

See the World Through the Eyes of a Child:

Learning from children’s cognitive maps for the design of child-targeted locative systems

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ABSTRACT

Inspired by HCI research advocating for the inclusion of children in the design process, this pictorial provides a qualitative case study on children’s perceptions of urban landscapes. Our goal is to create digital maps in the context of locative systems and wayfinding for children. For this purpose, we engaged 70 students from the city of Funchal (Portugal) in the drawing of a cognitive map of their journey from home to school in the Fall of 2017. These children (9-12 years old) also replied to a brief survey, and 31 out of 70 responded to a face-to-face interview in the Spring of 2018. This pictorial offers an analysis of the drawings as well as providing highlights of the children’s own account of their maps. Our work generates a set of 10 themes related to landmarks and design ideas for the creation of digital maps for children.

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Introduction

Building on mobile device ownership trends among children worldwide [19, 22] and motivated by HCI research advocating for the inclusion of children in the design process [1, 5, 8, 12], this paper provides specific examples of children’s “personal views” of their urban landscapes. These examples are drawn from a cognitive mapping activity (used as a research method) with 70 fifth-grade students from three public schools in Funchal, capital of Madeira Islands, Portugal. These ‘maps’ do not refer to exact reproductions of space, but represent “mental pictures” of a place, including geographical features as well as memories, emotions, and other connections [4, 13, 23].

Motivations: 5 Interrelated Factors

1. The rise in ownership of mobile devices with data services provided by parents, mostly for tracking and supervision purposes [22].
2. It is widely acknowledged that children’s independent mobility has declined over recent generations in many developed countries [10, 15, 20, 25].
3. The growing impact of children’s usage in the mobile media app market, leading to radical new forms of design and media use that address their needs and interests [26].
4. A radical change in urban mobility strategies and planning,

with increasing incentives to promote public and green services (e.g., bike sharing, “walking school bus” [9]).

5. The need to design digital maps for younger audiences. A quick search in the App store and Play store shows how the mapping app market is targeting only adults’ concerns (locating children’s position for parental control) or education (teaching geography).

Data Analysis

The coding activity was done iteratively, and collaboratively, by the first two authors. First, they coded the drawings, counting the number of elements that appeared on the drawings (e.g., the number of churches or bridges). Second, to probe and clarify the thematic coding, the first author conducted 31 interviews, the data from which was then cross-checked with survey results. Lastly, authors compared their codings and summarized some of them qualitatively and others quantitatively, identifying 10 relevant themes:

- | | |
|---|--|
|  Orientation Elements |  Shops and Supermarkets |
|  Urban Infrastructures |  Other (than their own) Schools |
|  Bus stop Markers |  Trees and Gardens |
|  Safety |  Sea & Sun |
|  Churches |  Personal Associations |

1. Orientation elements

By orientation elements we mean physical elements that are notable in the cityscape and easy to see at great distances. Interesting examples are the replication of a building's mural painting (the blue whale **1**), which the girl's motivation to draw the blue whale was to make it known; she wanted other people to see it. While the blue whale mural was an obvious landmark and powerful in conveying a sense of place to the child, two more physically notable visual elements were used by children as landmarks. First, a large, light orange billboard advertising a soda drink **2**; In the interview with the boy who drew it, he explained that the easiest thing to remember on his path from home to school was this advertising of a soda drink. Another striking example was from a boy who drew the Decathlon store **3** that had recently opened in Funchal. It is relevant to note that two out of the three examples reported here were very recent additions to the Funchal cityscape. Despite their newness, these places quickly became part of the cognitive map of the children. The girl who drew the blue whale followed the progress of the painting as she passed by the artwork's location everyday to get to school. The creative process of installing a piece of street art was embedded in her mobility and subsequent mental image.

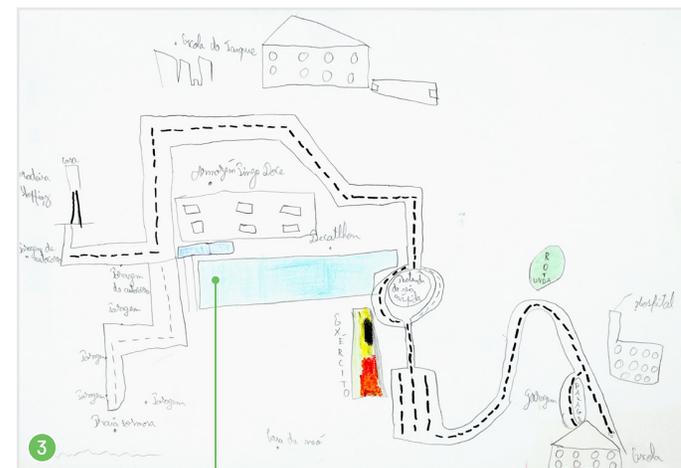


All children names quoted in the paper are pseudonyms.

