Let's walk!

Design the gait test station for children

Master thesis

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I am so grateful to have the chance to design this gait test station for children.

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Executive summary

This project aims at designing a gait test station for children. The gait test station tests children's walking in Child Brain Lab at Sophia Children's hospital. The children in this project are at the age of 4-10 with different capacities.

There are two scopes in this project, the service scope of the gait test and the experience scope of children.

The service scope is to define the current procedure of the gait test. The procedure includes the gait test device, the gait test process, and the test conductor's working experience. A service blueprint specifies the entire procedure.

Another research with physical therapists, child experts, and parents by questionnaire is conducted in the service scope. With those experts' experiences, I understand children's related capacities to follow and finish a gait test; some design opportunities also are found.

Regarding the scope of children's experience, as the gait test station has not been set up at the hospital, the research with children is conducted at home, based on the defined service blueprint. In the Covid-19 situation, the children are researched remotely or at the family home with permission. With the research results, children's current situations are defined and depicted in the experience maps. The current situations are four different typical situations at the gait test station.

After the series of research activities, children's current problems at the gait test station are defined. I formulate my design goal as Design an experience journey for children's (aged 4-10) gait test to induce their natural walking, make them motivated and fun, or learn about the walking. A shortlist of design requirements is also concluded in the service scope.

Before the design phase, there is a project phase of design sprints. I test and iterate different interventions in this phase for several rounds. With the intervention iterations, I can emphasize more on children to better design for them. With the iteration results, the design patterns are concluded on children's experience maps. A list of design elements is also concluded from the iteration interventions.

In the design phase, concepts have been generated with the combination of all the design patterns. As these are the combined concepts, I first evaluate if the concept includes all the design elements in different design patterns. The concepts are also evaluated with the hospital in the service scope. With these two evaluations, one concept has been selected. This concept contains three different tasks for different types of children. The three tasks are exploring walking knowledge, imitating animal walking, and sending animals to the jungle. Children can have one task during the gait test to achieve the envisioned experience.

In the final concept, the technology tool is changed from the previous concept to enhance the walking experience. With the final concept, a new service blueprint and a technology roadmap are made as final deliverables. Considering a long-term implementation, I also implemented the concept into the interactive videos for short term use. The interactive videos can directly work at the gait test station, also as a final deliverable.

Table of content

Project initiation

General introduction

This is a project in PlayWell Lab at TU Delft, collaborating with Erasmus MC-Sophia Children's hospital. The hospital is currently setting up a Child Brain Lab for both value-based healthcare and scientific research:

- **Value-based healthcare:** the Child Brain Lab is a test facility for children with different neurological or psychiatric capacity. Children do a series of brain tests in the lab. Data are collected in a child-friendly manner and analyzed later for children's clinical care.
- **Scientific research:** overall data are also used for scientific research. Children go to the Child Brain Lab at different ages for the tests. This long-term developmental curve creates meaningful outcomes with children's brain development and appropriate treatment.

My graduation project is to design the gait test station, one of the Child Brain Lab test stations for children. The gait test is about children walking on a gait mat. A series of footsteps are recorded while walking and collected by the gait mat software. The physical therapists then analyze the footsteps for the children's treatment and scientific research.

Client wishes

The client has two wishes for designing for children and the test conductor, the two main groups of people at the gait test station. The client wishes to provide value-based healthcare for children (Figure 1) and a fluent working process for the test conductor.

Children who go to the Child Brain Lab have varying physical and intelligent capacities. And the children in this project are 4-10. Children's age range is stated at the beginning and agreed upon by the project team for such reasons:

In parallel, two lab students are already participating

Figure 1: the adventure of Joep, a VR visit service provided by the hosp

in projects in the Child Brain Lab. They have the assignments for designing children's self-portraits and designing the ECG test station. They define their children from the age of 6-12. Hence, to coherent these two projects. Children in my project are first represented at the age of 6-12, as well.

Nevertheless, my project supervisor mentions that smaller children have more problems in cooperating with the gait test. Therefore, children in my project are defined as younger than in others. Children aged 4-10 are my target research and design group.

Project assignment

There are two scopes in this project. One is the experience design for both children's value-based healthcare, and the other is a service design for gait test stations, including the test conductor's working fluency. Children's experience design is the main focus. The project aims to find out the current experience problems, explore the design opportunities to improve the experience, and finally conceptualize at the gait test station.

pital (The adventure of Joep 2020)

Project approach

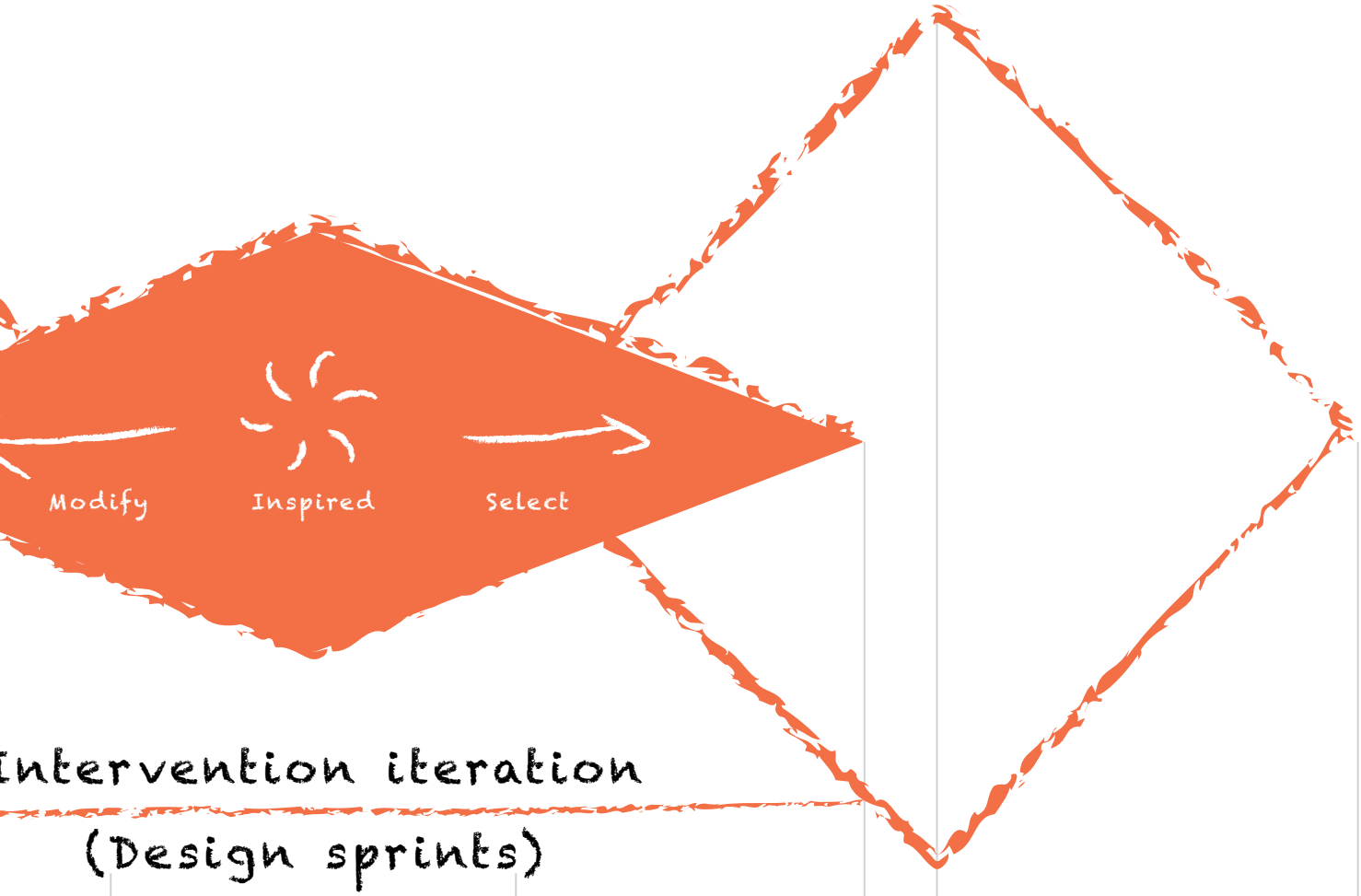
The double diamond approach conducts my diverging and converging thinking of the project. All the research results and ideas are valuable for the final design. In the converging phase, it takes unimaginative efforts to be sharp and critical to each conclusion.

Design sprints are also used in the project process. This is a buffer period to emphasize more with children. This is also an accelerating period as well to select ideas and pick up the best for children.

Project process

See Figure 2.

Figure 2: project process



Intervention iteration
(Design sprints)

Develop

Deliver

Modify
Repeatedly demonstrating is necessary to understand children adequately.

Inspired
Treasurable ideas are always from children and parents.

Select
The stuff is given to children. Provide them the best!

Final concept

Final evaluation

Final deliverables

...or's experience

...d their experience

...ations of children

... & design goal

Design 3 concepts

Concept evaluation

Fantastic learning from children :)

r = 1.5m

Section A
Research on the context, test conductor, and children

Chapter 1

Introduction of the gait test station

This chapter introduces the entire context of the gait test station and what is the gait test. The context's alignment is with the hospital supervisor and the PlayWell lab mates, with projects in the Child Brain Lab. The devices are researched by literature for design opportunities.

Research questions

1. What is the children's test journey in the Child Brain Lab?
2. What is the gait test?

Research process

Interview with hospital supervisor and the project mates.

RQ 1.1 The gait test station in Child Brain Lab

The gait test station is one of the test stations in the Child Brain Lab. It is in the hallway, another place outside the Child Brain Lab.

The tests in the lab are a one-day journey for children. The tests are for different purposes for children's brain functions. Children perform all the tests on this day in the Child Brain Lab and receive the problematic test results in consultation with the doctor.

The gait test is a test in between a break and the photogrammetry test (Figure 3).

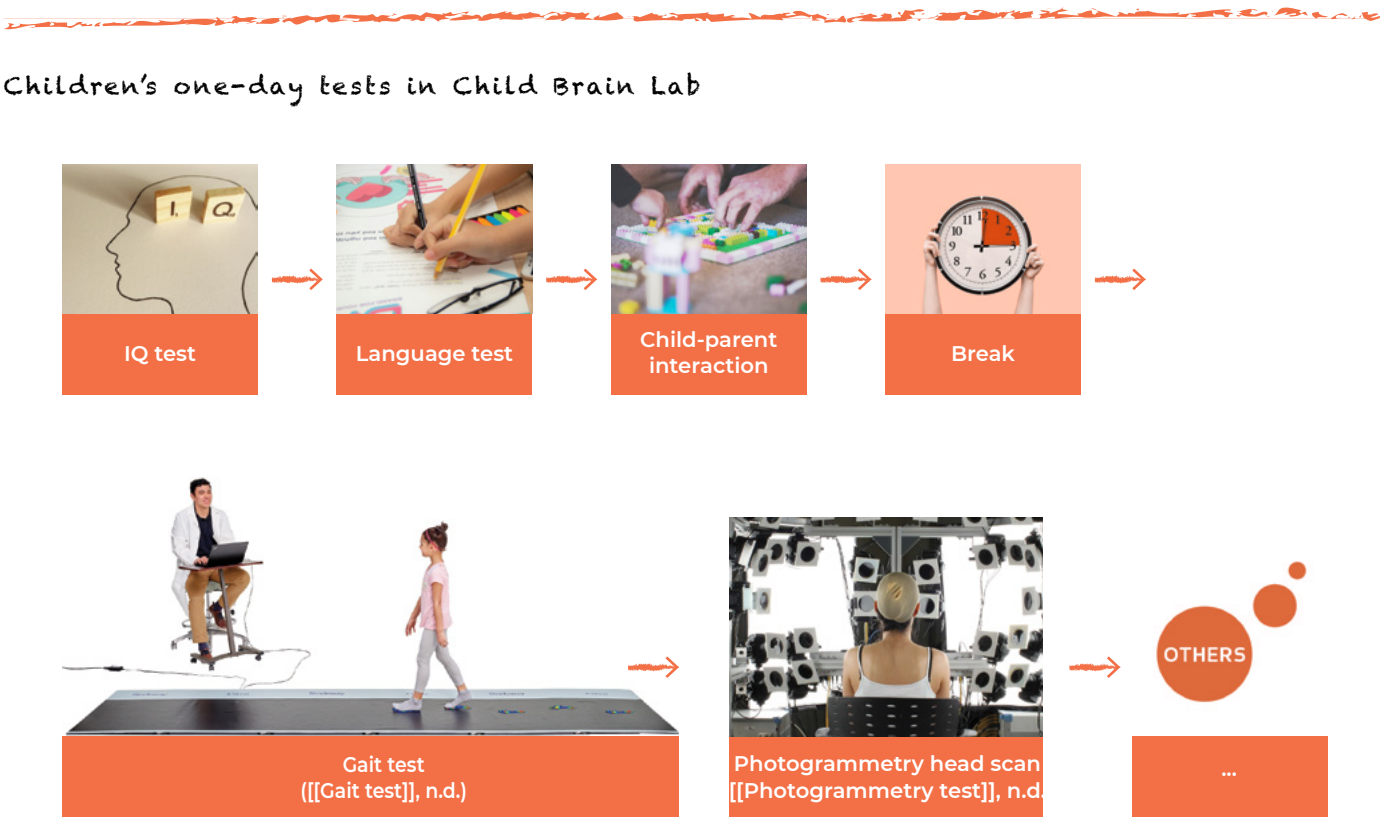


Figure 3: children's one-day tests in Child Brain Lab

RQ 1.2 Scientific knowledge of the gait test

Some scientific knowledge of the gait test has been gained in advance to understand the gait test better. The knowledge includes the gait cycle, normal walking, the gait test protocol, and the gait test device.

Gait test device

The gait test device is a 5-meter long walking mat with software. The walking mat records children's footsteps with multiple parameters (Verlinden et al., 2013, p. 501). There are expanded areas, around one meter long, on the two points of the mat. The extended area looks similar as the mat.

Two gait mats are optional. The only difference is the surface's materials, the hardwood surface, or the soft, smooth surface (Figure 4).

Gait mat with hard wood surface ([[Gait mat 1]], n.d.)

Gait mat with soft smooth surface ([[Gait mat 2]], n.d.)

Figure 4: the optional gait mats

Gait test protocol

The gait test protocol is a standard protocol. All the children use the same protocol so that the captured data is analyzed efficiently. At the start of the project, the protocol has not been determined yet. The protocol from another lab is referenced first. The protocol in this project is six times' of straight walking on a long walking mat.

Gait cycle

The gait cycle is a forward stride, a process of footing off, and on the ground (Figure 5). According to the hospital supervisor, 2 or 3 gait cycles should be captured for the footstep analysis.

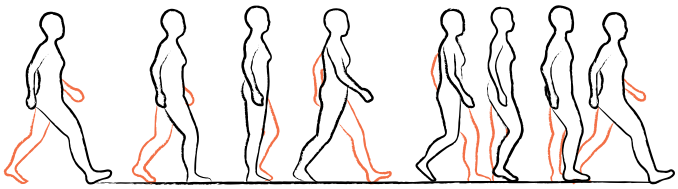


Figure 5: the gait cycle

For children at the aged of 4-10, their stride length (Figure 6) in one gait cycle is calculated by the average height (Growth-charts, 2010 & Dolan, 2020). Children's stride length is around 0.4m-0.6m, which means that one time walking on the gait mat can already collect enough gait cycles.

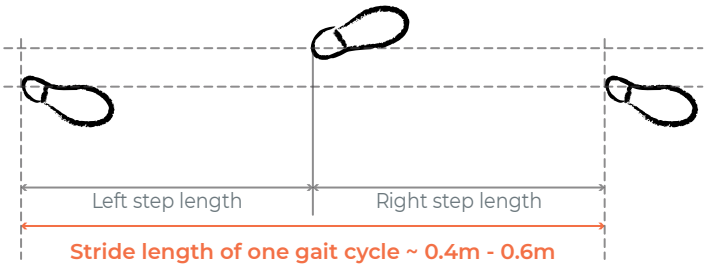


Figure 6: the stride length

Normal walking

In the gait test, children require to walk normally. Normal walking is defined as a relaxed stride. There is always at least one foot pressing the ground during the walking process (Figure 5). This character can differentiate walking from running. The running footsteps are not valid data for the analysis of the gait test.

Chapter takeaways

1. The gait test station is in the hallway at the hospital. It is outside the Child Brain Lab
2. The gait test is a test in between a break and the photogrammetry head scanning.
3. Children do not receive the test results immediately after the gait test.
4. The device for the gait test is a walking mat, which is 5 meter long.
5. At the two points of the mat, there are the extended areas around one meter.
6. The gait test protocol in this project is a 6 times of straight walking.
7. At least 2-3 gait cycles should be recorded for the footstep analysis.
8. One time straight walking can easily collect sufficient gait cycles.

Chapter 2

Test process and conductor's working experience

This chapter defines the test conductor's working experience at the gait test station. The test conductor's working procedure is firstly introduced. With the working procedure, two medical students with experience as gait test conductors are interviewed. The test conductor's current working experience is concluded from the interview results.

Research questions

1. What is the current working procedure of the gait test?
2. What is the test conductor's current working experience at the gait test station?

Research process

Two interviews are conducted with the working staff in the GenR lab. The GenR lab is another research lab at Erasmus. They have the gait test with both adults and children. Their working at the gait test station is asked (Figure 7). With the interview results, I depict the gait test's working procedure; and the conductor's working experience can be defined, as well. Interview materials are in Appendix A1.

