able to affectively experience and interact with their surroundings are eventually deprived of familiarizing themselves with a sustainable practice of active mobility within the public space.

3.1. The Sample

The study area is located in the metropolitan city of Milan, Italy, where we identified 56 municipalities differing in dimensions, degree of urbanization, and centrality. Within the study area, we decided to analyze all public schools belonging to the first cycle of education (i.e., primary schools and lower secondary schools) to cover the age group of 6–14-year-old pupils. This age is the most delicate, in which a child is old enough to learn to experience space consciously and yet young enough not to have fixed in their knowledge references that act as a model during adulthood [62,63]. According to this criterion, we considered 416 schools (of which 260 are primary and 156 are lower secondary, about half in the city of Milan) attended by over 141,000 pupils (to identify the schools within the study area, we used the Open Data of the Lombardy Region, with reference to the 2017/2018 school year [64]; the data relating to the number of pupils for each institute came from the database of the Ministry of Education and Merit (formerly the Ministry of Education, University and Research), with reference to the 2016/2017 school year [65]). Having identified the sample of schools, we analyzed the school squares (Figure 2).

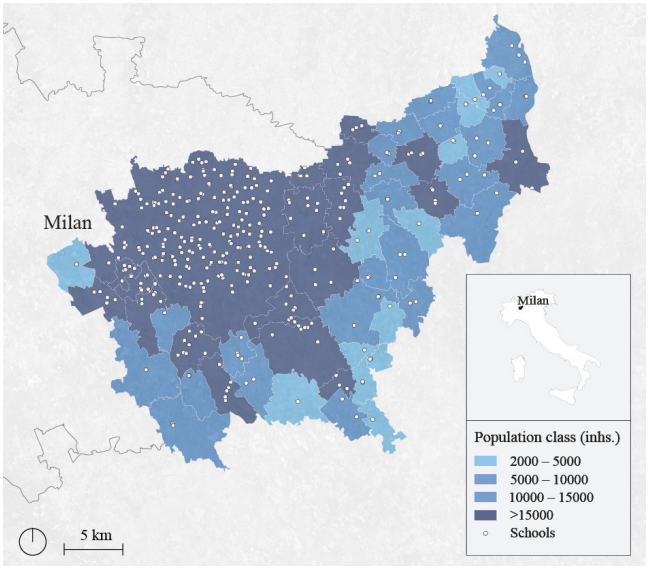

Figure 2. The study area is part of the metropolitan city of Milan. It includes 416 schools in the city of Milan in the municipalities to the east and those to the south. Source: elaboration by authors.

3.2. Methodology

The methodology of analysis was structured in three consecutive phases:

1. Phase 1—type of school squares: localization and classification of the school squares according to their geometry and functions. The identification of these four different types of school squares is quite innovative, since, to our knowledge, there exists no previous reference on this topic in other works (similar classifications on the typology of spaces have been presented for schoolyards, namely, for the playground spaces inside a school [66–68]).
2. Phase 2—physical affordances: identification of the spatial features and characteristics that might directly favor or hinder active mobility practices.
3. Phase 3—symbolic affordances: identification of the elements and characteristics that might induce different affective responses towards the school square and, consequently, influence mobility choices.

Phase 1 identified four types of school squares, starting with the most favorable situation for active mobility, as presented below (Figure 3).

- Type A—park or pedestrian area: large and protected place entirely dedicated to pedestrians, with greenery, seats, and other services where children can move and play

freely, for example, an urban park, the main square of a municipality, or an entire road closed to traffic. In this type of school square, we can find the highest attention paid to the quality and to the design for pedestrian use: Such places appear welcoming to parents and their children and encourage them to walk or cycle to school.