Can you describe your drawing?
I thought that the drawing [the piece of public art itself] of the whale near the firefighter station was very cute. It's very funny. I pass here [pointing to the drawing] every day. I think it's important everyone knows how important it is to see it [the piece of public art itself] like this and I loved doing this [drawing the cognitive map]. I felt that this drawing [the piece of public art] deserved to be seen by someone [else] and be painted by someone, so I chose this drawing [the piece of public art] just for this ...
 – Rita, 12



What was easier [to remember] was the Brisa [referring to the drink in the ad], this is always here. – Ricardo, 10

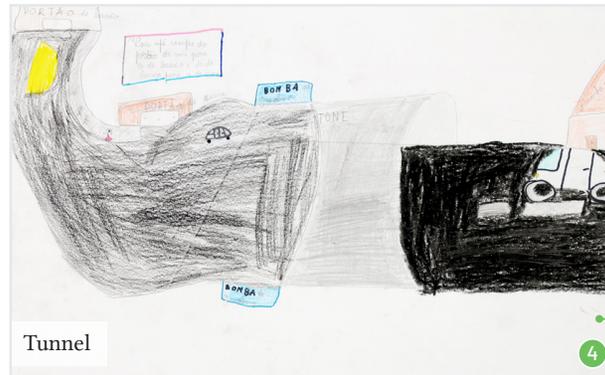


Can you describe your drawing?
Yes, I colored the Decathlon, because it is new. It is a place that makes reference to the roundabout... – Rui, 10



2. Urban Infrastructure

Due to its particular street layout, Madeira has many tunnels, bridges, and roundabouts, the latter being relatively common on the entire island and country. These elements recur in the children's representations. In fact, out of 70 children, 28 depicted roundabouts, 11 included tunnels, and 2 drew bridges. Elena was one of our participants and she lives the farthest from her school, about 10 km away from the center of Funchal, where the schools that partnered with us are located. Her drawing of the journey from home to school was very minimal, hardly illustrating the road and with only one tunnel. We asked her why she chose to draw her map the way she did, with just one path and only a few elements (gas stations). She said she could not remember the way well, except for the experience of the tunnel ⁴.

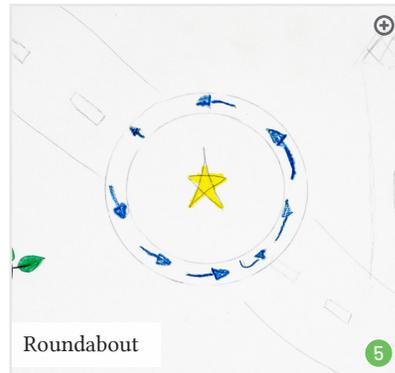


Tunnel

4

How would you describe your drawing to somebody who does not know your path?

I live in Câmara de Lobos [city] and I come to school early in the morning, and there are few things I remember, because I'm almost never looking out of the [car] window, I'm almost always looking at my cellphone... But there are things I remember, like the tunnels, and where my father drops me off. I go through several tunnels on the fast lane. – Elena, 10