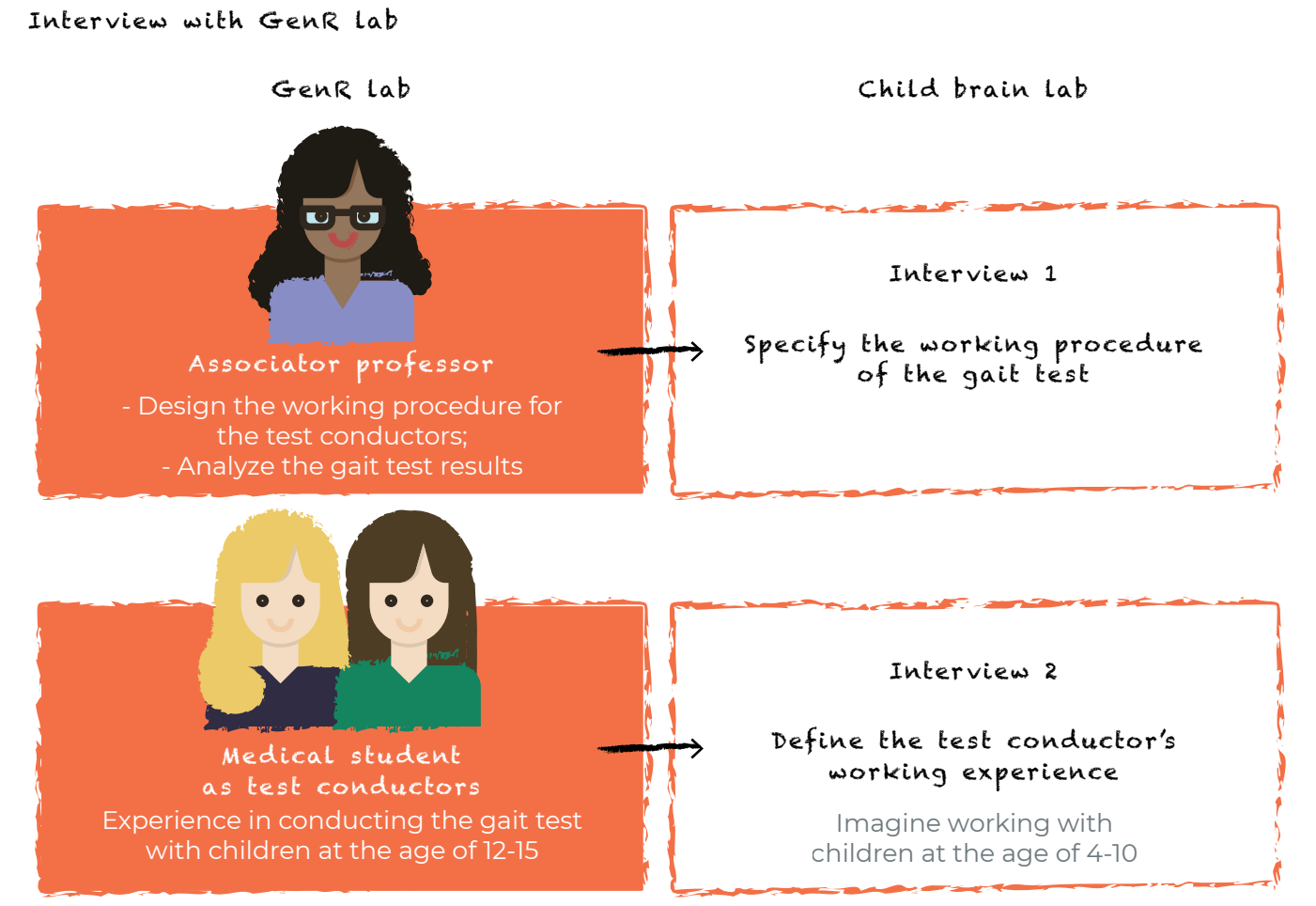


Figure 7: interview with GenR lab

RQ 2.1 The gait test working procedure

For each gait test, the test conductor enters specific data to identify each participant before they come to the test station.

When the participant comes, the conductor welcomes the participant and asks the participant to stand on the mat; once the participant prepares well on the mat, the test conductor clicks “Auto suspend” to start recording the footsteps.

The test conductor instructs the gait protocol to the participant and shows how to do the protocol if necessary; during the participant’s walking, the test conductor checks the software from time to time to ensure the data is captured.

After the participant finishes the gait protocol, the conductor clicks “done” to complete the software and asks the participant to leave the mat.

RQ 2.2 The test conductor’s working experience

According to the test procedure, I divide the test conductor’s work into two parts, operating the software and instructing the participant to do the gait protocol. And I find that the test conductor’s working experience is mainly influenced by the test participants instead of the software (Figure 8).

In a fluent gait test, the test conductor stays neutral on average, with the easy-to-use software and participant’s neutral walking process. However, the participant can influence the conductor’s working experience in the following situations:

When the participant is distracted in the hallway, the test conductor explains the gait protocol more times. The test conductor would feel annoyed with the extra times of instruction, and this feeling is enhanced when the conductor works with children at the age of 4-10.

Nevertheless, the test conductor has the confidence to instruct children, and they like to give instructions to the participant; and the conductor’s emotions can be higher when seeing the children.

To conclude, the test conductor’s working experience is mainly influenced by instructing children. And the test conductor worries that children are easily distracted in the hallway.

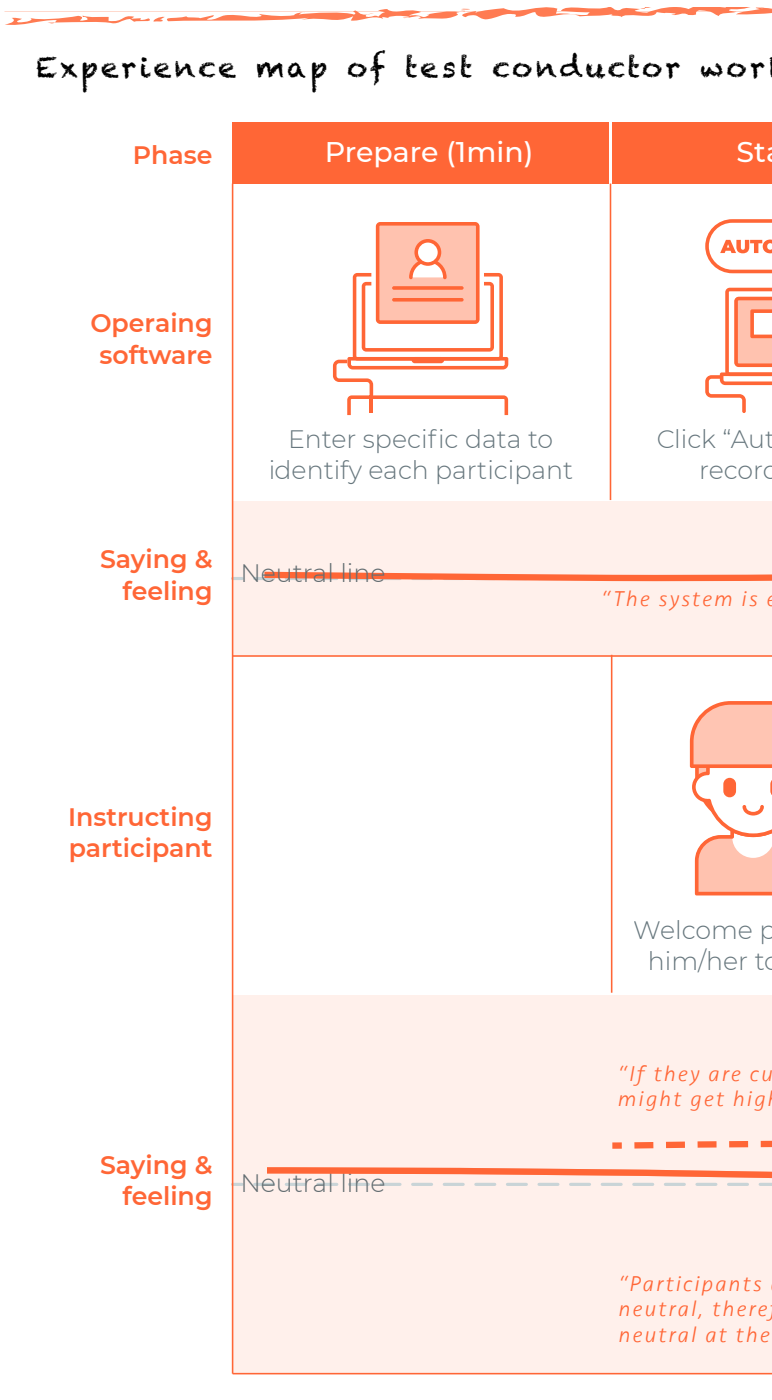
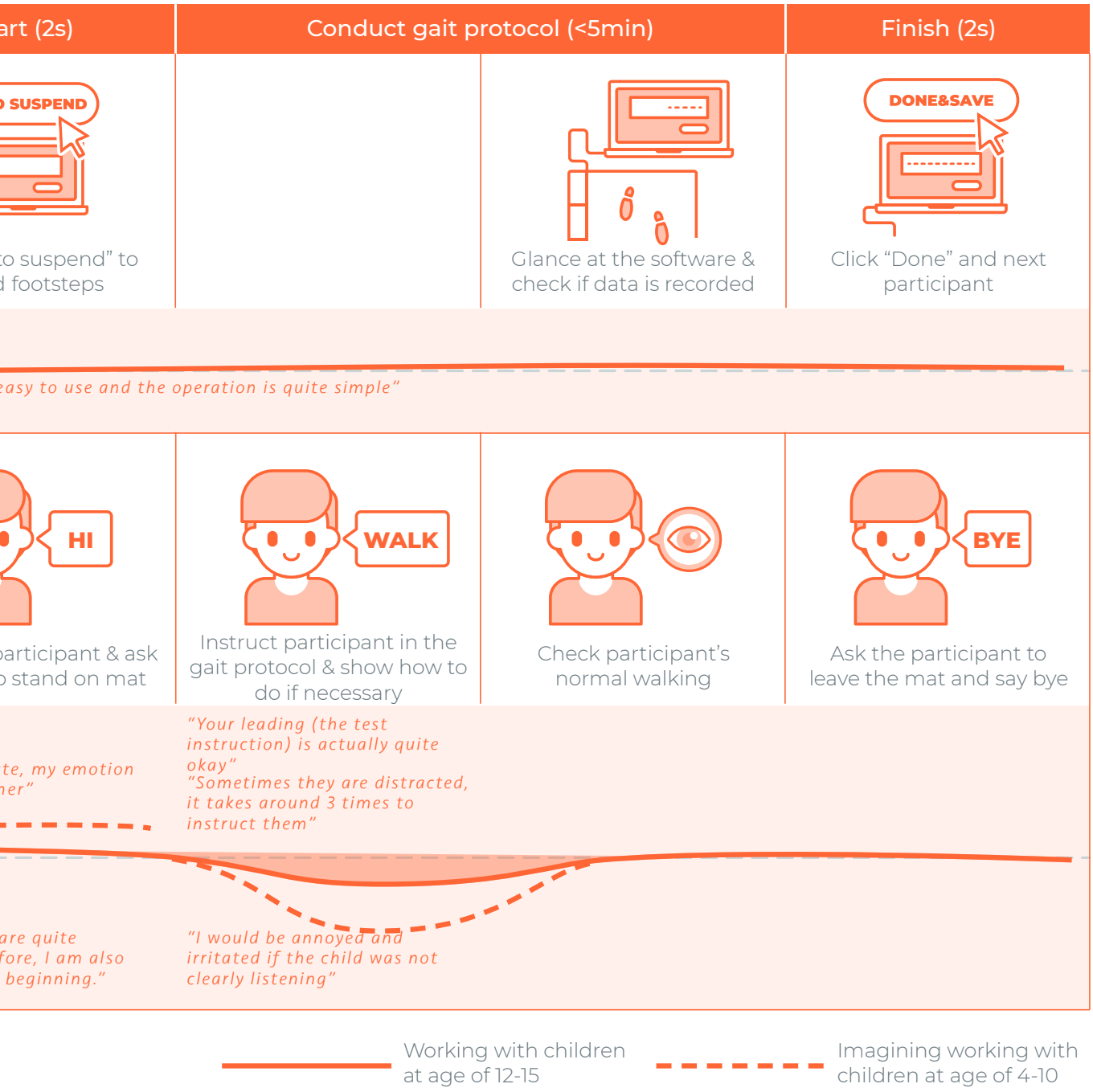


Figure 8: experience map of test conductor’w working on one gait tes

king on one gait test



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Chapter takeaways

1. The test conductor takes two jobs at the gait test station, operating the gait software and instructing children to the gait protocol;
2. Participants influence the test conductor's working experience, and with children, the influence becomes higher;
3. The test conductor feels confident to give the instruction, and they like to lead the test;
4. The test conductor worries about the distractions in the hallway.

Chapter 3

Children and children's experience at gait test station

This chapter defines children's relevant capacities and their experience at the gait test station. I relist the research questions to find the children's experience problems and design opportunities with this definition.

Research questions

1. How to define children's revelant capacities?
2. How to define children's experience at the gait test station?

Research process

Literature research and child expert interviews are conducted to define children's relevant capacities and children's experience at the gait test station.

Figure 9 shows the profiles of child experts. All the interview materials of the child expert are in Appendix A2.

RQ 3.1 Define childre's revelant capacities

Children in my project diverse a lot in terms of their physical, intelligent capacity, their ages. And knowing how they feel and think of the gait test station is also important to define their experience at the gait test station.

As I know, children's physical capacity relates to children's performance of the gait test. Children's intellectual capacity relates to understanding the instruction from the test conductor. And the age indicates children's cognitive development. Last but not least, children's feeling and thinking of the gait test station is involved in their cognition (Bjorklund & Causey, 2017).

After figuring out the relations, I keep children's

Figure 9: child experts

identification from their physical capacity and intellectual capacity; children's cognition development replaces age identification.

Children at the age of 4-10 are at two different stages in their cognitive development, the pre-operational stage, around the age of 2-6, and the concrete operational stage, around 6-11 (Schacter, Gilbert, & Wegner, 2011). They are continuously constructing their cognition, which is initially entirely different from adults (Silverthorn, P.,1999). Therefore, I identify younger children and older children based on these two distinct stages to detect the difference in their current situations at the gait test station. The main characters of these two stages (Ginsburg &Opper, 1988; Wood&Grossniklaus, 2001) are shown in Figure 10.

Characters of the preoperational stage

Memory and imagination are developing;
Their thinking is egocentric and intuitive, not logical;
They tend to focus on a limited dimensions of information.

Characters of the concrete operational stage

Logical and systematic manipulation of symbols are developing;
Their thinking becomes less egocentric, more nature, and "adult like";
They can focus on several aspects of a situation.

Figure 10: characters of the two stages

RQ 3.2 Define children's experience at the gait test station

According to children's activities at the gait test station, I define children's experience as the walking process, dynamics with the test conductor, the perception of the hallway, and the test stations' initial perception.

The walking process is when children are doing the gait protocol. Walking is the main activity of children at the gait test station.

Dynamics with the test conductor is about children listening to the conductor's instruction or other communications that might happen between them.

The perception of the hallway is throughout the entire process of children at the gait test station. According to the expert, children are easy to be distracted. People and objects in the hallway can distract children immediately and unreasonably. People and objects mainly include parents and devices at the gait test stations.

The initial perception of the test stations is the other environmental interaction. It happens when children go to the gait test station and the photogrammetry station.

Figure 11 (Page 18) overviews children and children's experience at the gait test station. The hierarchies of children's experience are also made based on the duration of the process.

List the research questions to find children's current problems and design opportunities at the gait test station

As children's relevant capacities and children's experience are defined, research questions for current problems and design opportunities can be listed.

Due to the coronavirus, different research activities are designed to find problems and opportunities. This chapter gives a complete list of all the research questions and the research activities, and the next two chapters are the answers to them.

Research questions for the problem finding (PF) and design opportunities (DO) at gait test station

PF 1: If children with low walking capacity can finish the gait test?

PF 2: If children with low intelligent capacity can understand the instruction from the test conductor?

Children and children's experience at the gait test station

Walking process of 6 times' walking | Dynamics with the test conductor | Perception of the hallway | Initial perception of the test stations

1. Identify younger children and older children based on their cognitive development
2. Children's physical capacity to finish the gait test
3. Children's understanding capacity of the instruction
4. Parents and devices are the main distraction detected on the hallway
5. Children's initial perception of the gait test station
6. Children's initial perception of the next photogrammetry

Figure 11: children and children's experience at the gait test station

PF 3: If younger children can understand the instruction from the test conductor?

PF 4: What is the current problem of children's walking process?

PF 5: What is the current problem of dynamics with the test conductor?

PF 6: How do children think of different test devices?

PF 7: What is the parents' role at the gait test station?

PF 8: What is the current problem of the initial perceptions of the test stations?

DO 9: What are the current ways to trigger children's behavior? Can we learn anything from asking children to walk?

DO 10: How to communicate with children? Can we learn anything about the test conductor's instruction?

DO 11: What is the children's favorite walking environment in common?