- Type B—lay-by: punctual widening of the sidewalk in correspondence with the school entrance, for example, a "peninsula" facing the road or an indentation obtained from setbacks of buildings with a variety of shapes, sizes, and paving. In some cases, a lay-by is furnished with benches, playgrounds, or vegetation. This widening of the sidewalk functions as a symbolic affordance that communicates to the city the importance of the school square, since in this setting children and their parents are able to affirm their presence through lingering. Nevertheless, planners should remember the necessity of evaluating the size of the lay-by in relation to the number of pupils attending the school.
- Type C—sidewalk: This school square develops in a linear manner, almost following the flow of movements that pupils produce in order to reach the school entrance. Unlike the lay-by, the sidewalk is independent of the presence of the school and acts as a transit space rather than an area in which to linger: It has been noted that a sidewalk does not offer enough space when pupils and parents crowd in front of the entrance, often leading to occupying part of the road and thus reducing their sense of safety.
- Type D—car park: public car park used by other citizens or specific areas within the school complex with access regulated by gates separating the road. The presence of a car park as a school square can be interpreted from two different points of view. On one hand, a car park might be perceived by parents and school staff as an element of convenience for reaching school, since in a certain sense it frees streets and sidewalks from "wild parking." On the other hand, it might be perceived as a problematic element. In fact, an area full of cars reduces the overall sense of safety and subtracts space from pedestrians, especially if rush hour coincides with the period in which pupils frequent the area. It was noted that in addition to the many negative aspects caused by traffic (e.g., danger, noise and environmental pollution, visual barrier, etc.), a car park functions as a (negative) symbolic affordance, encouraging the use of private cars and communicating a distorted cultural message, according to which the car is the "natural" way to get to school.