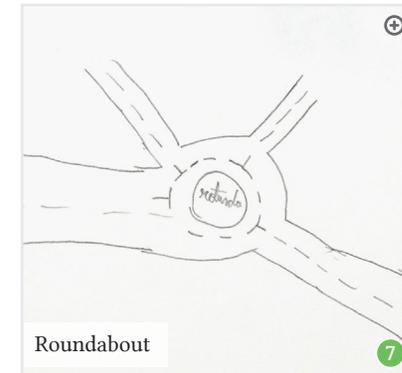
Roundabout

5



Roundabout

6



Roundabout

7



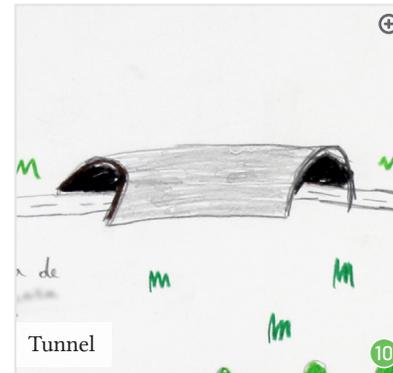
Roundabout

8



Roundabout

9



Tunnel

10



Tunnel

11

⊕
drawing
detail

3. Bus-stop Markers

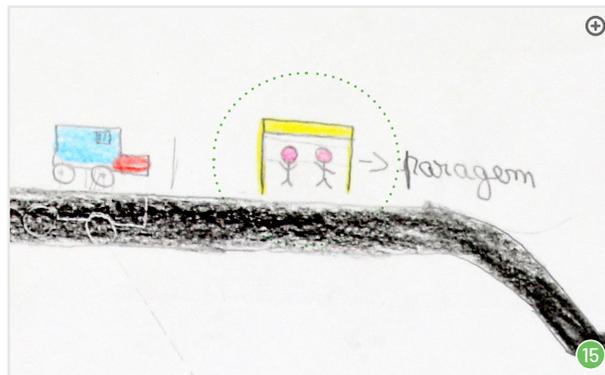
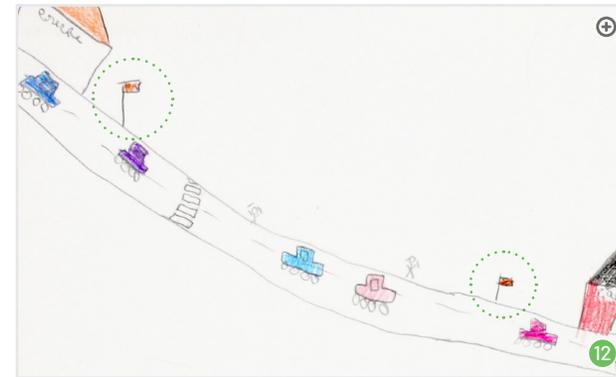
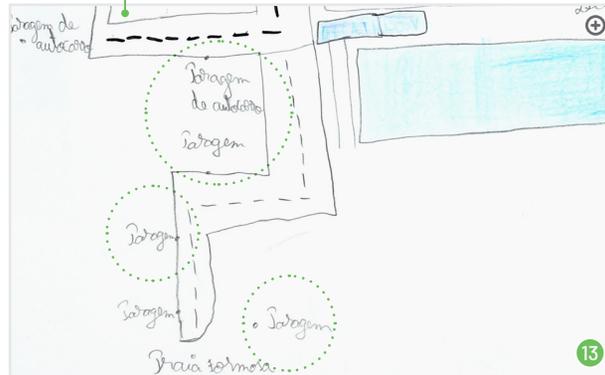
In the survey, out of 70 children, 45 (64.29%) stated they travelled to school by car, 5 (7.14%) went to school only by bus, 5 (7.14%) went to school by walking, and 1 (1.43%) went to school only by motorbike. The remaining 14 (20%) selected more than one means of transportation. Despite the car's prevalence, the cognitive maps still convey some interesting cues related to the world of public transportation. Out of the 11 children who stated they ride a bus to school (5 using only bus; 6 using bus along with other means of transportation), 3 of them included bus-stops in their cognitive maps. Interestingly, 5 children who went to school exclusively by car included bus-stop markers. Along the from home to school path, some children drew buses on the road (n=3), while others indicated several bus-stops (n=5), either by writing down "paragens" ("bus-stops") or depicting the bus-stop pole itself. Others also represented a group of people waiting at a bus-stop. One child drew a digital timetable with the destination and the name of the bus company on the island of Madeira, as well as the bus passing by the display. A girl who was asked why she used the specific colors, said: "I colored the school in yellow, because there are bus-stops nearby [the color of the local bus company]..." Here, it is important to note that at the introduction of the drawing activity, the lead author introduced the students to the subject of "mobility" and "sustainable mobility", by asking them if they knew what these terms meant. They

were told the project was, to some degree, concerned with these, and that we wanted to understand how the students moved around their local environment.

A boy who included several bus stops in his map described his drawing:

"This way I made several stops along the way, and along the way there is also the Madeira shopping and there is a [bus] stop there..."