Research activities in chapter 4

- Child expert interviews -> PF3; DO9; DO 10
- Physical therapist interviews -> PF 1; PF 2
- Questionnaire -> PF 6; PF 8; DO 11

Research activities in chapter 5

- Fast simulation gait test station -> PF 4; PF 5; PF 7
- Contextmapping research with children -> PF 4; PF 5; PF 7

Chapter takeaways

1. Children are defined in three aspects, their physical capacity, their intellectual capacity, and their cognitive development;
2. Children's physical capacity is to identify children's performance of doing the gait test;
3. Children's intellectual capacity is to identify children's understanding of the instruction from the test conductor;
4. Younger children and older children are defined based on their cognitive development;
5. Younger children and older children are used to detecting the different situations of children at the gait test station;
6. Children's experience at the gait test station is specified in 4 parts. The walking process, dynamics with the test conductor's, the perception of the hallway, and the initial perception of the test stations.

Chapter 4

Finding children's current problems and design opportunities 1

This chapter answers the following research questions of children's current problems and design opportunities at the gait test station.

Research questions

PF 1: If children with low walking capacity can finish the gait test?

PF 2: If children with low intelligent capacity can understand the instruction from the test conductor?

PF 3: If younger children can understand the instruction from the test conductor?

PF 6: How do children think of different test devices?

PF 8: What is the current problem of the initial perceptions of the test stations?

DO 9: What are the current ways to trigger children's behavior? Can we learn anything from asking children to walk?

DO 10: How to communicate with children? Can we learn anything about the test conductor's instruction?

DO 11: What is the children's favorite walking environment in common?

Research process

Child expert interviews (Appendix A2), physical therapist interviews (Appendix A3), and questionnaires (Appendix A4) are the research activities for these questions.

PF 1: If children with low walking capacity can finish the gait test?

The gait test of 6 times of walking is easy, and all the children can finish the gait test. They can be treated as normal children at the gait test station.

Children with low walking capacity are with extra supports during walking. They have to walk several times to collect good footsteps; however, they may feel reluctant with several times of walking.

> *All the children (with Angelman Syndrome) were able to walk on the gait mat because it is easy. They all walk over the mat and able to walk back(Physical therapist interview 1, Appendix A3);*
>
> *Children with poor walking quality have to walk for several times (e.g. 10 times); After one or more times of walking, some AS children feel reluctant with doing it again and again; but they accept to finish the test (Physical therapist interview 1, Appendix A3);*
>
> *Five minutes of walking is not difficult for them. (Physical therapist interview 2, Appendix A3);*
>
> *There are different walking types for children. Children with AS have different walking capacities. Some of them need extra support (Physical therapist interview 1, Appendix A3).*

PF 2: If children with low intelligent capacity can understand the instruciton from the test conductor?

Children are easily instructed to walk or shown how to do it by the test conductor.

Parents, as experts of their children, can help with the gait test. Parents can support the test conductor by communicating with children in

advance and giving cues to ask the child to walk during the process.

> *They are asked in advance about how to give the most helpful communication with children; During the test, parents give cues and help besides the mat; the test coordinator follows the cues as well.(Physical therapist interview 1, Appendix A3);*

PF 3: If younger children can understand the instruction from the test conductor?

Younger children's intelligence is still developing; therefore, children with low intellectual capacity need additional instructions.

Nevertheless, attracting younger children's attention is more important in communication because they are easily distracted.

> *Shi mentions that catching children's attention is more important for a teacher than perceiving their understanding ability. Children with normal intelligence can understand things with proper ways of explanation or proper reading material. But losing attention would affect their receiving information (Child expert interview 1, Appendix A2).*
>
> *They're distracted from the environment (during walking) Distraction such as toy, parents, or they just walk away instead of doing what is asked (Physical therapist interview 2, Appendix A3);*

PF 6: How do children think of different test devices?

The gait mat or other possible devices are asked, such as cameras, sensors on the body, or tablet.

Body sensors are scary for some children; for other devices, children can see them interesting and would like to explore.

> *10/23 parents answer they worry about the sensors on the body because children would feel scared about the device (Questionnaire, Appendix A4).*
>
> *Older find something new...8, 9,10, 7&6 as well if they find a new place and you see a lot of really interesting stuff in there, like in laboratory in Museum, then they want to go and look at everything and maybe touch everything that they're not supposed to (Child expert interview 2, Appendix A2).*

PF 8: What is the current problem of the initial perceptions of the test stations?

The gait test station outside the Child Brain Lab is a new environment for children. There is always a transitional period of insecurity when children come to a new environment. They watch around to find if they know or trust something.

Since younger children can easily get excited about someone/-thing in the hallway, their insecure period can be short. Older children may already lose interest in the gait test, which means they are neutral in the new environment and would not feel insecure.

However, there is a group of children in between, they are shy and hesitant in the new environment, and their transitional period of insecurity can take long.

With a safe and comfortable feeling to the new environment, children begin to explore the ground with their curiosity.

> *Their first reaction is a bit of Shy hesitation first observe and watch and see if they know or trust something before they do something new. Of course, there are children who will come in and walk to wherever they find interesting and just start playing or start running around for, So they'll probably cling on to whatever they know is probably a parent or a teacher or you know, someone they already know.*
>
> *Younger children are very easily excited; when it comes to when they get a little bit older eight 910 year olds, it's*

sometimes it's more difficult to get them interested into something.

Attachment can create a feeling of security for children, but not all the children need attachment.

DO 9: What are the current ways to trigger children's behavior? Can we learn anything for asking children to walk?

Children need to be motivated. Collecting stickers or little things are often used in class;

Fun and challenges are often involved in PE activities. A high-five or praise is given after PE activities.

Rewarding, such as stickers or compliments, is used by one physical therapist for three purposes. She rewards children's efforts to let them know they walk well; or uses rewards to attract children when they run away, or uses those to motivate children when they refuse walking. Small rewards work for most of the children.

Children like repeating things that they are interested in.

Parents can also be a way to motivate children and are seen as a design opportunity.

A bit of gaming involved activities, where they play a game, they can win sometimes, or they can be together to win sometimes. And yeah, the more the more fun. I always try to create by adding any game element into it...

...Yeah, I can tell the children bounce the ball as many times again. Or I can challenge them and say, Hey, who can bounce the ball at the most times in two minutes?...

...I do know that some like cleaning class teachers are they do their work really well they can get like a sticker or they get like little little things to collect. Okay, cuz we don't have physical work I don't have a piece of paper that I could put a sticker on for example. So it's usually comes to you know, praise compliments or high five something like that (Child expert interview 2, Appendix A3).

It's important to reward their efforts (sticker, compliment) so as to let them know they did good and they did their best...

..,.the worst scenario happens with younger children (before 4) or children who have maybe behavioral problems; -> reason for the preparation and rewarding...

Small reward also works for most of the children (Physical therapist interview 2).

Shi mentions that younger children like repeated things in the picture book and have interests in repetition (e.g. you have a blanket, I have a blanket and she has a blanket, as well...) (Child expert interview 1, Appendix A2).

Autism likes repeating if it's fun a lot; most of the children like to play different games and it depends on what you do and their likeness...

... How to motivate: use parents and toys or other types of motivation (Physical therapist interview 2, Appendix A3) .

DO 10: How to communicate with children? Can we learn anything about test conductor's instruction?

The instruction should be clear, short, firm, and flexible. Body language can be used as well.

Use short sentences and repeat these for young children (Child expert interview 1, Appendix A3).

Body language is very important for communication with children. If you want that they move, then you move too. Be active as a PE teacher. Be clear and firm with rules but flexible when you can (Child expert interview 3, Appendix A3)

DO 11: What is the children's favourite walking environment in common?

One child expert mentions the environmental design for children's emotional impact; therefore, children's favorite walking environment is researched for space design inspiration. Their favorite walking environment is asked by a questionnaire (Appendix 4).

The most selected images and features are collaged and used for visual design inspiration (Chapter 17).

Other finding: the worst scenario of running away

The physical therapist mentions the worst scenario. Some children refuse to walk or cry or run away. These happen both on younger children or children with low walking capacity.

> *The worst scenario is that they don't walk or refuse/cry/ running away. The worst scenario happens with younger children (before 4) or children who have maybe behavioral problems; -> reason for the preparation and rewarding (Physical therapist interview 2)*

Other finding: test conductor's extra work of motivating

As mentioned in DO 9, children need to be motivated. I find that the test conductor in Child Brain Lab has two parts of work. The test conductor needs to instruct and motivate children at the same time. The medical student, as a test conductor, neglects motivating children.

Chapter takeaways

1. In terms of children's walking, most of the children can be treated as normal children.
2. Children with low walking capacity are with extra support and need more walking to collect good footsteps.
3. There exist the worst scenarios of children refusing walking or running away.
4. Children can understand walking instruction and can be instructed to walk.
5. For younger children, attracting their attention is more important to consider when instructed.
6. The instruction to children should be clear, short, firm, and flexible.
7. Children between the younger and the older have a long transitional period of insecurity in the new environment.
8. Children need to be motivated. There are many ways to motivate children, such as rewards, fun, challenge, or parents.
9. When working with children, the test conductor has extra work of motivating children.

Chapter 5

Finding the current problems and design opportunities 2

This chapter answers the following research questions of children's current problems and design opportunities.

Research questions

PF 4: What is the current problem of children's walking process?

PF 5: What is the current problem of dynamics with the test conductor?

PF 7: What is parents' role at the gait test station?

Research process

Two activities are used to research with children, fast simulation gait test (Appendix A5) and Contextmapping research (Appendix A6).

The fast simulation gait test is a test using a complex protocol in GenR. This research is conducted when discussing the gait protocol with the GerR. Therefore, I use a complex protocol in this research.

Contextmapping research uses the protocol in the Child Brain Lab. As it is a rare opportunity with children, I also test some ideas.

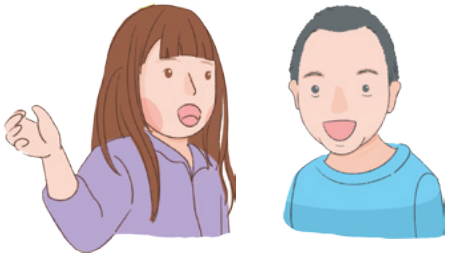
All the children recruited are normal children due to the limited contact resource. As discussed in Chapter 3, most children can be treated as normal children because they can finish walking, and they can understand the instruction. Therefore, research with normal children is acceptable.

Figure 12 shows the research process. All the consent forms for the child-family recruitment are in Appendix A13.

Fast simulation gait test

Child at age of 3 (almost 4) | Child at age of 4 | Child at age of 5 | Child age o

Contextmapping research



Family 1: children at age of 4 & 5

Process

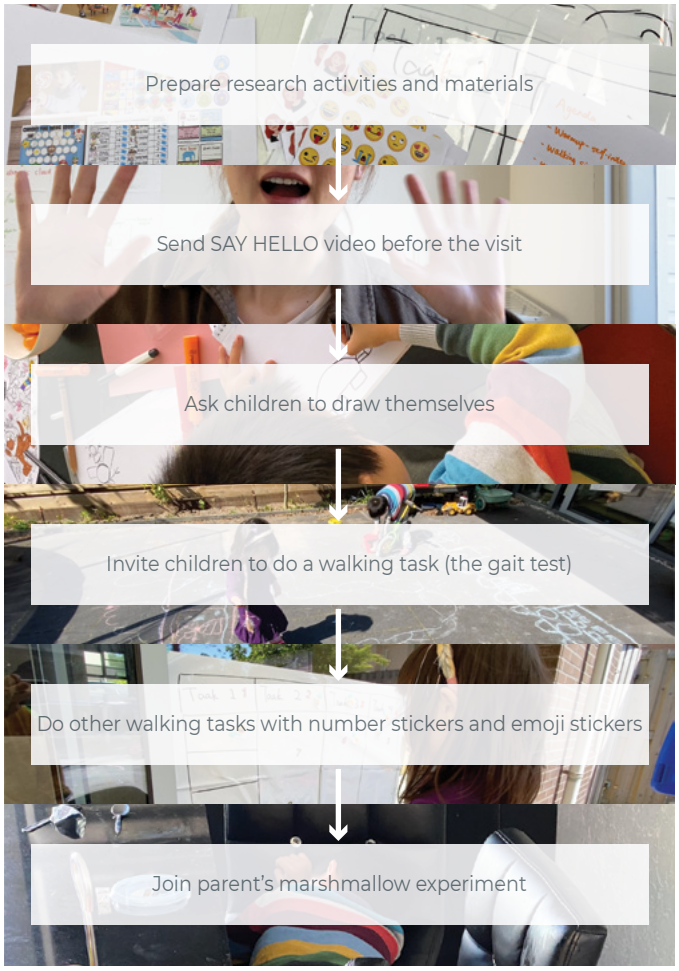


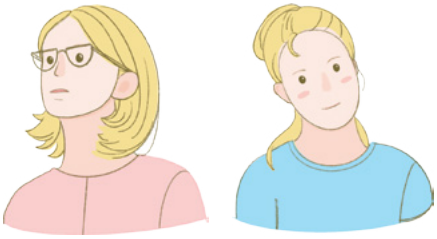
Figure 12: research process with children

d at
of 8

Child at
age of 10

Process

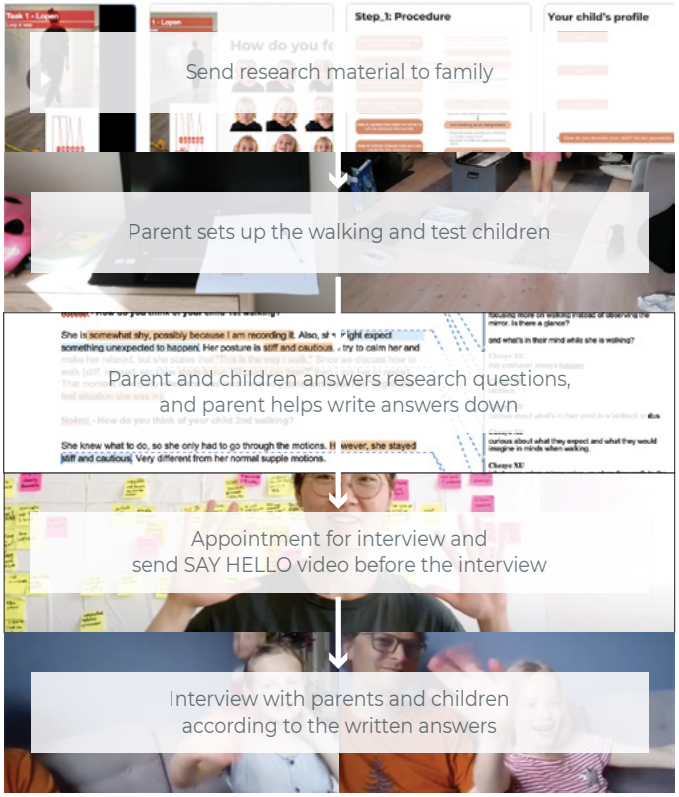
5 families are online contacted and children are asked to do a complex gait test. The complex protocol is from GenR lab and has more tasks, including normal walking. Children's walking status are recorded by video and analyzed later.



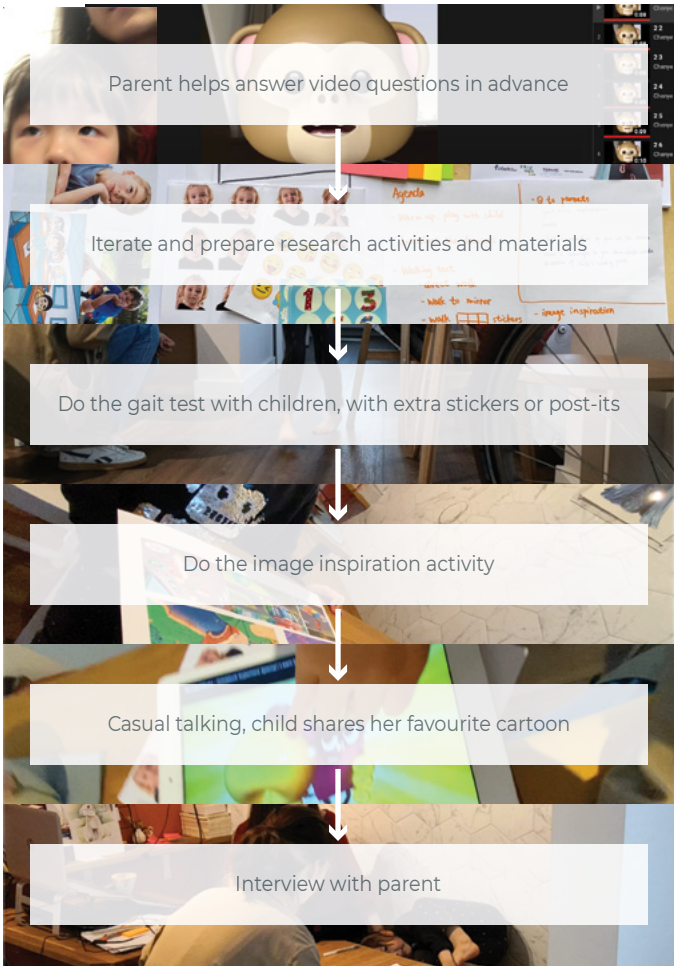
Family 2: children at age of 8 & 7

Family 3: child at age of 5

Process



Process



PF 4: What is the current problem of children's walking process?