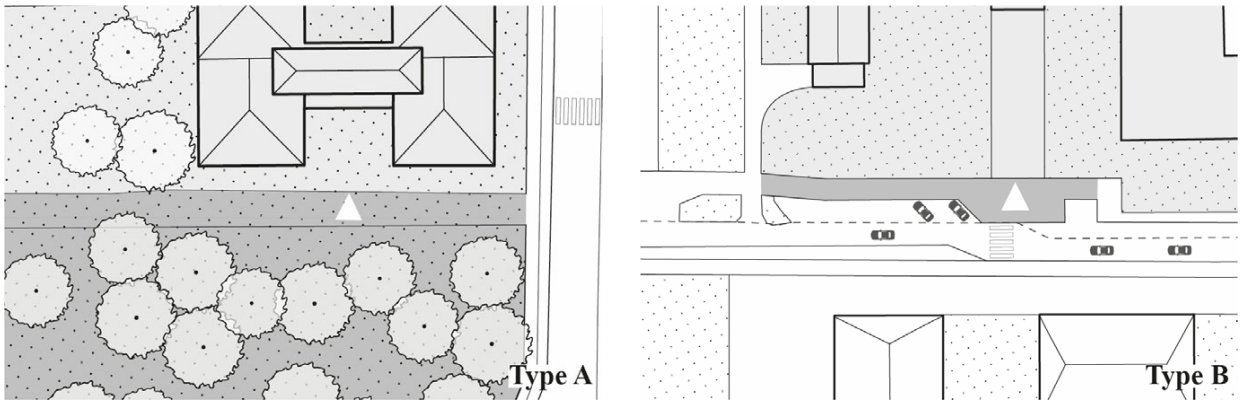

Figure 3. *Cont.*

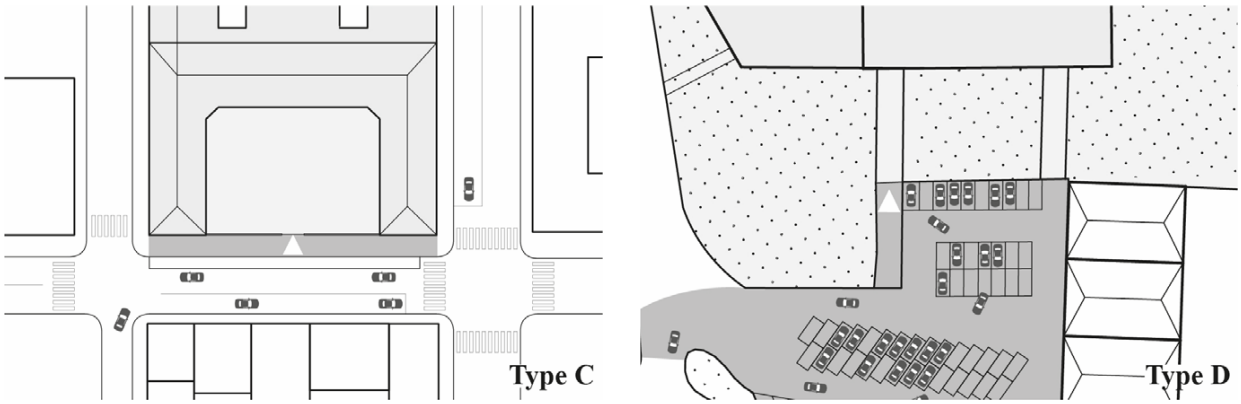

Figure 3. Schemes of the four types of school squares (in light grey, the school building and its yard; in dark grey, the urban area related to the school). (**a**) Type A—park or pedestrian area; (**b**) Type B—lay-by; (**c**) Type C—sidewalk; (**d**) Type D—car park. Source: elaboration by authors.

The features taken into consideration in Phases 2 and 3 are the following:

- Bicycle rack: embodies the concept of sustainable mobility because it provides pupils with a space to leave their bicycles while they are at school.
- Protective barrier: could favor active mobility protecting schoolchildren from the traffic of the street and make walking to school safer.
- Bench: encourages walking to school, providing the chance to rest and socialize with other people. It favors the possibility of experiencing a place slowly on foot or by bike, rather than just passing it to get in the car.
- Parked cars: make it more difficult and dangerous to go to school on foot or by bike. In addition to hindering active mobility, the presence of cars also lowers the quality of a school square, negatively influencing the affective perception that pupils have of this place.
- Greenery: The presence of trees, hedges, bushes, flowers, or flower beds was mapped within the sample area, assuming that greenery positively affects the walk to school and the permanence in a school square.
- Dustbin: a recurring element in school squares. Although schools need to manage a large amount of waste, placing it at the entrance gate has a negative influence on the affective perception of that place.

In Table 1, we interpreted the aforementioned features as physical affordances that directly influence active mobility practices (Phase 2), symbolic affordances that indirectly influence affective responses towards the school square and overall mobility choices (Phase 3), or both (see also Figure 4).

Table 1. Unpacking physical and symbolic affordances for active mobility in school squares. Features marked with (+) positively influence active mobility; features marked with (−) negatively influence active mobility. Source: elaboration by authors.

Feature	Physical Affordances	Symbolic Affordances
Bicycle rack (+)	✓	✓
Protective barrier (+)	✓	
Bench (+)	✓	
Parked cars (−)	✓	✓
Greenery (+)		✓
Dustbin (−)		✓

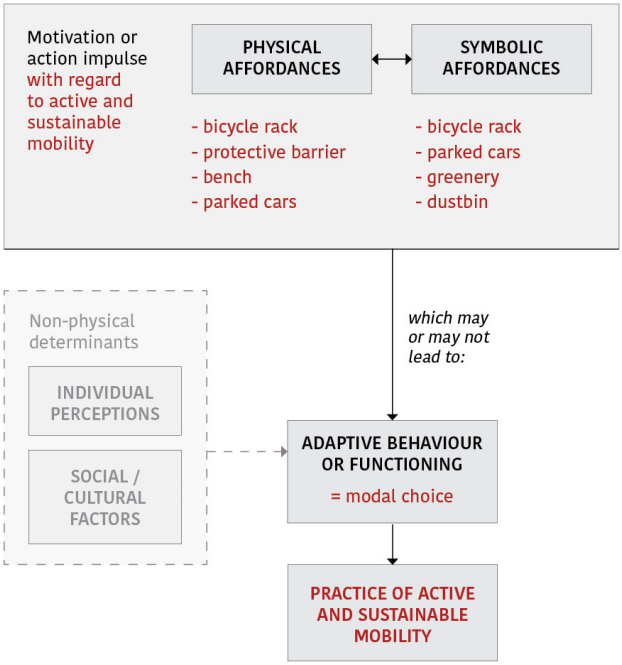

Figure 4. Expanding Figure 1: how affordance theory might be conceptualized for active mobility (new additions in red). Source: elaboration by authors.