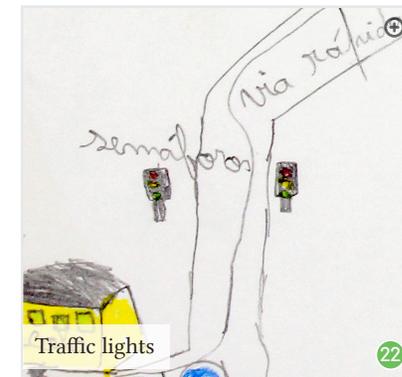
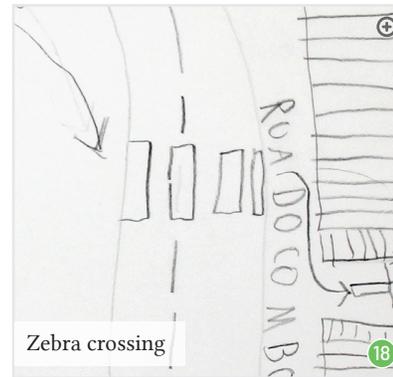
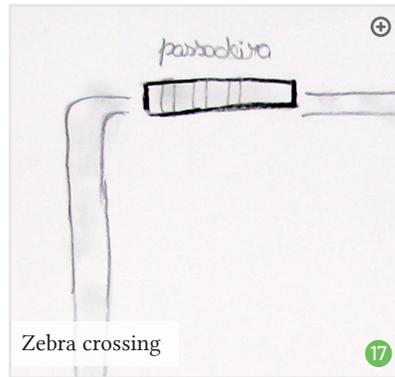
– Rui, 10



○ indication of bus-stops
⊕ drawing detail

4. Safety

This category addresses all the urban elements that are related to safety issues, such as pedestrian crossings, traffic lights, and signals. This outcome shows that some children in our study (n=16) recall these safety elements of the environment when moving around a city by locating these landmarks in their cognitive map. One child included stop signs by drawing the hexagonal plate and colored it red. Some just drew a plate and wrote “stop” directly in English on it to represent a stop sign. Others made sure to identify traffic lights by drawing and coloring red, yellow, and green circles on their maps.



"I drew the stop when the truck passes and the crosswalk when people pass, because the cars have to stop."
 – Carolina, 10

⊕
drawing detail

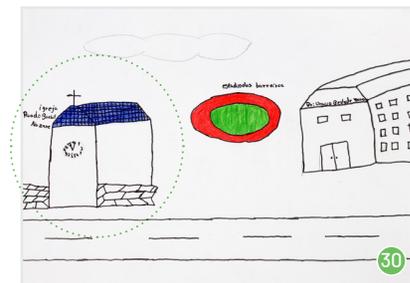
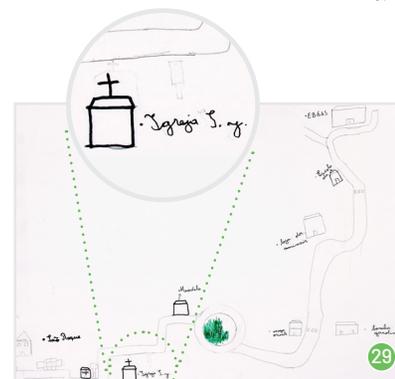
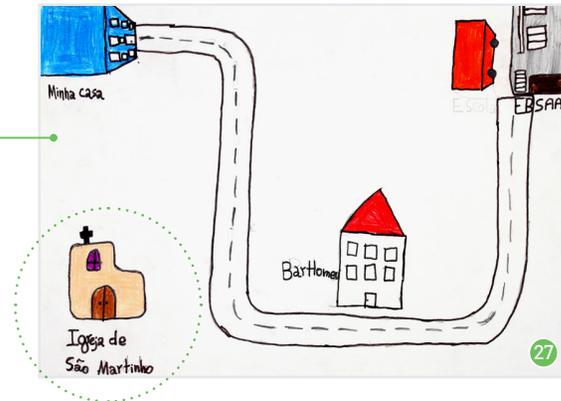
5. Churches

Churches are a culturally important landmark, particularly in Catholic and Christian countries such as Portugal where the cityscape is extensively marked by church buildings. Experimentally, they are tied to the idea of community, as families congregate in these spaces. Churches give rise to the idea of culture and social capital, as family has a strong cultural value in Portuguese society. When responding to the class survey, some children said that they did not know their own street names [Fieldnotes, November 2017]. However, our data revealed that some children (n=5) knew the names of the local churches and wrote them down in their drawings alongside their depictions (27, 28, 29, 30). In addition, when asked about what he would have liked to include in his drawing, one boy said he would have included “Igreja de Santo Antônio” and “Igreja de São Roque” (Santo Antônio church and São Roque church) “because they are monuments that have been created for a long time, such as churches, schools...” To the same question, another boy (Marcus, 10) had a similar answer, saying he would have liked to include the “Igreja de Santo Amaro”. When asked why, he said: “because it is near my house. It is on the path where I pass. It would make sense to put the church, but there was no more space...”.