In research, I find different walking statuses of children (Figure 13). The statuses include striding, scampering, nervous walking, running, and almost running status. These statuses happen for different reasons, shown in the figure.

- **Striding:** this happens when children walk normally and relax.
- **Scampering:** this happens when younger children when they are relaxed. They move and jump quickly with short little steps.
- **Unnatural walking:** this happens when children walk nervously. The unnatural walking includes that children walk with the stiff body or in small steps. Or they mention that they feel nervous when walking.
- **Running:** running or almost running happens when children are not motivated in the gait test. Some children are motivated out of the gait test and run away; some children accelerate their walking and almost run in a hurry.

These walking status are discussed with the supervisor team. As a result, striding is accepted for the gait test. Scampering, as a natural status for younger children, is accepted as well. The hospital is willing to record different types of walking for analysis as well.

Stiff walking is defined as a current problem because nervous walking is a negative experience for children. Running is a problem because running is different from walking, with a phase of all feet above the ground (Running, 2020).

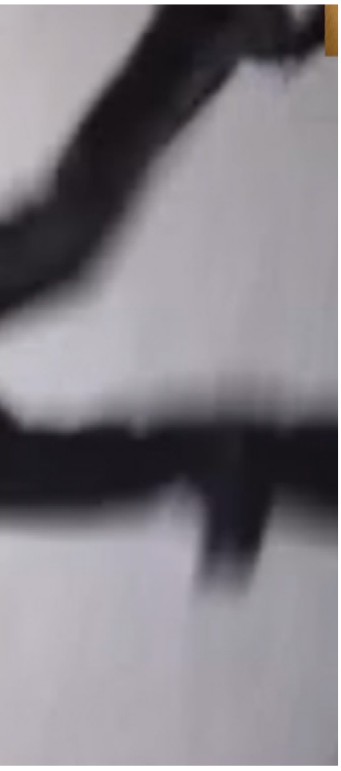
Striding: the two children (aged 8 & aged 4) walk forward in a big step walking.

Stiff walking: The child (aged 7) on the left knows she is recorded and she walks nervously, with small steps and body stiff. The child (ag However, when asked how he feels during walking, he mentions a lit he walks right.

Figure 13: children's different walking status, observed in research

. And they feel relaxed when

Scampering: these are the walking back moments, and the children (aged 5 & aged 8) think the moments are not included in the test; therefore, they walk unintentionally and scamper in relaxation.



seen by someone; therefore,
ged 10) on the right strides.
ttle bit nervous for not sure if

Running: the child (aged 5) on the left is running. He is motivated by the other task and runs fast during walking. The child (aged 8) on the right walks in a hurry and almost runs. She is near the end of the walking and would like to finish it as soon as possible.

PF 5: What is the current problem of dynamics with the test conductor?

In a simulated gait test, children's dynamics with the test conductor have already included the two parts of being instructed and being motivated.

Conclusion of being instructed

In research, the instructions are freely given by my parents or by myself. Those instructions make children independent from the instruction, with two situations are concluded (Figure 14).

One is that "walking six times" is not confirmable for some children. It is easy for some of them to walk mindlessly and forget the times of walking.

The other is that the instruction at points is not timely. Once the instruction is not followed up, the child ends up by themselves and has no idea what is next.

Conclusion of being motivated

The gait test is too easy to motivate children; therefore, they begin to expect something from the test conductor.

I conclude two different reactions of children in research (Figure 15). One is that children's emotional status decreases without achieving expectation; the other is children's continuous expectation with rewards.

The decrease in children's emotional status is a problem because it is a negative experience for children at the gait test station.

Rewards are used to motivate children during walking and result that children keep asking for rewards. This continuous expectation means that the rewards can motivate children and ask children to finish the walking. As a design opportunity, it is currently kept.

The child (aged 8) is only instructed 6 times' walking at the beginning. She doesn't count the times and keeps asking the times during walking.

The child (aged 5) only mentions to walk to the point and paste one post-it. After that without the following instruction, the child walks casually.

Figure 14: conclusion of being instructed

The child (aged 4 almost) smiles at the camera holder after his first time walking back. Then, he receives the next walking instruction instead of a confirmation of his walking. The second time walking back, there is no smile on his face; he looks at the camera and waits until another instruction.

The child (aged 7) looks disappointed and jumps. Her father mentions that she expects something during walking and she doesn't achieve that till the end.

The child (aged 4) walks and counts her steps at the same time. The child knows that she can receive emoji stickers after walking. After she finishes walking once, she immediately turns back to the conductor and tells what she has done.

Figure 15 conclusion of being motivated

PF 7: What is the parents' role at the gait test station?

Parents, as children's company at the gait test station, are mainly considered in the context. With all the research, I find that parents can play two roles.

- **Creating secure feeling for children:** when children come to a new environment with an insecure feeling, they look around, try to find the attachment, and overcome the insecure period (PF 8, Chapter 4). Parents can be seen as an attached person. With the company of familiar people, children can overcome an insecure period quickly.
- **Motivating children:** parents, as their own children's experts, can quickly motivate children. Parents to motivate children is seen as a design opportunity (Figure 16).

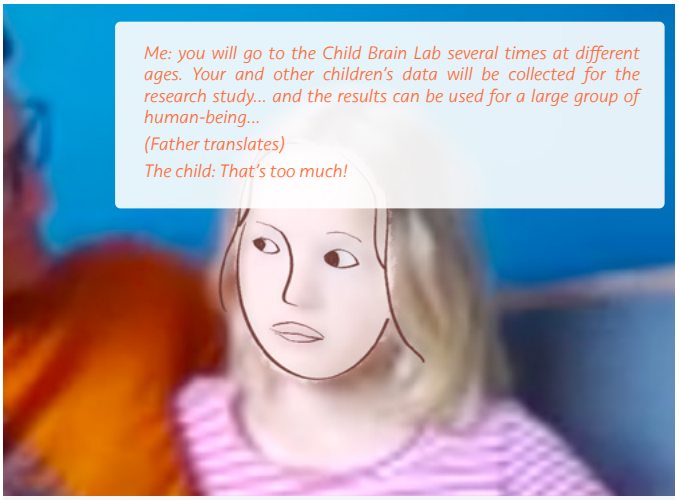
The child (aged 4) struggles in walking heel to toe. His mother asks him to imagine walking on the single-log bridge. He is motivated and keeps laughing. He finally gives up walking and runs to his mother.

The child's mother mentions playing a game tonight. The child (aged 8) is motivated at that night. This is the beginning of walking. He smiles to his mother and waits for the start.

Figure 16: parents motivate children during walking.

Other finding: what can achieve children's expectation

In research, I find that the walking knowledge can be the design opportunity, so as to create a moment beyond children's expectation. With the knowledge, the children can know why they have the gait test in a brain lab. Inspired by the research research results, the walking knowledge can be about the brain and the gait, instead of the information of Child Brain Lab, such as visits at different ages, or recorded data for research (Figure 17).



The child (aged 8) is told the entire information of the Child Brain Lab and is asked if she wants to know it at the test station. She moves her body back in a sudden and goggles. She feels overwhelmed about all the information.

The child (aged 7) mentions she wants to know something interesting at the gait test station.

Figure 17: children react on the information given in the test.

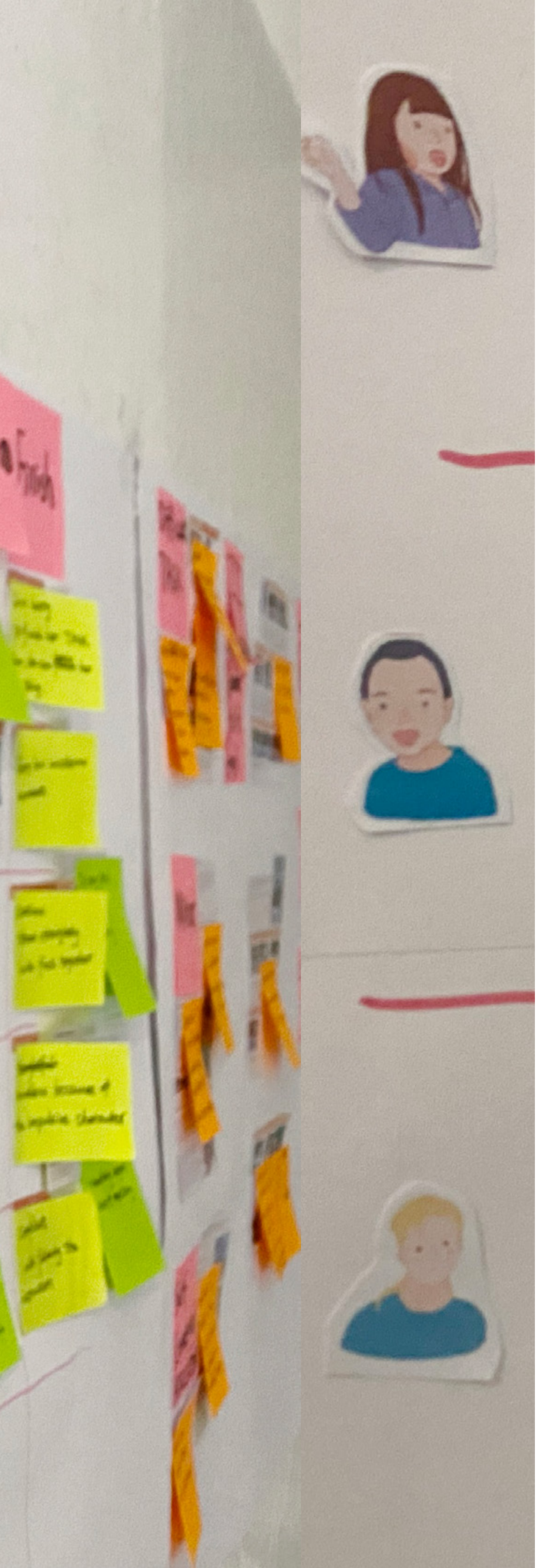
Other finding: self-observation with transformation can motivate children

When children observe themselves in mirror or phone camera, some transformations can motivate children (Figure 18). With the transformation, some walking task can be triggered. This is seen as a design opportunity.

The child (aged 4) notices herself in the front-head phone camera and detects an illumination change on screen. She keeps changing her positions to see the transformation. Her bother also joins her later.

Figure 18: children react on the information given in the test.


1 2 3 4 5 6
disrupting
Unwillingness &
following instructed
because with forced
promise
the instruction
the unwillingness
walk slowly
sister
the task
elaxed and
tart running as he
ishes
y cannot understand
e instruction of walking
stroking and
ting ground at
end
She is entertained
Stay Cautious
with stiff body and
head tilted
autious walking
nd cannot be relaxed
se of being monitored
no idea of why walking
Complaining
because of the
unclear test
confused with the
start point and end
point
mindless
following what you asked



Chapter takeaways

1. There are different walking statuses of children at the gait test station. Striding and scampering are accepted as children's natural walking; Stiff walking and running are not accepted in the gait test.
2. The current instruction is not confirmed and timely for children. Children become independent during walking, and mindless mistakes happen during the test.
3. In this easy walking, children are not motivated; therefore, children begin to expect more.
4. Some children expect to know more of the gait test; some children expect a confirmation of their walking;
5. Some children achieve their expectations out of the gait test; they are distracted, motivated by the distraction, and run away.
6. Rewards, parents, and the walking knowledge can motivate children, which are seen as design opportunities.

Chapter 6

Research synthesis: Current situations of the gait test station

With the previous chapters' research results, a service blueprint is to map the test conductor's working experience, the device, and the gait test process. It also shows the dynamics between children and the test conductor.

Under this service blueprint, I depict children's test experience into four typical situations with severe problems.

With the concluded problems, I formulated the design goal and interaction vision for children's walking experience. A shortlist of design requirements is also made based on the service blueprint.

Synthesis 1: the current service blueprint of th

The current service blueprint connects the children's test process and the test conductor's working process at the gait test station (Figure 19). And this service blueprint shows the following keynotes:

1. The test sequence in the Child Brain Lab is a break, the gait test, and the photogrammetry head scanning.

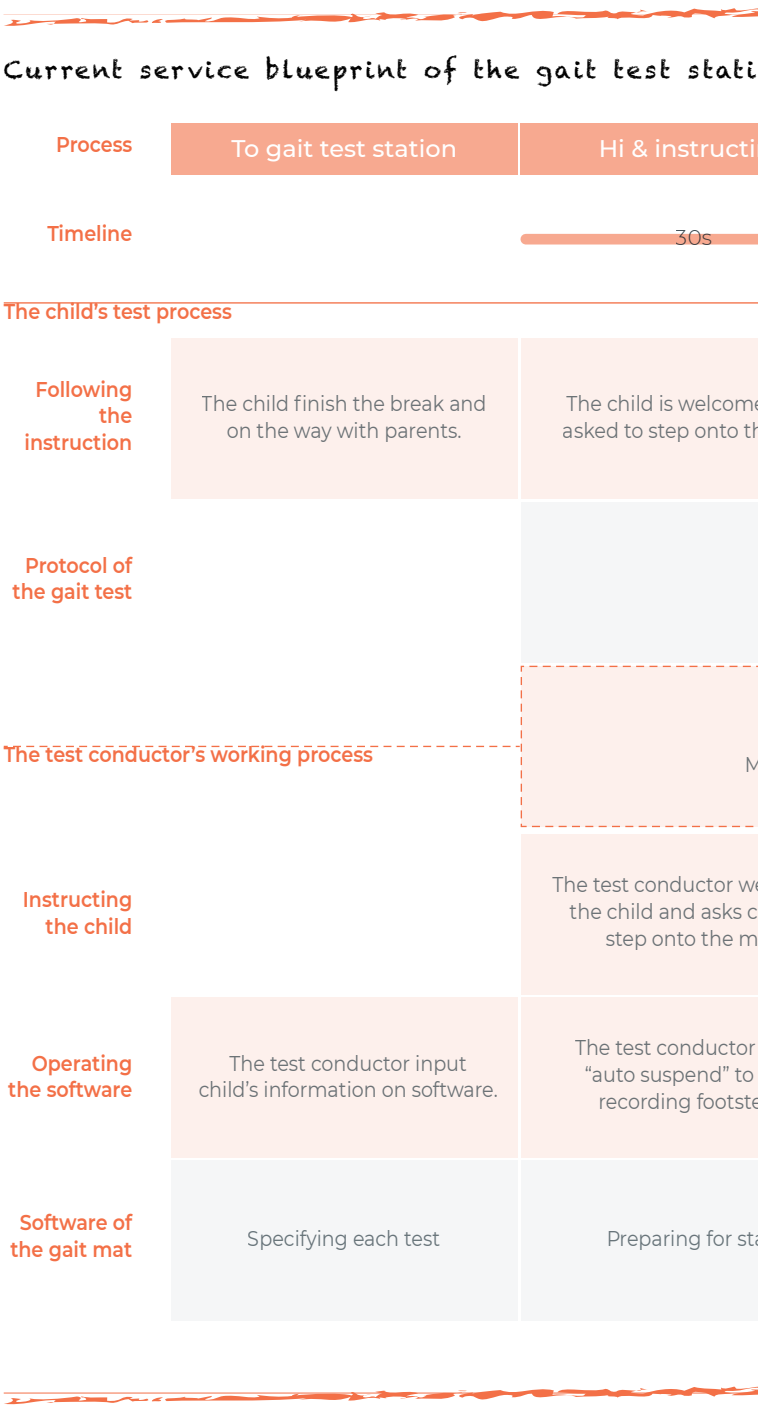


Figure 19: current service blueprint of the gait test

e gait test station

2. The gait test of 6 times of walking doesn't take a long time. It is a short test.
3. Children, as test participants, follow the instruction from the test conductor,
4. Motivating happens, only when it's necessary, to some of the children.
5. The test conductor's work includes three parts, instructing children, motivating children, and operating the software.
6. For the test conductor, motivating children is always ignored.

on

ng	During walking	After walking	To photogrammetry station
	< 60s	30s	
ed and he mat.	The child follows the instruction and does the walking protocol.	The child is asked to leave the mat.	The child goes to the next station of photogrammetry.
6 times of walking as a standardized walking protocol for all children, with chance to modify; In result, at least 2 or 3 gait cycles should be recorded for data analysis			
Conductor's specific work for the child as test participant: motivating Motivating depends on different types of children and sometimes are ignored by test conductor.			
elcomes hild to at.	The test conductor instructs the child flexibly and watches the child walking.	The test conductor asks the child to leave the mat.	
clicks start eps.	The test conductor glances at the capturing data on software when watching child's walking.	The test conductor clicks "done and save" to save the test results.	The conductor input the information for the next child.
art	Capturing footsteps from mat	Saving footsteps	Specifying each test

Synthesis 2: the current typical situations at the gait test station

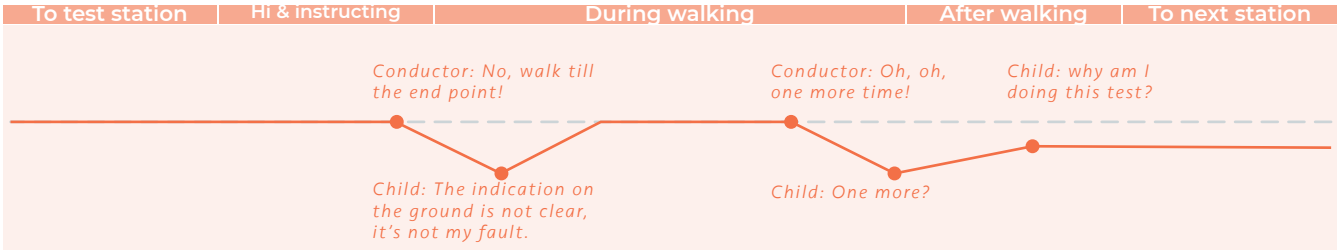
Figure 20 shows the 4 typical situations at the gait test station.