4. Results

4.1. Phase 1—Type of School Squares

Phase 1 of the analysis allowed the geometry and the function of the 416 school squares surveyed in the metropolitan area of Milan to be studied based on the four types identified in the methodology.

- Type A—parks and pedestrian areas, articulated as school squares, were found to have the least frequency in the study sample: 12% of the cases, with 20 schools in Milan and 30 schools outside Milan.
- Type B—lay-bys were more widespread in the municipalities around Milan and in those to the east (75 cases out of 198 outside Milan, 67 cases out of 218 in Milan) and accounted for 34% of the cases. The average size of the lay-bys in the sample area is 100 m^2, whereas the average number of pupils per school is 340 children: It follows that each child has on average 0.3 m^2 of peninsula available (0.15 m^2 if we consider the presence of a parent for every child) and that dimensions of lay-bys are often undersized.
- Type C—the sidewalk typology was the most common within the sample area: 40% of cases, equal to 165 schools, with an average width of 2.5 m, and just enough space for two people side by side. Sidewalks were mainly in the city of Milan (115 schools out of 218).
- Type D—in the sample area, school squares in the form of car parks were found above all in urban areas with large availability of space: Out of 59 cases (14% of the total), 16 were in Milan and 43 outside Milan.

Although the diffusion of the types of school squares varied depending on whether they were located in the city of Milan or in the more distant municipalities, we observed that there is no rule according to which the school square is located in urban space and relates to the rest of the urban area: We surveyed school squares in historic centers, in residential areas, inside parks, in industrial areas, and so on. However, it became evident that the context and location could have a consistent influence on determining the characteristics, type of mobility, and methods of use of a school square. For example, when a school is located in the center of a municipality with narrow streets or in a limited traffic zone, the

school square tends to be experienced on foot, both because it is particularly pleasant to reach it by walking (especially in lively contexts due to the presence of recreational, cultural, and commercial activities), and because the layout and management of the spaces render getting around by car more difficult. If, on the other hand, a school is located far from the inhabited center or from other activities, surrounded by large spaces dedicated to cars, the school square tends to be reduced to a place of passage reminiscent of "kiss and ride" services, discouraging its use on foot or by bicycle (for a detailed analysis of the correlation between types of school squares and physical and symbolic affordances, see Table 1 and Figure 5).

4.2. Phase 2—Physical Affordances

Through Phase 2 of the analysis, we identified the spatial features and characteristics that might directly favor or hinder active mobility towards school squares.

- Bicycle rack: found in 47% of cases (105 cases out of 198 outside Milan, 91 cases out of 218 in Milan).
- Protective barrier: found in 49% of cases (58 cases out of 198 outside Milan, 146 cases out of 218 in Milan).
- Bench: found in 29% of cases (79 cases out of 198 outside Milan, 43 cases out of 218 in Milan).
- Parked cars: found in 84% of cases (156 cases out of 198 outside Milan, 195 cases out of 218 in Milan).

4.3. Phase 3—Symbolic Affordances

Through Phase 3 of the analysis, we identified the elements and characteristics that might induce different affective responses towards school squares and influence mobility choices.

- Bicycle rack: found in 47% of cases (105 cases out of 198 outside Milan, 91 cases out of 218 in Milan).
- Parked cars: found in 84% of cases (156 cases out of 198 outside Milan, 195 cases out of 218 in Milan).
- Greenery: found in 45% of cases (111 cases out of 198 outside Milan, 74 cases out of 218 in Milan).
- Dustbin: found in 52% of cases (112 cases out of 198 outside Milan, 105 cases out of 218 in Milan).