Mateus (11) lives approximately 3.5 km from his school. He owns a smartphone and reaches school by car and he wouldn't like to change his mean of transportation. His drawing indicated mountains and valleys, tunnels, roundabouts, stores, restaurants, bars, other schools, a cemetery, a stadium, a hospital, the ocean, a church, and other things. In the survey he said he had never used Google Maps, but during the interview he clarified that he enjoys looking at satellite images on Google Earth/ Google Maps, which served as an inspiration for his cognitive map. It included a legend and a path marked with a sharpie, highlighting his usual route to school.



This drawing was made by a boy (Marcelo, 10) who lives approximately 12 km away from his school. He owns a smartphone and had never used Google Maps. He goes to school by car, but would like to go by motorbike. Despite the long distance, his cognitive map has just a few elements, including the origin (home); destination (school), a bar, and a church. What is interesting to highlight here is the fact that the child did not include names of roads or streets in his drawing. However, he did include the name of a church.



indication of churches

6. Shops and Supermarkets

Eighteen children included and identified the names of well-known and popular grocery stores, department stores, and snack bars. Beyond those who included these commercial elements, our interview data showed that more children found it relevant to include this type of element in the urban landscape. For example, to the interviewer's question, "When you look at your drawing, what do you think you should have included in it?" one girl answered: "a candy store ... because I always go there, although I do not like gums."

One of the girls (Gabriela, 10) who drew "Clara's house" (category 10 - 63) described her map this way: "here is my house, it is not very well done, there are many shops near my house, that's why I designed it." She included a department store and wrote its name on the façade.

Similarly, a boy (Diogo, 10) found the easiest thing to remember was a store on the way from home to school, despite the fact he never goes there. He said it was easier to remember that because the store was big enough to be seen from a distance. He also wrote the name of the store in his drawing ("Hipermercado dos Viveiros").