Older children

Older children consider the gait test easy, and therefore, tend to make careless mistakes, such as forgetting the times of walking and leaving the mat in advance. They expect to know more about the gait test. However, the current gait test cannot achieve their expectation, and they tend to run near the end to finish the test quickly.

The conductor instructs them at the beginning and keeps correcting the mindless mistakes by during walking.

Experience map



Pain points

- The instruction, given at the beginning merely, is not enough. Mindless mistakes can happen during walking.
- The gait test is easy. They are not motivated and expect to know more about the gait test.

Design opportunities

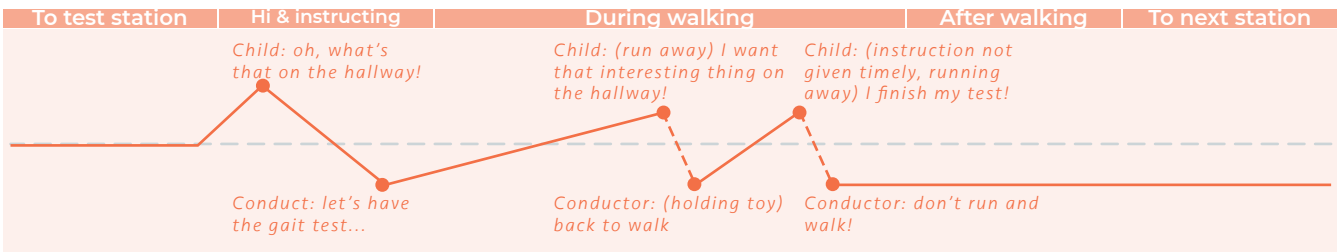
- Instruct children timely during walking;
- Motivate children by the walking knowledge.

Younger children

Younger children are still self-centered, sticking with their point of view strongly; therefore they cannot follow the instruction compliantly. In this easy walking process, they are easily distracted on the hallway, motivated out of the gait test, and run away as a result. Once the instruction is not given timely, they also end the walking independently.

The test conductor instructs them and motivates them by toys or rewards, to ask them to finish the walking.

Experience map



Pain points

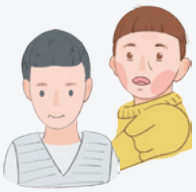
- They are easily distracted, motivated out of the gait test, and run away;
- They end the walking independently without a timely instruction;
- The running away breaks and influences the gait test itself; extra efforts are needed to filtering their footsteps;
- The test conductor pays extra efforts to motivate them to finish.

Design opportunities

- Keep the test station less distracted;
- Motivate children during the walking process for the entire gait test.

Figure 20: children react on the information given in the test.

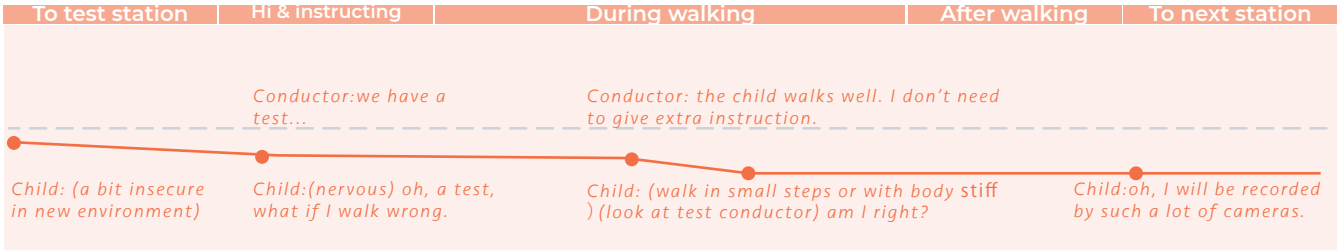
Children in between



The children in between can be instructed and finish the entire walking process. The main problem is at the beginning, they have a long transitional period of insecurity in the new environment and they feel nervous once they hear of “the gait test”. They feel uncertain about their walking and expect confirmation from the conductor. The insecure feeling happens again when they go to the next station.

The test conductor only instructs children and ignores motivating them.

Experience map



Pain points

- They feel insecure to the two test stations, which can enhance their nervous feeling at the beginning;
- They feel nervous about the test; therefore, they expect a confirmation from the conductor, which is neglected by test conductor in normal;
- With the nervous feeling, they can walk in small steps or with body stiff.

Design opportunities

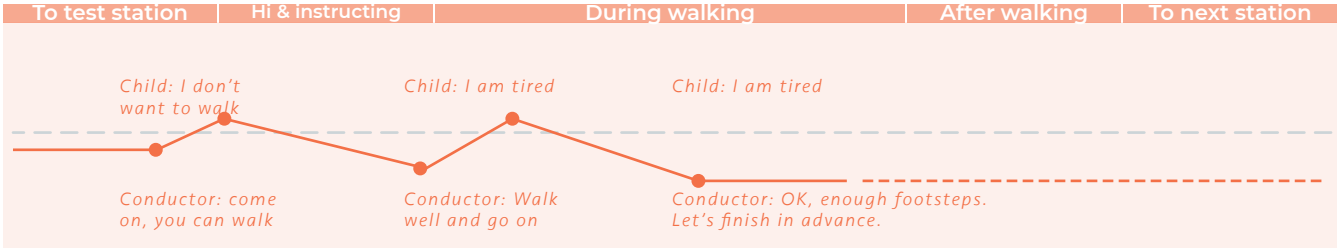
- Design the space of the test station to help children overcome the insecure period quickly;
- Release children’s nervous feeling before the walking.

Younger children with low walking capacity

For younger children with lower walking capacity, in addition to the characters of the younger children, they are tired of the gait test because they have the walking treatments a lot at the hospital. They need walk more times to collect gut footsteps, However, they get tired and give up the test easily.

The test conductor instructs them and motivates them by appreciating their efforts and encouragements.

Experience map



Pain points

- They are tired of the test and don’t expect the test;
- They need more times of walking to collect footsteps in good quality;
- They give up the test easily in advance. The test conductor pays extra efforts to motivate them to finish.

Design opportunities

- Motivate children at the very beginning of the test;
- Motivate children to finish the entire gait test, which can already collect enough footsteps in good quality.

Synthesis 3: problem statement

According to the experience hierarchy in Chapter 2 and Chapter 3, the problems in those typical situations are concluded (Figure 21).

As the problem 4-6 are in the service scope and are the results by the problem 1-3, they are defined as side problems.

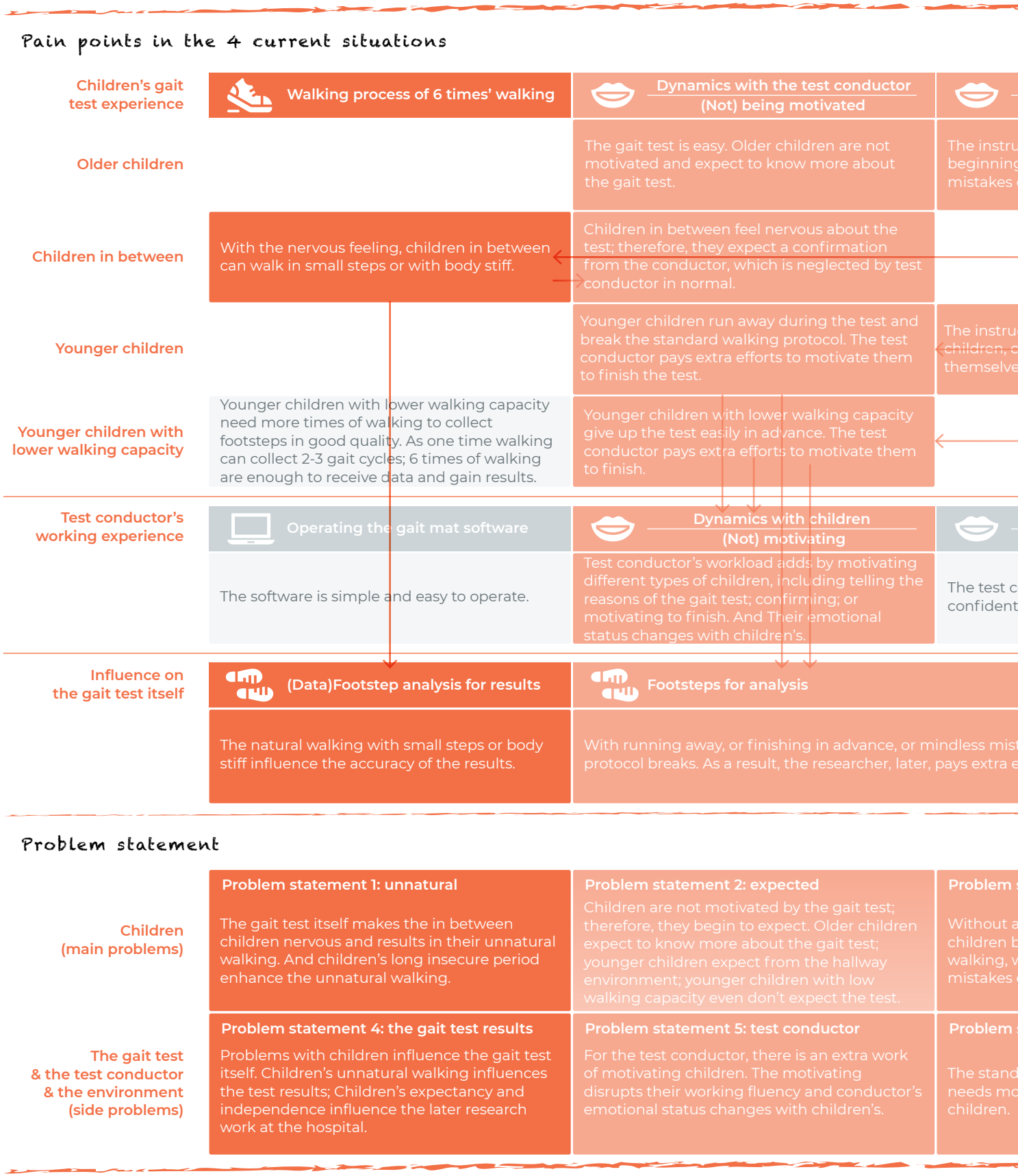
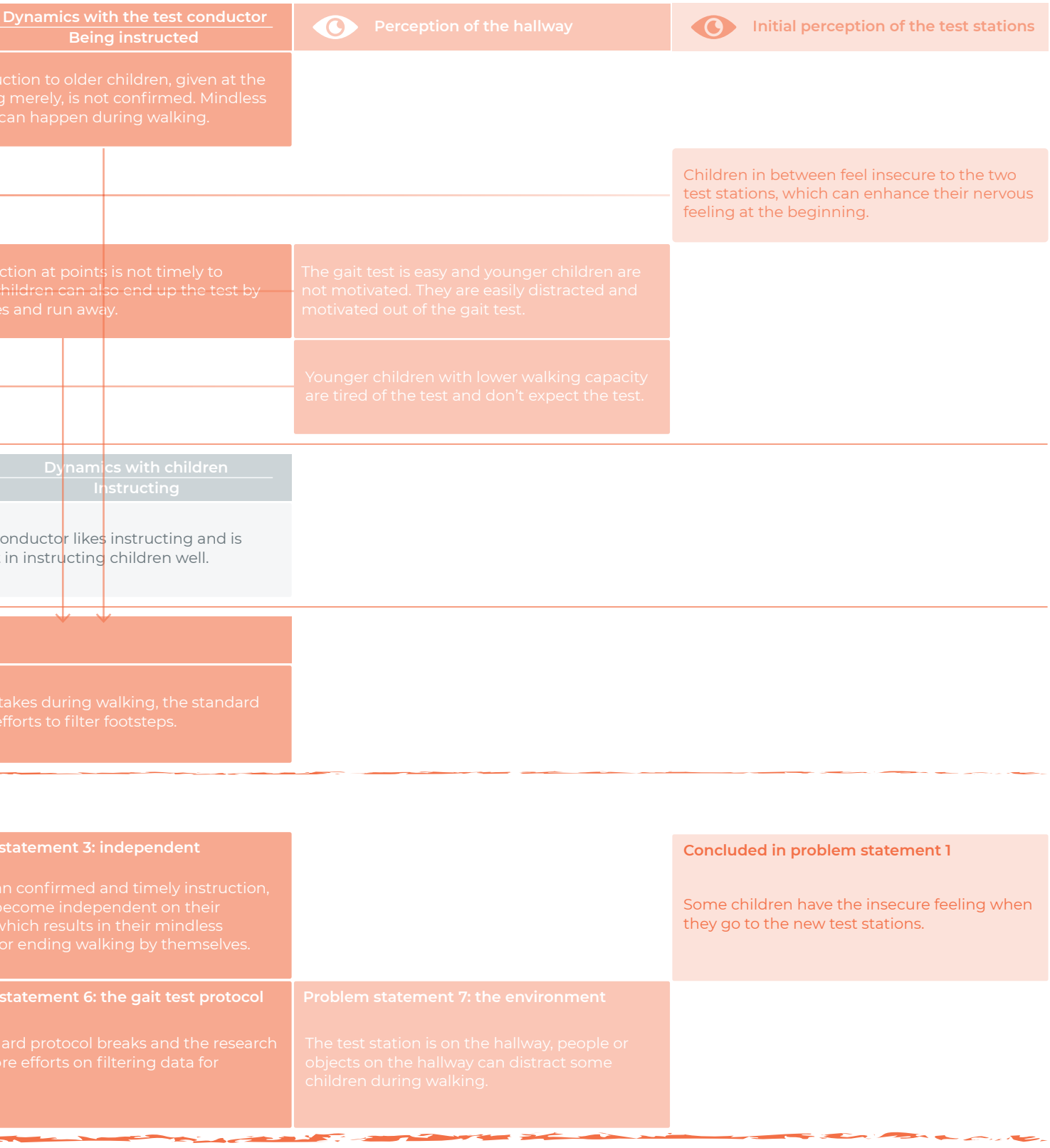


Figure 21: current situations of different types of children.


Dynamics with the test conductor
Being instructed
uction to older children, given at the
g merely, is not confirmed. Mindless
can happen during walking.
Perception of the hallway
Initial perception of the test stations
Children in between feel insecure to the two test stations, which can enhance their nervous feeling at the beginning.
ction at points is not timely to
hildren can also end up the test by
s and run away.
The gait test is easy and younger children are not motivated. They are easily distracted and motivated out of the gait test.
Younger children with lower walking capacity are tired of the test and don't expect the test.
Dynamics with children
Instructing
onductor likes instructing and is
in instructing children well.
takes during walking, the standard
fforts to filter footsteps.
statement 3: independent
n confirmed and timely instruction,
ecome independent on their
which results in their mindless
or ending walking by themselves.
Concluded in problem statement 1
Some children have the insecure feeling when they go to the new test stations.
statement 6: the gait test protocol
ard protocol breaks and the research
re efforts on filtering data for
Problem statement 7: the environment
The test station is on the hallway, people or objects on the hallway can distract some children during walking.

Synthesis 4: design goal and interaction vision

With the main problem statement 1-3, I have my design goal and interaction vision as:

Design an experience journey for children's (aged 4-10) gait test to induce their natural walking, make them motivated and fun, or learn about the walking

Unnatural

The gait test itself makes the in-between children nervous and results in their unnatural walking. Some children's long insecure periods enhance their unnatural walking.

Natural

Children in-between can stride or scamper during walking in relaxation.

Expected

Children are not motivated by the gait test; therefore, they begin to expect. Older children expect to learn more about the gait test; younger children expect something interesting from the hallway environment; younger children with low walking capacity even don't expect the test.

Motivated

Children are motivated in the gait test; for older children, they are motivated and learn about their walking; for younger children, they are motivated and achieve a moment of joy; for younger children with lower walking capacity, they are motivated to finish the entire test.

Independent

Without confirmed and timely instruction, children become independent on their walking, which results in their mindless mistakes or ending walking by themselves.