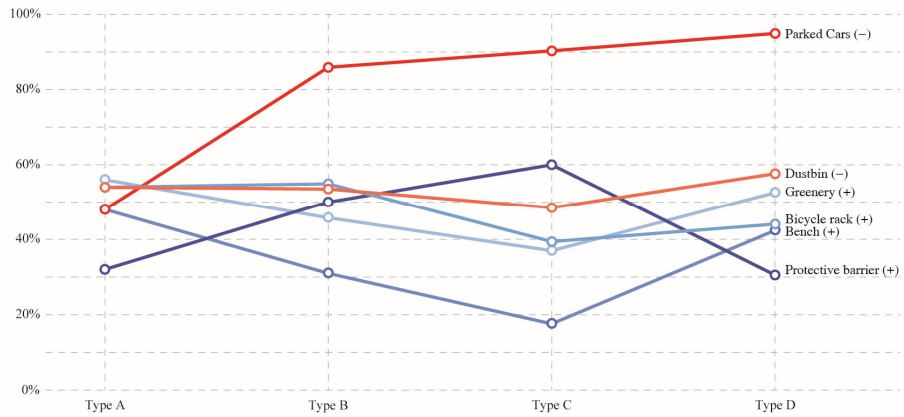

Figure 5. The figure implements the content of Table 2, displaying the association between types of school squares (Phase 1) and physical and symbolic affordances (Phases 2 and 3, respectively). It shows the percentage of school squares for each type in correlation to the features found. Features represented with blue and marked with (+) positively influence active mobility; features represented with red and marked with (−) negatively influence active mobility. Source: elaboration by authors.

Table 2. The table shows which physical affordances (Phase 2) and symbolic affordances (Phase 3) can be found in the different types of school squares (Phase 1). Features marked with (+) positively influence active mobility; features marked with (−) negatively influence active mobility. Source: elaboration by authors.

School Square Type	Bicycle Rack (+)	Protective Barrier (+)	Bench (+)	Parked Cars (−)	Greenery (+)	Dustbin (−)
Type A (park or pedestrian area)	✓		✓		✓	✓
Type B (lay-by)	✓	✓		✓		✓
Type C (sidewalk)		✓		✓		✓
Type D (car park)			✓	✓	✓	✓

5. Discussion

This study set out to identify the key determinants that influence individuals' modal choices of active mobility from an urban planning perspective, without, however, omitting the socio-psychological dimension. Building on affordance theory and well-being discourses related to active mobility, we considered school squares as a context in which interaction with the material environment evokes affective responses [31] and determines mobility behavior and choices. As Anable and Gatersleben [69] (p. 163) argued, "greater attention to affective factors may improve our understanding of mode choice." For this reason, we analyzed 416 school squares in the metropolitan city of Milan through the HABITAT@SCUOLA research project both in terms of spatial features (Phase 1: type of school square; Phase 2: physical affordances) and affective potential (Phase 3: symbolic affordances).

The results of this study suggest a discouraging picture of the situation of the school squares investigated. The "typical" school square is located in predominantly anonymous places that in most cases overlook the street, from which they are separated by a narrow sidewalk. This sidewalk is rarely a space modelled for a school and dedicated to socializing; it is instead a transit area conditioned by the road that runs alongside it. Sometimes, and above all outside Milan, the sidewalk becomes a lay-by at the entrance gate of a school, a condition that apparently seems preferable to the sidewalk alone yet has proven to be far from optimal if compared with the number of pupils attending the school. It follows that the design of public space is inadequate for the most vulnerable users (children, but also the elderly or people with disabilities), who are not given enough space and are forced either to occupy the street or to take refuge inside the school. Even the third most widespread case, car parks, does not represent a quality school square for children and for the wider community: Instead, it functions as a negative symbolic affordance, incentivizing the use of private cars, miseducating younger generations, and contributing to practices of unsustainable mobility.