Snack Bar

31



Supermarket

32



Local Stores

33



Department store

34



Supermarket

35



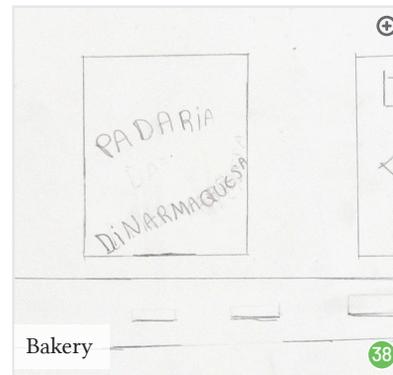
Cafe

36



Department store

37



Bakery

38



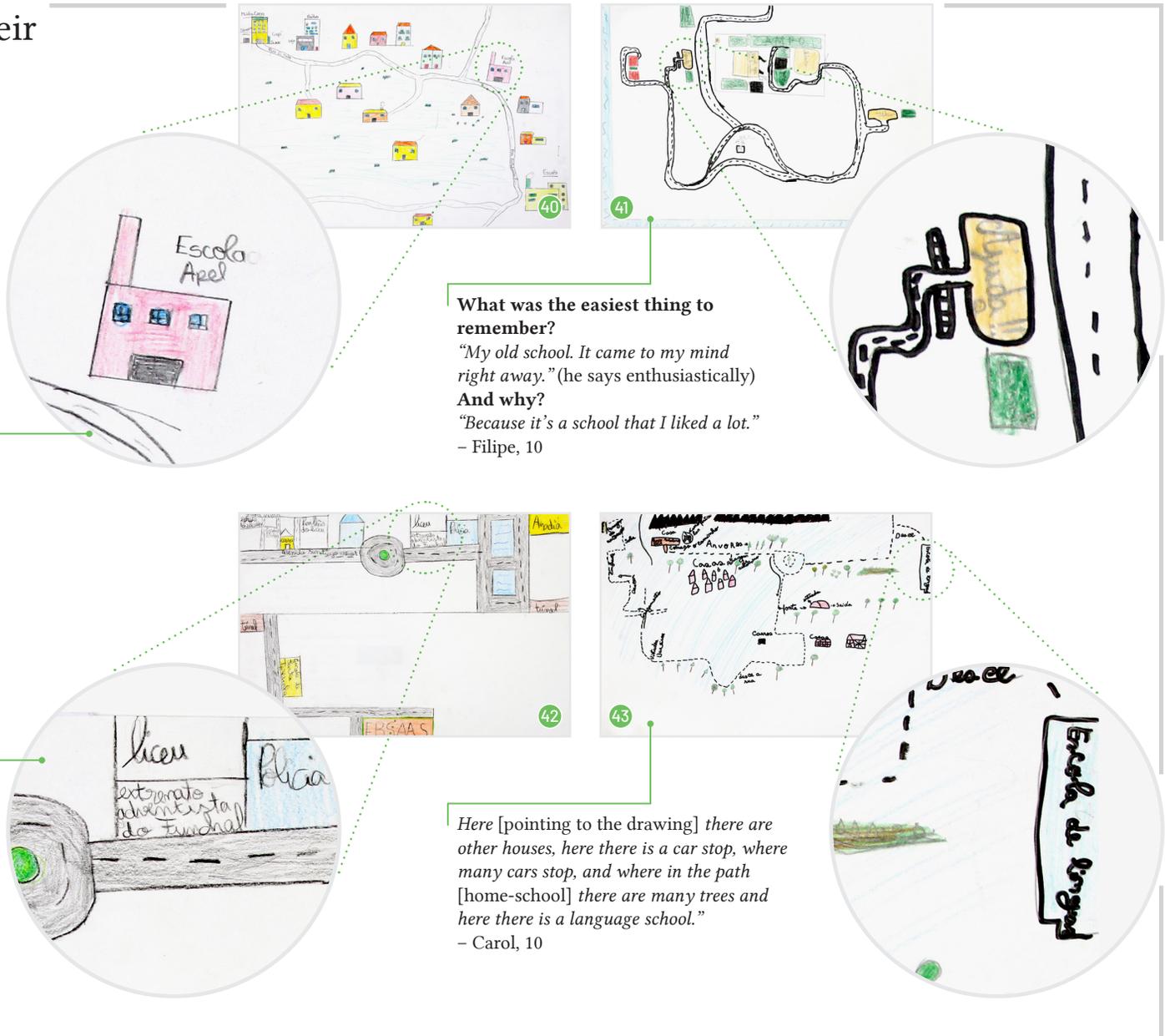
Department store

39

 drawing detail

7. Other (than their own) Schools

Several children (n=16) drew and named schools other than their own on their map of the from home to school path. These schools were related to friends or siblings, or were simply the child's previous school. Moreover, this space has typical elements that make it easily recognizable, such as lettering, color and large dimensions. Our interviews report these schools (as distinct from their own) being the easiest landmark to remember for some children.



What was the easiest thing to remember [in the path home-school]?

The Apel school (...) because it's my brother's school, and I remember when the classes are over, I'm always going there to meet him.
– Clara, 10

What was the easiest thing to remember?

"My old school. It came to my mind right away." (he says enthusiastically)
And why?
"Because it's a school that I liked a lot."
– Filipe, 10

"I pass by a 'liceu' [high school], there are some blue apartments, then there is a roundabout, there is a kindergarten and a primary school..."
– Inês, 10

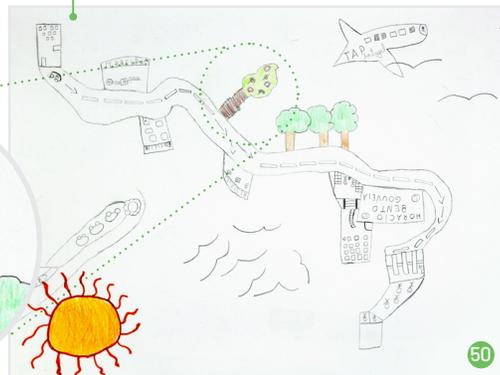
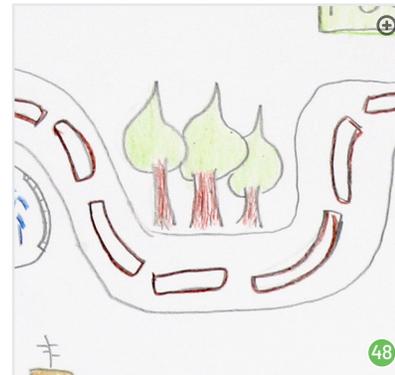
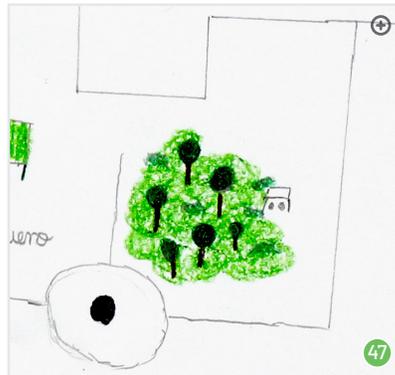
Here [pointing to the drawing] there are other houses, here there is a car stop, where many cars stop, and where in the path [home-school] there are many trees and here there is a language school."
– Carol, 10

8. Trees and Gardens

Since flora is a relevant characteristic of the subtropical island, it is not surprising that some children included different representations of large and small trees (n=23). Besides these, they included green areas by coloring in green grass, flowers, mountains, fountains, butterflies, and some animals.