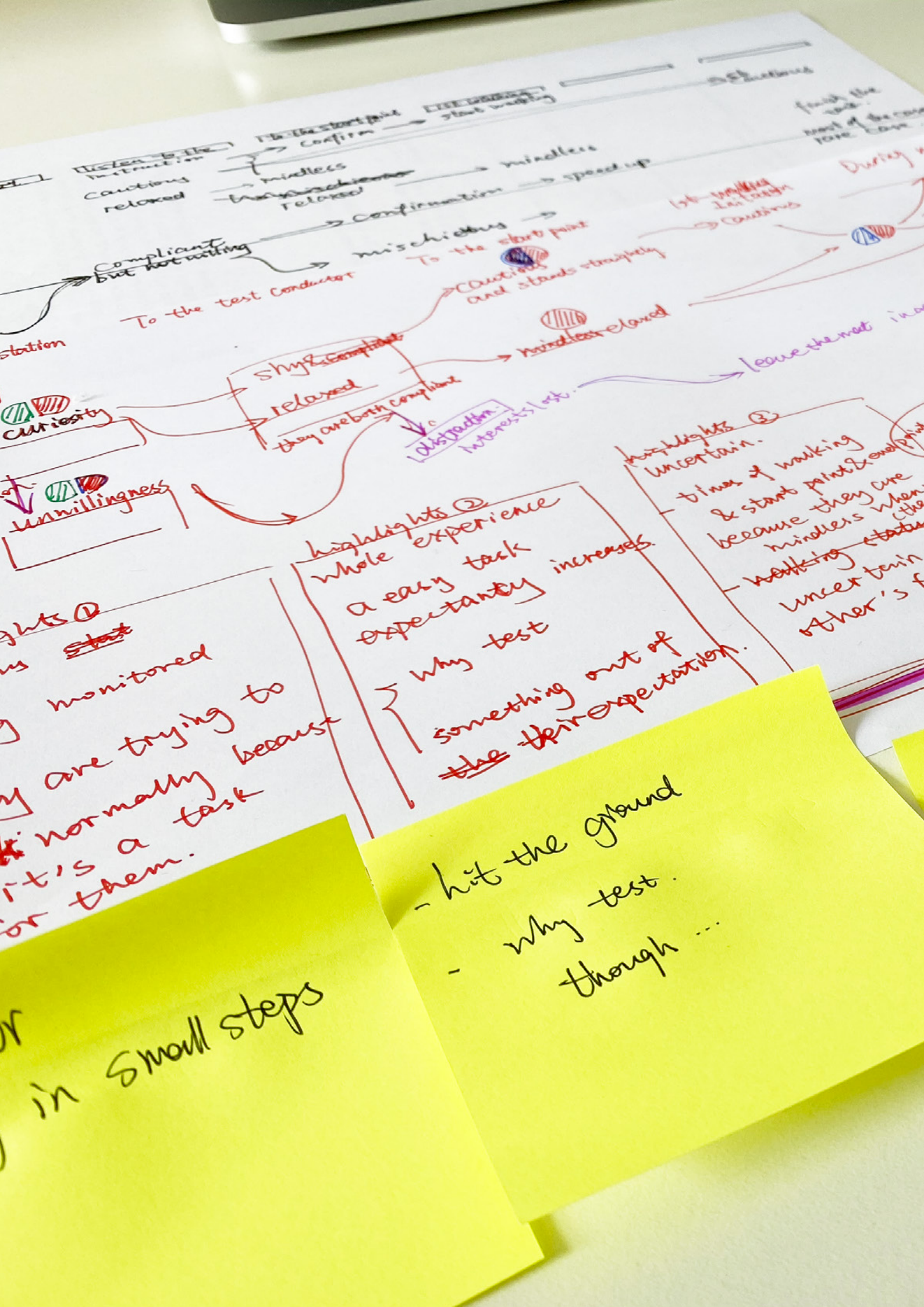
Instructed

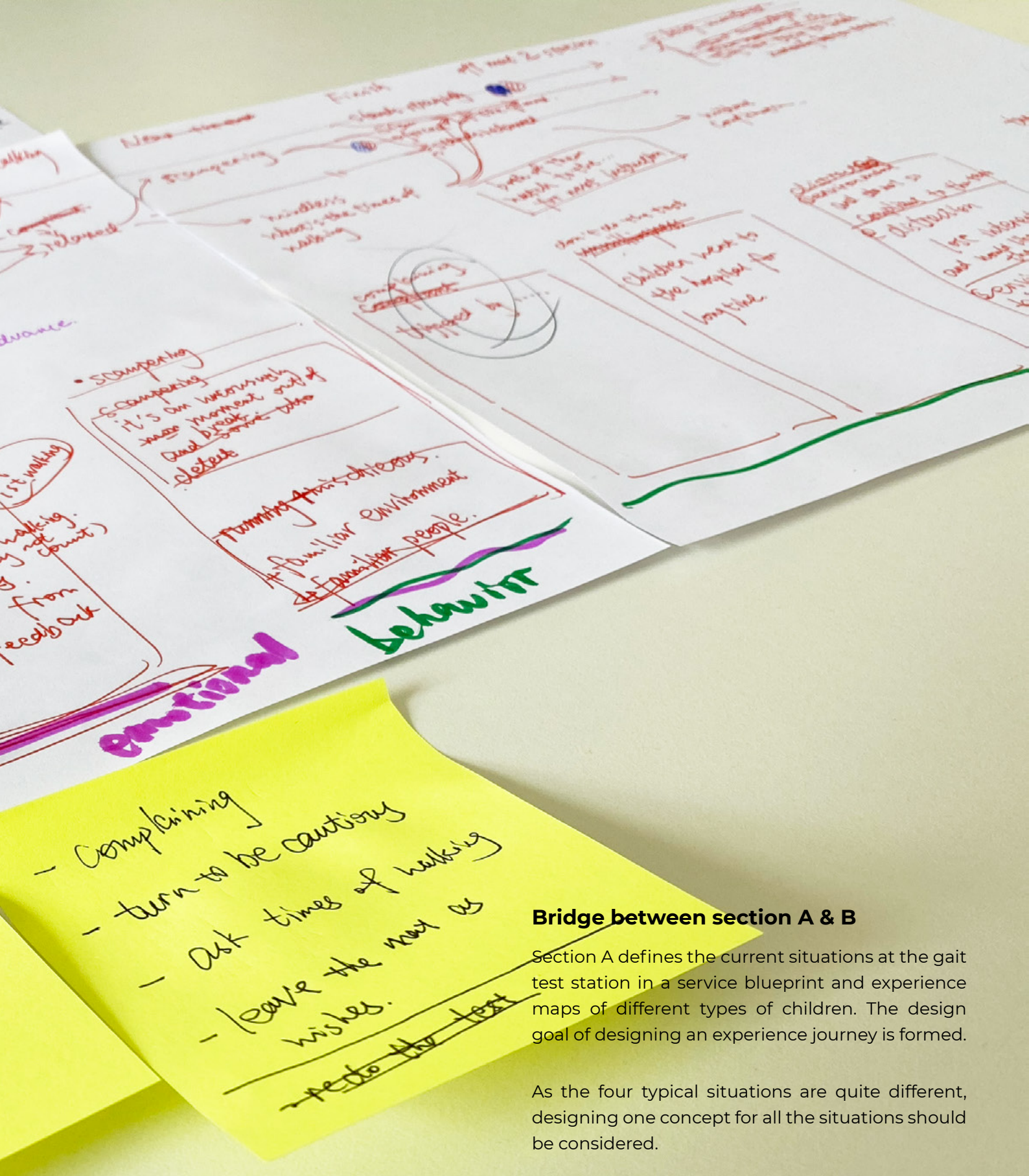
All the children are instructed confirmably and timely during the gait test. There is no mindless mistake happen during walking, and children will not end up the test by themselves.

A shortlist of design requirements

1. The experience journey should not influence the test conductor's working fluency;
2. At least 2-3 gait cycles should be captured for the test results
3. The gait test protocol should be standard so as to make the data filtering easy for analysis
4. The environment should be less distracted.


Children's gait test is just like rolling this sushi!


Compliant but not willing
To the test conductor
To the start point
Curiosity
Unwillingness
shy
relaxed
they are both compliant
distraction
interests | etc.
highlights ②
whole experience
a easy task
expectancy increases.
why test
something out of
their expectation.
monitored
are trying to
normally because
it's a task
them.
- hit the ground
- why test.
though ...
in small steps



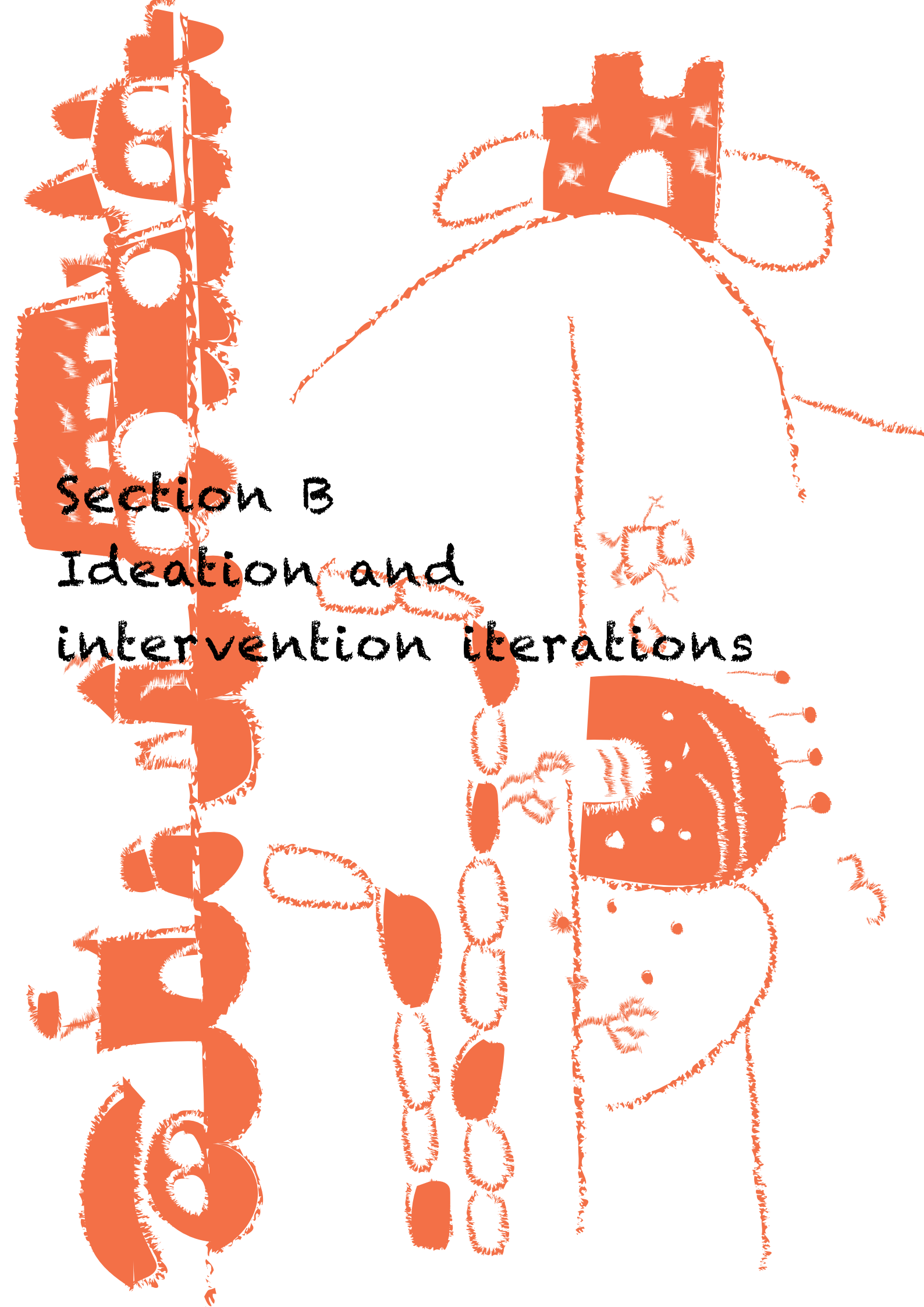
Bridge between section A & B

Section A defines the current situations at the gait test station in a service blueprint and experience maps of different types of children. The design goal of designing an experience journey is formed.

As the four typical situations are quite different, designing one concept for all the situations should be considered.

The next section of intervention iteration, on the one hand, tries to find solutions to problems. On the other hand, the iteration will help consider combining all the solutions into one concept.

Moreover, with the intervention iteration, I gain more emphasis on children to better design for them.



Section B
Ideation and intervention iterations

Chapter 7

Ideation session

The ideation session helps to brainstorm design ideas. There are two sessions held under the same topic (Figure 22). All the session materials are in Appendix A7.

The session results are collected for the next iteration phase.

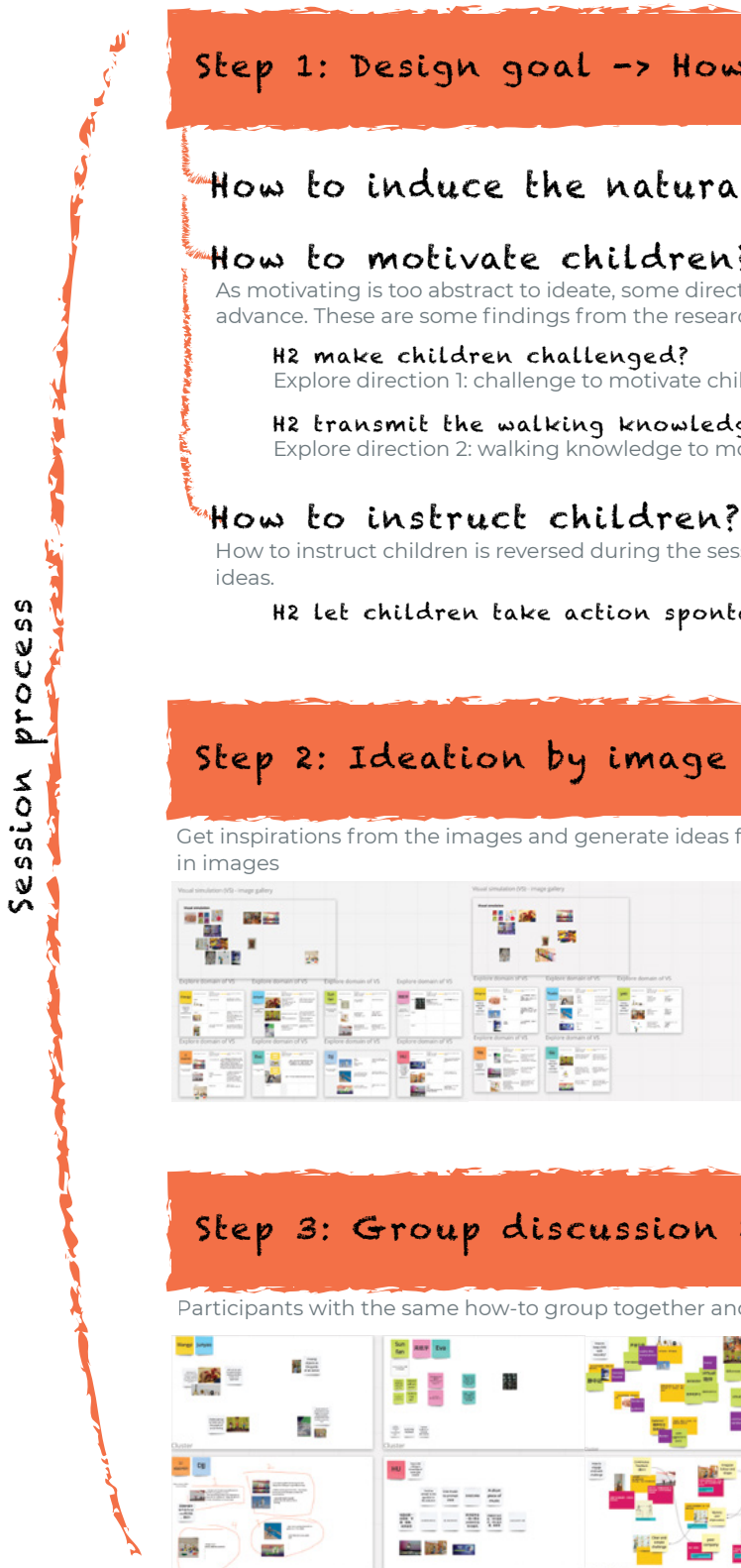


Figure 22: the ideation session

tos -> H2s

l walking?

?

tions are given in
ch phase.

ldren (Chapter 3)

ge to children?
otivate children (Chapter 5)

sion for innovative

aneously?

stimulation

rom different elements

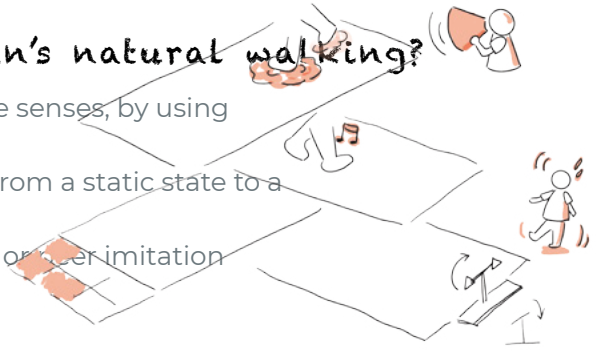
& cluster

d cluster similiar ideas.

Session results

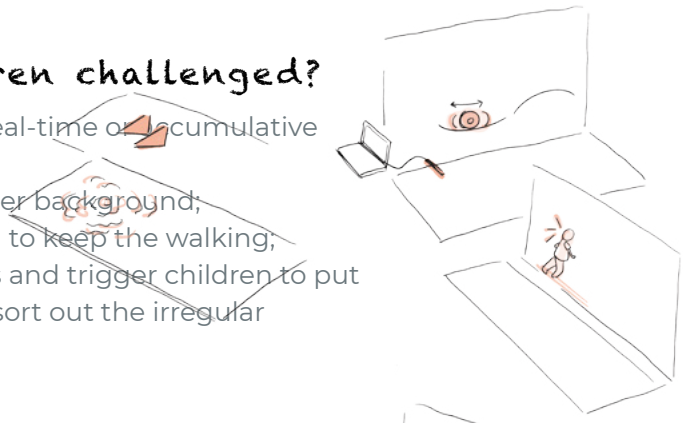
H2 induce children's natural walking?