The analysis of Phase 1 showed that three out of four school square typologies (lay-bys, sidewalks, and car parks) reinforce the role of private motorized transport, accounting for over 80% of schools. The physical characteristics of these three typologies do not provide people with space to linger, and such school squares are experienced more as transit spaces in which to load/unload children. In addition, it must be noted that parents perceive these types of school squares as dangerous, noisy, and polluted (as noted in the interviews carried out during the research. Moreover, in 2017 the "Cittadini per l'aria" association [70] carried out a series of samplings to verify the level of nitrogen dioxide in some sensitive places in Milan, from which it emerged that 88 out of 101 schools surveyed reported an average level of pollutants that is higher than the legal limit) and prefer that their children go to school by car, which instead is perceived as the safest means, becoming themselves the cause of the inadequacy of school squares. In conclusion, the majority of school squares in the sample area do not support affective experiences such as spending quality informal time with peers, nor do they promote children's active engagement with the urban surroundings (Figure 6).

In a minority of cases surveyed, the school square is a park or a public square to which car traffic is forbidden and clearly represents the preferable situation. These places, especially if the public space has been designed with particular attention to quality, become "educational places" that encourage parents to perform AST with their children and might even urge children's independent mobility [61]. Furthermore, since these school squares are more physically enticing and welcoming than the other types, they might be active beyond school hours and possibly host many different activities that stimulate socializing and living within open-air public space. Hence, such school squares are experienced as "places" rather than "spaces" [69] to be reached through active, sustainable mobility (Figure 7).

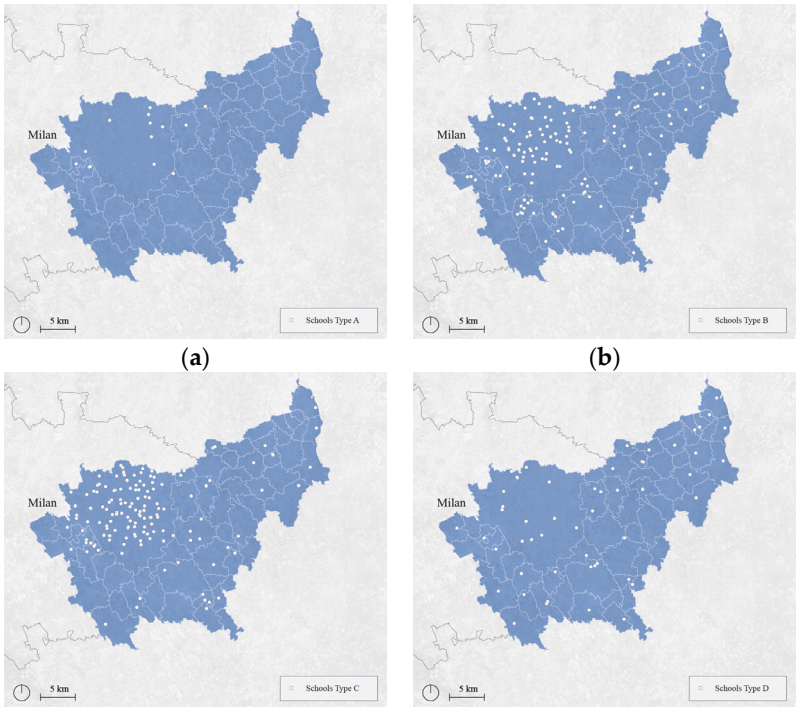

Figure 6. Distribution of the different types of school squares within the sample area. (**a**) Type A—park or pedestrian area is the least common type of school square, found only in 50 cases; (**b**) Type B—lay-by is found in 142 cases; (**c**) Type C—sidewalk is the most common type of school square, found in 165 cases; (**d**) Type D—car park is found in 59 cases. Source: elaboration by authors.