One boy (Pedro, 10) said that the easiest thing to remember in the path from home to school was a tree: *"I really like this tree. I find it fun because it has the shape of a pear..."*

Besides the tree, this boy included in his drawing a restaurant, a building, the CR7 campus (reference to the soccer player Cristiano Ronaldo), other trees, a TAP (Portuguese airline) aircraft flying overhead, birds, people, and the sun. Interestingly enough, he only colored in the trees and the sun.



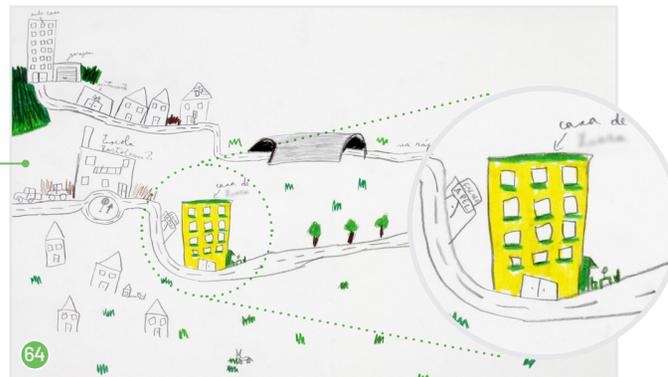
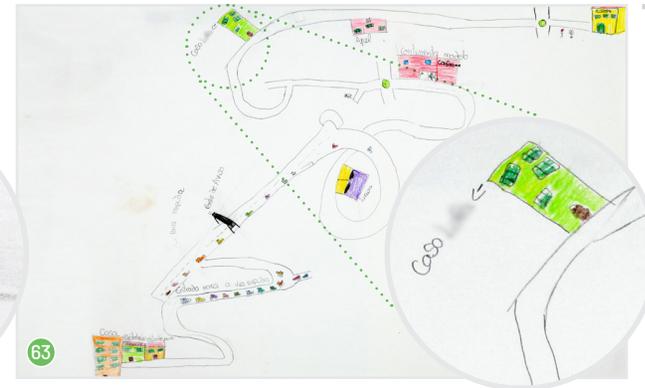
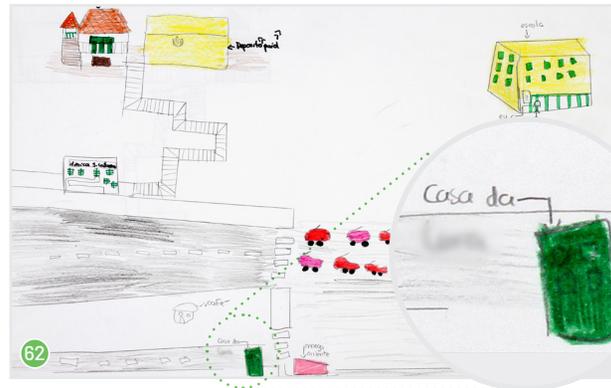
⊕ drawing detail

10. Personal Associations

This category encompasses landmarks that represent places that are related to friends, relatives, or people children know, expressing some level of emotional attachment or sense of place. A clear example of this category is represented by the house of Clara, one of the children included in the study. Clara lives very close to one of the schools, and her house appeared in three cognitive maps.

What was the easiest thing to remember [in the path from home to school]?
 “Clara’s house...”
 – Isadora, 10

Another example is represented by a boy (Paulo, 10) who, when questioned about the easiest element from the path to draw, answered: *“the easiest thing to draw was my aunt’s house. It’s not very big and it is simple, and it’s on the way to my school, so I drew it...”*



Similarly, the easiest thing to remember for the creator of this map was a shop. When asked why, the child (Carlos, 10) said that the shop belongs to one of his aunts and that he goes “there every day.” His map was quite different from the others, as he drew the perimeters of the island of Madeira, as though he was looking at the island from the outside, with almost a bird’s eye view. He used an arrow to indicate the island and labeled it “Madeira.”