- Engage children's multiple senses, by using bright color and sound;
- Make the start in motion from a static state to a dynamic state;
- Use peer competitiveness or peer imitation



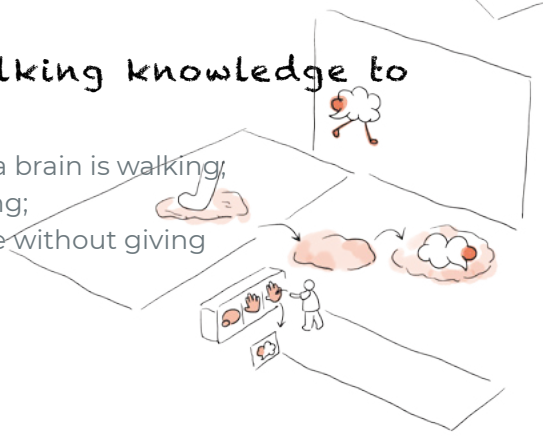
H2 make children challenged?

- Give children either real-time or accumulative feedback
- Play an average temper background;
- Let peers ask children to keep the walking;
- Use abnormal objects and trigger children to put them back to normal (sort out the irregular shape/color etc.)



H2 transmit the walking knowledge to children?

- Storytelling: tell a story that a brain is walking;
- A process of learning by doing;
- Ask children to freely explore without giving specific answer



H2 let children take action sponstanously?

- Multiple senses of children;
- Transfer children's attention to hand & leave the interaction area not on foot;
- Create a following/guidance without thinking via abstract company/or by some trends;
- Create calm guidance via beats of some borders;

Chapter 8

Intervention iteration

The intervention iteration takes one month in total (Appendix A8). As it is remote cooperation with parents, the ideas sometimes cannot thoroughly be tested. Therefore, I use these iterations to receive enough idea feedback and insights before the conceptualization. Figure 23 shows the process of this iteration.

All the ideas tested in this phase are shown in Figure 24 (Page 50-51).

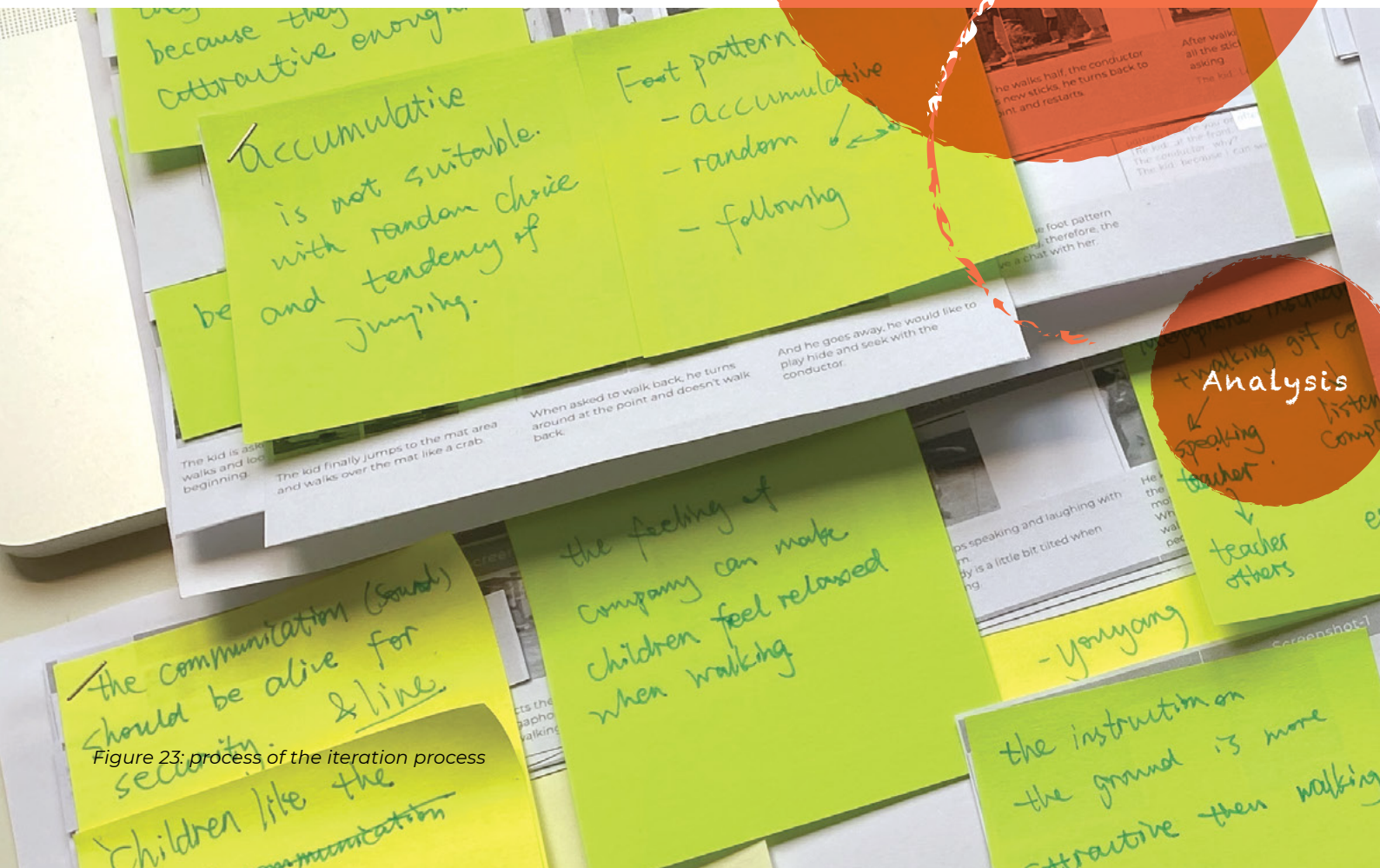


Figure 23: process of the iteration process

ng

from parents

duct the test;
now how to
rovements

test by myself

s from video are not enough
npathesize with children and
est conductors

with the family

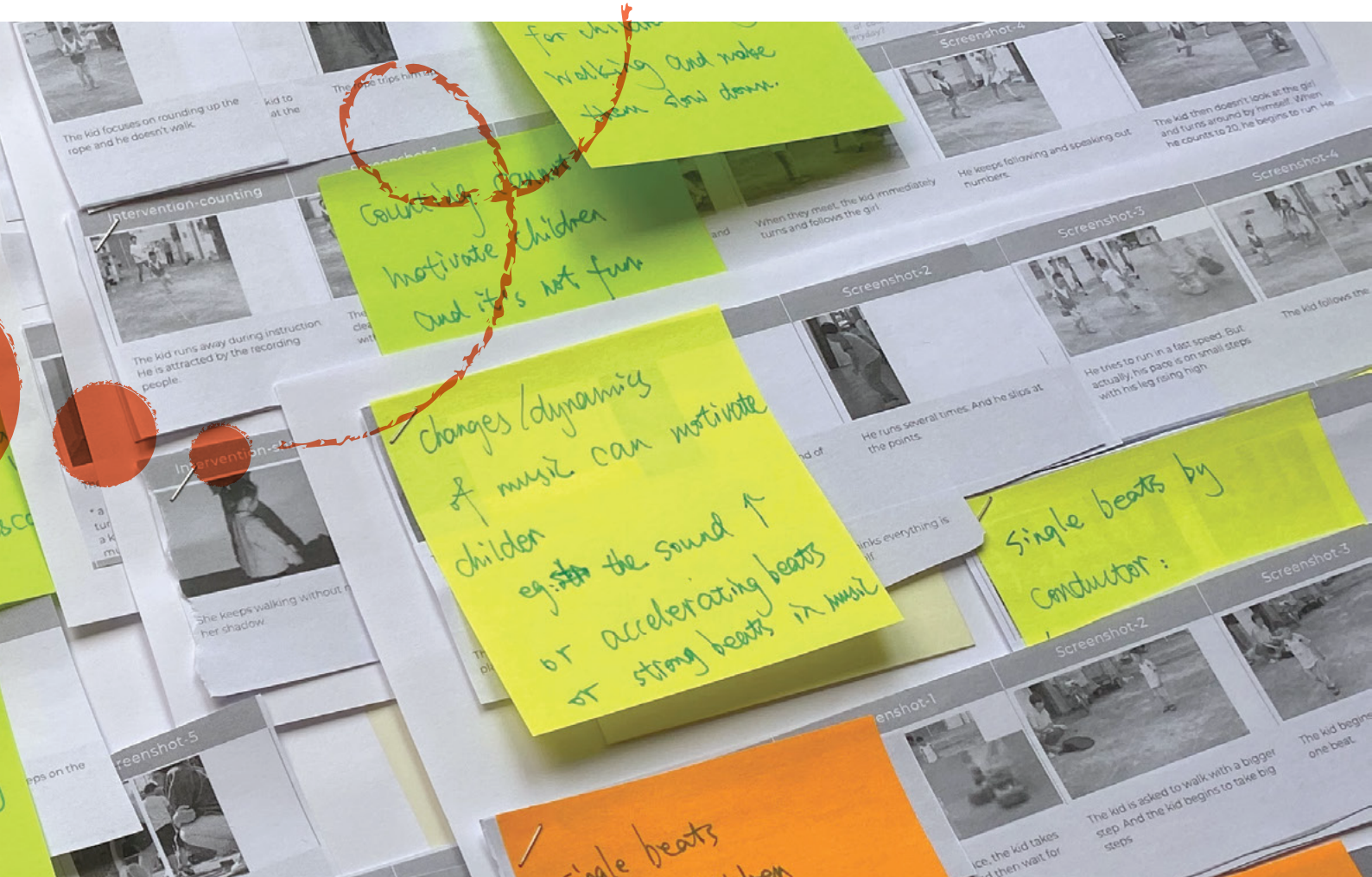
by children's association, not
and treasurable

Conceptualization

Combine solutions in one compact concept (Section C)

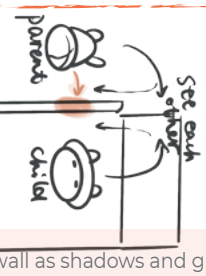
Iteration conclusion: Design patterns

- Modify some previous research results;
- Design patterns for different situations;
- Demostrate the patterns based on the iteration results;



8.1 Ideas in the intervention iteration phase

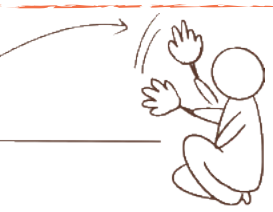
Figure 24: tested ideas in the iterations



wall as shadows and guide meet at points

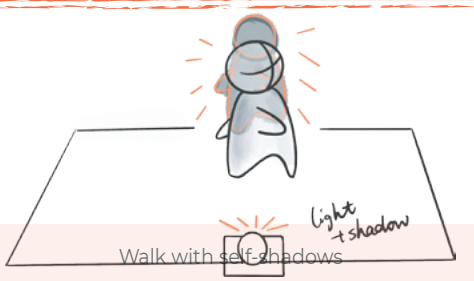
A shadow follows children's walking

Walking with real people or walking gif

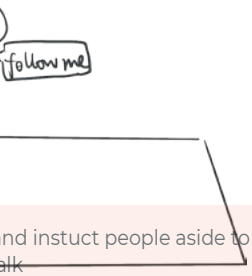


ifferent height at points

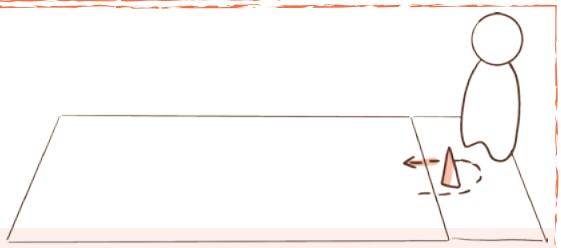
Parents stand at points and ask children to imitate their walking. They have a high-five at the points



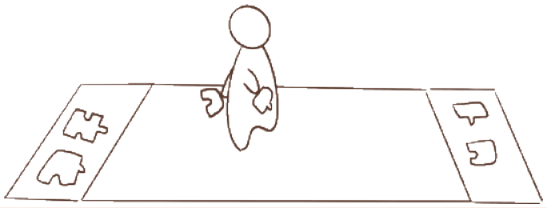
Walk with self-shadows



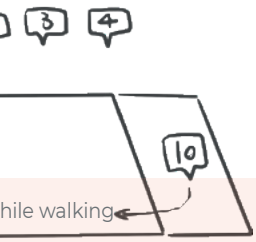
nd instuct people aside to lk



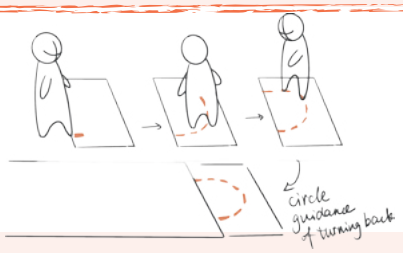
Setting barriers at points and asking children to turning at the points



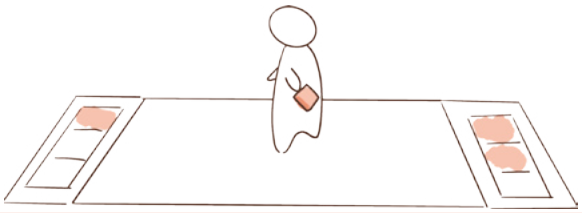
Collecting puzzles



hile walking

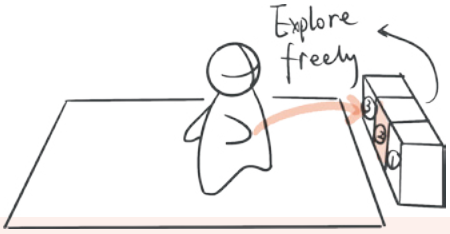


Immediate guidance only at points

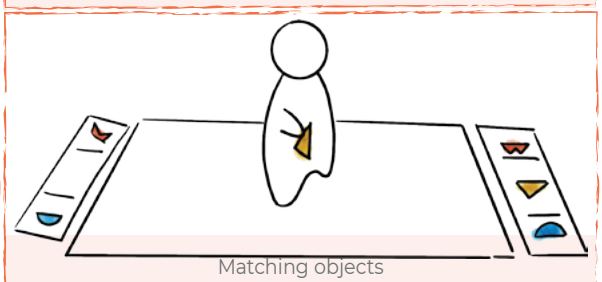


Filling in blanks

ith different animals

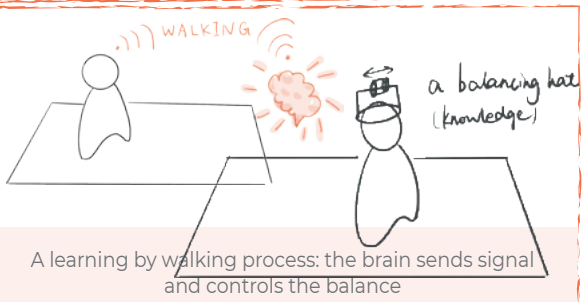


Free explore the walking knowledge



Matching objects

ess: left brain controls right n the opposite side



A learning by walking process: the brain sends signal and controls the balance

Ask children to discover the knowledge during walking

8.2 Iteration results

With the iteration, the experience patterns are concluded. Execuable ideas are also listed under each patterns. This chapter overviews the patterns (Figure 25). In the following chapters, the execuable ideas are introduced under each patterns.

The gait test is a task

After the iteration, I redefine the gait test as a task for children, children are given this task and has to finish it.

How to induce children's natural walking?

For children in-between, a task, instead of a test, is given to divert their attention from the pure walking, so as to induce their natural walking; Company or attachments are designed at the two stations, by which children can overcome their insecure feeling quickly.

How to motivate children?

For older children, three walking knowledge are designed and are appropriate for the gait test station. In the task, the goal of finishing walking is easy as expected. The walking knowledge gives children the reason for walking in the Brain Lab and creates a peak moment beyond children's expectations.

For younger children, an extra task is designed to motivate them. This additional task is easy and makes children fun. It aligns the walking task to finish.

For younger children with low walking capacity, they are not tested in the iteration. The pattern is generated from the interview results of the physical therapists. During walking, they are often encouraged, and their efforts are appreciated. Therefore, an extra task is designed, with an ending of appreciating their efforts.

How to instruct children

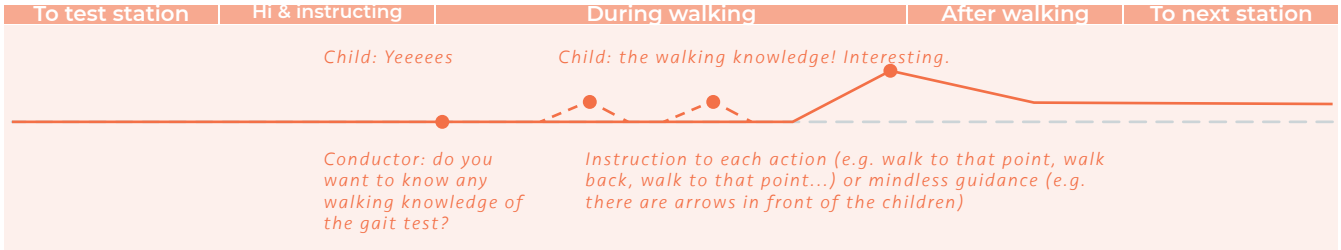
When observing parent's instruction to children, I find that the most confirmed and timely instruction is one instruction to one action. Therefore, at each point of the gait mat, the instructions need giving.