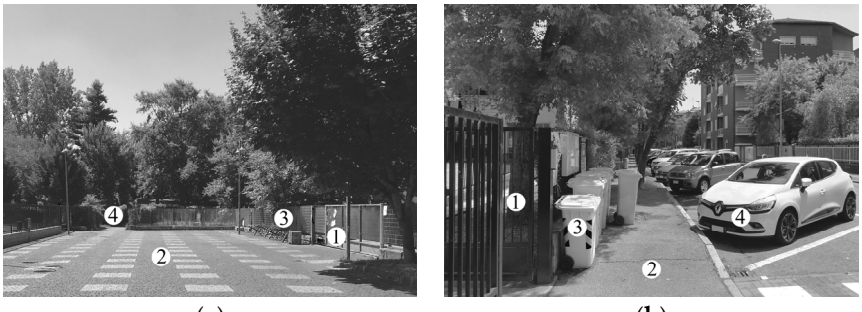

Figure 7. Positive and negative examples of school squares. (**a**) A positive example of a pedestrian area (Type A) outside the gate (1) of the primary school "A. Grandi" in Pieve Emanuele, with pavement (2), bicycle racks (3), and accessible greenery (4); (**b**) a negative example of a sidewalk (Type C) outside the gate (1) of the primary school "D. Bramante" in Cesano Boscone, with degraded asphalt (2), dustbins (3), and parked cars (4). Source: elaboration by authors.

Following these considerations, it was found that only four out of 416 schools are distinguished for the quality of their school square, overlooking a place with large spaces in which to move, play, or rest. In these cases, the school square is perceived and experienced as a safe and pleasant place, where children can acquire social skills and independence much more than elsewhere.

A strength of this study is the rigorous analysis of a large number of schools in the metropolitan area of Milan, which might be useful for future policy, planning, and design interventions for active and sustainable mobility. Nevertheless, the methodology implemented has three main limitations, especially with regard to Phases 2 and 3. Firstly, it is non-exhaustive: We only focused on a selection of spatial features and did not consider certain physical affordances (such as paving material or paving continuity) or symbolic affordances (such as noise pollution, shading, or playing infrastructure) that might influence the affective perception of school squares. In addition, an in-depth study of children's mobility in the sample area is needed as a cross-reference to the results of the analysis. This non-exhaustiveness could be addressed in future research. Secondly, the method is characterized by non-immediacy, since the quality of school squares does not only depend on the mere presence or absence of spatial features but also on its use and its usability: For instance, the presence of bicycle racks might be generally regarded as positive but needs to be considered in terms of the position in the space and the optimal usability. Finally, the method comprises a certain amount of subjectivity and interpretative bias on the part of the researcher: For instance, spatial features such as a protective barrier might protect individuals from motorized traffic but at the same time restrict pedestrian space on a sidewalk.

Although currently practitioners and academics are calling for reconnecting public health and urban design as a means to promote active and sustainable mobility, "it remains challenging to develop and implement design-oriented guidelines that specify what characteristics public spaces need to stimulate physical activity" [16] (p. 1). Future research should delve deeper into the role of environmental psychology in mobility behaviors and choices so as to identify the wider multitude of urban features and qualities that might shape affective experiences and determine decisions of practicing active mobility. Considering that urban design qualities evoke specific affective experiences that might guide an individual's mobility choices, it would be useful to conversely examine this phenomenon by highlighting the fact that urban regeneration through design might generate new mobility habits. As far as the case study of school squares is concerned, further studies could address the affective dimension of urban spaces adjacent to schools from a child's standpoint [71,72]. For instance, involving children in research through the use of photovoice will allow for an understanding of children's own affective perception of school squares, as well as particular micro-level urban design features that might influence such perceptions [72–74]. Giving voice to children's own affective experiences of urban public space and exploring how they engage with their immediate environment might provide significant insight in terms of affordant spatial features that may encourage active and sustainable mobility choices.

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