Discussion and Conclusions

The scientific pursuit of understanding children and maps [non-digital] is not a new one [2, 14, 28]. The need to design maps specifically for children is often justified by Jean Piaget's seminal work on the development of cognition during the years from birth to adolescence [14, 24, 28]. Yet many of the current existing wayfinding apps [digital] are designed by, and for, adults without taking into consideration how children perceive their local environment or understand digital maps. This pictorial is a first initial step to address this gap and presents how a group of 70 children perceive their urban landscapes through cognitive maps (see all drawings at: childrensworld.m-iti.org/funchal-cognitive-maps). It is important, however, to remember that, as Downs and Stea emphasizes in [4], a cognitive map is not necessarily a 'map' as it does not have the directly physical properties of a cartographic one (e.g., scale and accuracy may be irrelevant) [4, 23]. In accordance with Kitchin [13], we regard that the study of cognitive maps can supply designers with knowledge that could improve locative system's interface.

Therefore, we should acknowledge that our results regarding some landmarks that are time-influenced (e.g., the level of the sea and the position of the sun) could have been different if, for example, the prompt had been to draw the path from school back to home. It is also important to bear in mind that most of the participants of this study are driven to school by their parents (n=45, 64.29%), which might have affected their understanding of landmarks.

More broadly, this work also contributes to the large body of research on landmark-based navigation. Landmarks have been first studied in the seminal work of Lynch [16], later on in adult navigation [7, 18, 21, 27], but also in children's understanding of wayfinding [3, 11, 28], as well as in the tech industry [6], but less so in the specific context of HCI.

We find it key to address this in the HCI literature regarding the design of children's locative and wayfinding systems. A clear outcome and contribution of this pictorial is to display how the children in our study understand urban landscape and, more importantly, identifying what type of landmark

they memorize and why, by identifying 10 main categories under the observations and studies of the drawings crossed with the interview data.

Finally, we conceptualized the 10 themes into four clusters of similar meaning and we extracted a set of design recommendations for each of them:

1) Newness:



This cluster relates to two categories, "orientation elements" and "shops and supermarkets," and refers to the fact that children retained recent additions to the Funchal cityscape and included them in their cognitive map. The notion of newness introduced in this pictorial suggests that the city is an animated thing for these children, in which landmarks are formed in a fluid way. Considering a locative system not only for wayfinding purposes but also to provide a child with a sense of place, the system should allow the user to add landmarks that are new, as these children "witness" the constant changes of landmarks, but also when they are gone, since children might refer back to it, by saying "here it used to be."

2) Cultural personalization:



We may say that, for these children, the mental images of Funchal, were laden with cultural and social capital meaning. This cluster is relevant for a locative system that not only helps a child to orientate herself in terms of wayfinding but also in terms of place-making and having a clearer sense of place. With this in mind, we suggest that allowing the creation of layers is key to the inclusion of personal views and memories related to the way place has been experienced by these children. We suggest that each theme related to cultural elements (e.g., a church) or personal associations (relatives' houses) could be designed as a layer on the top of the map background, that could be selected to guarantee these urban elements be always visible and recognizable.

3) Infrastructure:



This cluster refers to 'urban infrastructure,' 'bus-stop markers,' and 'safety'. In Portugal, studies have found that

the main reason for parental fear hindering children's independent mobility is traffic danger [15]. This parental concern is also shared in other parts of the world, as the lack of walking facilities and crossings, and pedestrian unfriendly urban planning that support a car culture, increase the fear parents have about their children's safety [17]. The design of a locative system for children should try to alleviate these concerns by including and highlighting urban infrastructure related to safety (such as pedestrian crossings and traffic lights) in the digital map interface, while relating it also to the universe of public transportation: bus-stops, train stations or bike-sharing stations. This might help the child orientate themselves by using sound, for example, and proximity sensors. This may also help reduce the anxiety of parents regarding traffic danger.

4) Natural Landscape:



This cluster refers to "Sea & Sun" and "Trees and Gardens." Past studies on maps and children have found that children often use personal landmarks (e.g., the pear-shaped tree) or ephemeral landmarks (e.g., the sea and sun) in their route descriptions, "such as a curious architectural detail, or something immediately diverting such as an ice cream van" [28]. Although, later on, children come to understand that more serviceable landmarks are those which are permanent, memorable, and shared by others (e.g., statues) [28], the design of a locative system for children should address ephemerality of natural elements by allowing users to add their own landmarks and then to search for locations based on their own history of landmarks. In order to avoid disorientation due to massive additions of ephemeral landmarks, the system should ask questions related to the temporality of the landmark the child wants to add (e.g., "How long has it been there? Is it fixed? Is it a moving thing? Can it be recognized by other people?"). These questions may help the child to orientate themselves and start recognizing more shareable landmarks. This ephemerality can be also addressed by allowing children to customize their maps, for example by uploading and geo-tagging their own drawings, or photos of natural landscape, as landmarks.

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