In addition to the instruction, mindless guidance in front of the children are also tested. As a results, the mindless guidance with a distance in front of the children are designed and can be used without interfering the gait test.

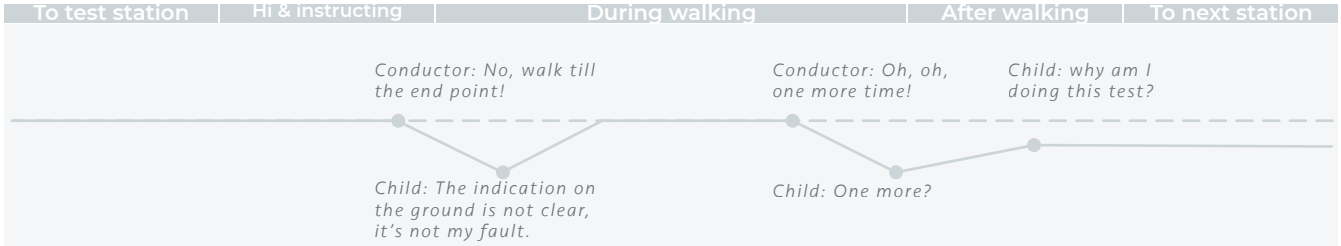
Older children

Desired situation: Older children can finish the walking easily, with an instruction to each action or mindless guidance. Exploring the walking knowledge is used to motivate children. Children learn the walking knowledge, and the knowledge exceeds children's expectation in the easy task and create some peak moments during walking.

The experience journey



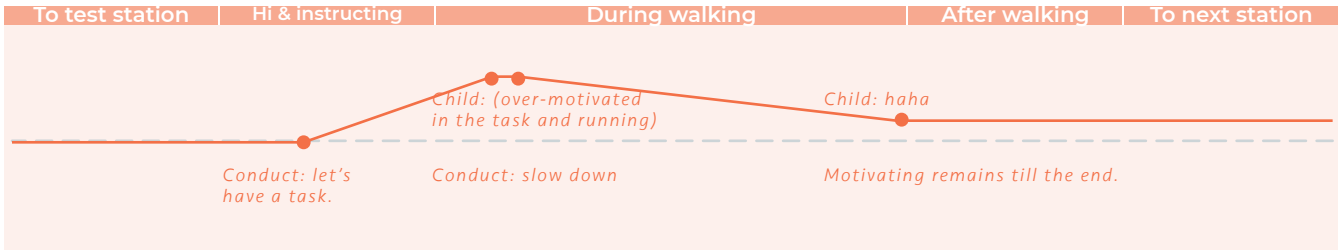
The current situation



Younger children

Desired situation: younger children are attracted by the test station, instead of the hallway. Then, an extra task aligns the easy walking is given to the children. This easy task is a task that can motivate children. Sometimes, children are over motivated and run. The test conductor asks them to slow down. The task can remain the motivating until the end of walking and children feel fun in the task.

The experience journey



The current situation

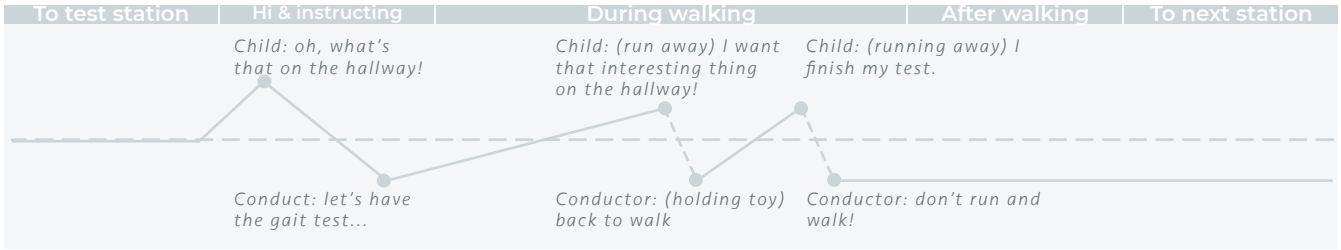
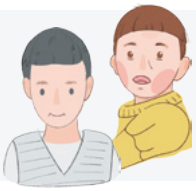


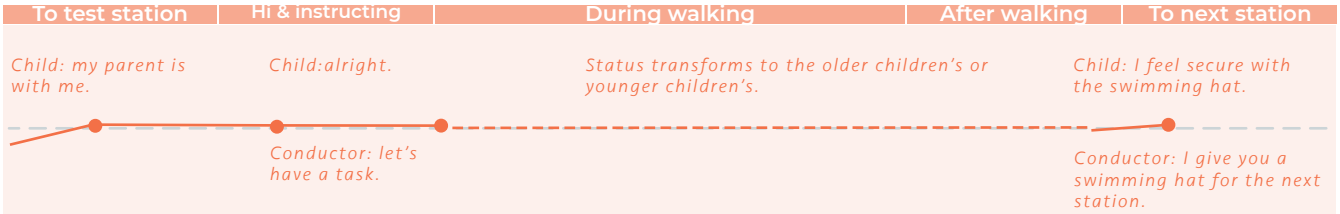
Figure 25-1: the experience journey concluded from the iteration results

Children in between

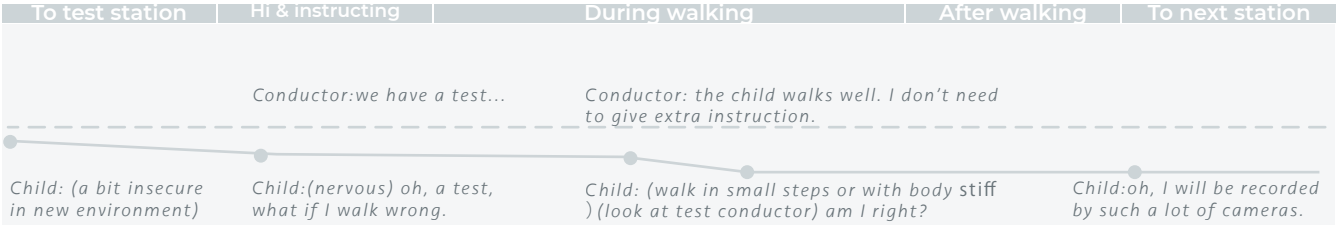


Desired situation: They are given a task instead of a test. Therefore, their attention on walking is diverted, or they are motivated by the task. With their nervous feeling released, they can walk naturally and their status changes quickly to the older children's or the younger children's. At the two stations, they can find something they are familiar with to overcome the insecure period quickly.

The experience journey



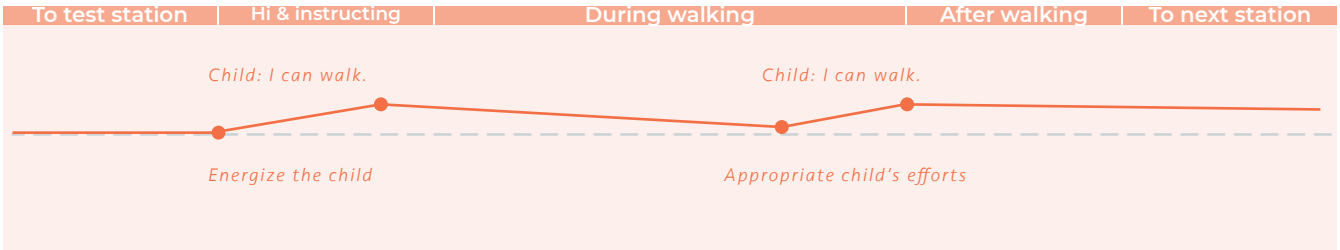
The current situation



Younger children with low walking capacity

Desired situation: as younger children, they are attracted by the test station. Then, they are energized and can start walking. During walking, their efforts on walking is appreciated. With the appreciation, they are motivated and finish the entire walking.

The experience journey



The current situation

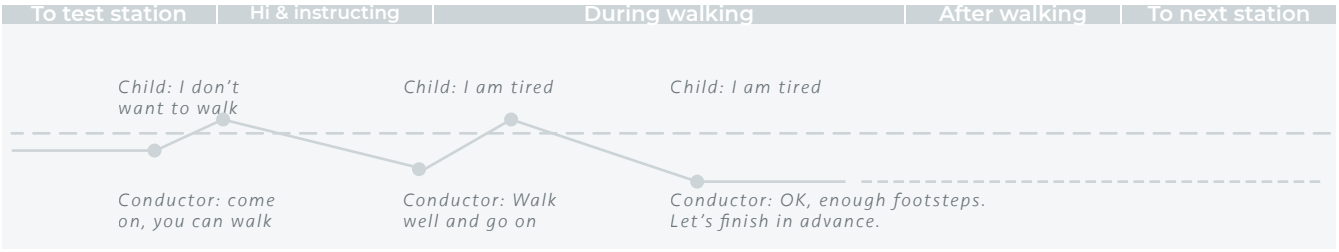


Figure 25-2: the experience journey concluded from the iteration results

Chapter takeaways

1. With the iteration results, design patterns on the experience map is made. This chapter overview the design patterns. The following chapters will explain in detail.
2. You can also skip the following chapters, go to section 3 and conceptulization under the design patterns.

Chapter 9

The "task" to induce a natural walking

Children in between feel nervous when hearing of the test. Moreover, those children also have a long transitional period of insecurity, which can enhance their nervousness. They walk with their body stiff or in small steps with the nervousness, influencing the gait test. Therefore, it is a high priority to induce children's natural walking.

This chapter introduces how the task induces children's natural walking; and how some elements can shorten children's insecure period.

9.1 The task to induce a natural walking

From the iteration, I conclude the way to induce children's natural walking (Figure 26). First, children's nervous feelings can be released by the task, instead of the test. The gait test can be directly given as a task, or an extra task can be given, as it diverts children's attention from walking.

Then, I ideate if children's unintentional walking can be triggered, as unintentional walking is the most natural walking. However, I find that in the task, children are still instructed to walk. Therefore, unintentional walking cannot be triggered.

In brief, to induce children's natural walking, "task" can be informed to children initially. Children feel neutral about the task so that they will not walk nervously. The "task" can be an extra task so that children's attention can be diverted from walking to walk more naturally.

Figure 26: ways to induce children's natural walking

9.2 Overcome the insecure period

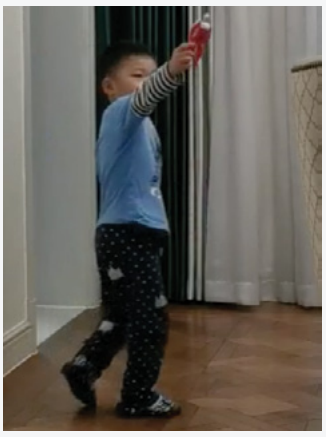
When children come to a new environment, they have an insecure period. The company and the attachment can give children a feeling of security and help children overcome the insecure period (Child expert 1, chapter 3).

In the test, I also find that some children are looking for the company. The company is a necessity for some children. And at the photogrammetry test station, an attachment is ideated by one child, which is also to overcome children's insecure feelings.

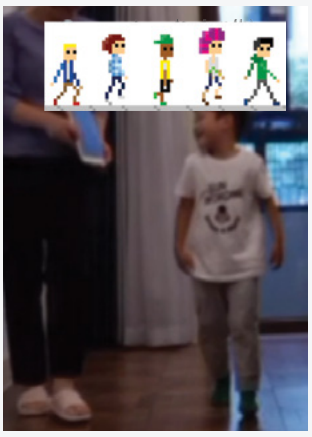
lking

Extra task diverts children's attention

Walk and ... "Walk" is always instructed.



*The conductor: Imagine you are **walking** back and forth and selling your toy.*



*The conductor: Follow the animated peers and **walk.***

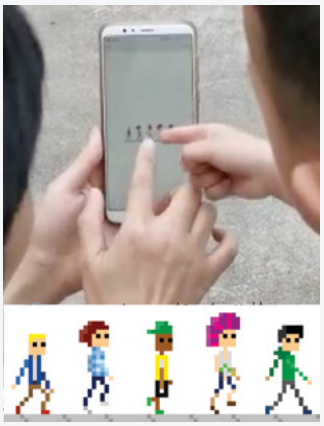
~~Unintentional walking~~

No unintentional walking

Company or attachment overcome insecure feeling

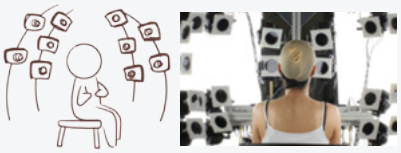
The company

The child: I feel my mother is after me and accompanying me.



The conductor: Kid: too many peers, I cannot know which one is my aunt (the test conductor)

Attachment: swimming hat



The child: it is just like I am wearing a swimming hat, so I am not afraid.

9.3 After being relaxed

Once children feel relaxed, their status transforms into older children or younger children, as these two types of children are relaxed status and begin to feel more about the gait test or the hallway.

Chapter takeaways

1. The extra task diverts children's attention from pure walking so as to induce children's natural walking.
2. Peer's or parent's company can help overcome children's insecure feeling at the gait test station.
3. A swimming hat, as an attachment, can be used at the photogrammetry test station to overcome children's insecure feelings.

Chapter 10

Walking knowledge for older children to learn

For older children, they want to learn more about the gait test; therefore, walking knowledge, as a design opportunity, is explored in the iteration.

As “motivated“ is defined in the interaction vision, motivating children with walking knowledge is designed first.

“Do you want to know anything about your walking?“ This sentence can already motivate children. In the iteration, I also find that the knowledge itself can keep motivating children. “Do you want to learn more, “ is asked to children, and they always nod and willing to learn more. Walking knowledge can achieve children’s expectations. They are satisfied with the knowledge.

There is something interesting in the designed walking knowledge. These interesting parts exceed children’s expectations; this is when the peak experience happens in the gait test (Figure 27) when they achieve a moment of fun. Moreover, how to transmit walking knowledge takes the same effects of exceeding children’s expectations.

This chapter introduces the walking knowledge and different ways that can be used to transmit the knowledge at the gait test station.

10.2 Walking knowledge and interesting findings

The walking knowledge is discussed with some medical students and simplified for children (Figure 28). The interesting parts of the knowledge are all pointed out by children and parents.

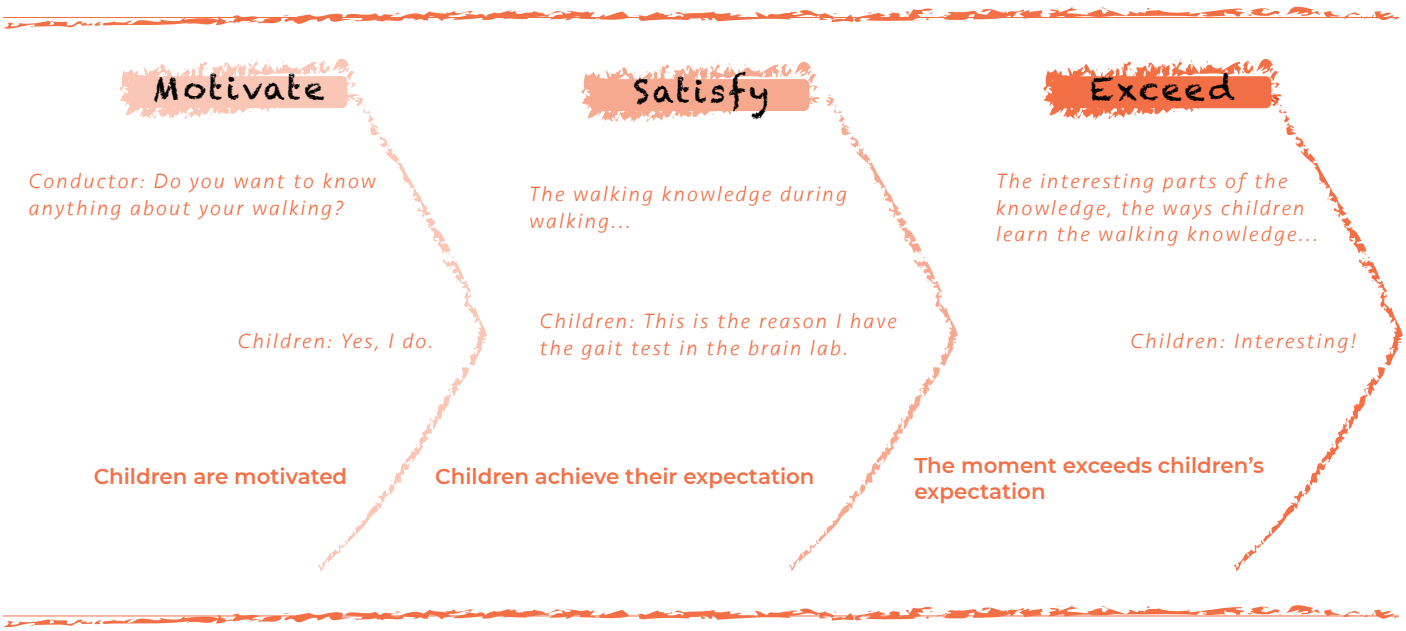
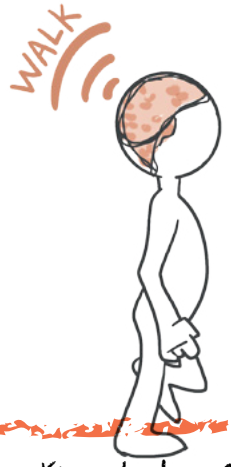


Figure 27: how the walking knowledge take effects during the walking.

The walking knowledge

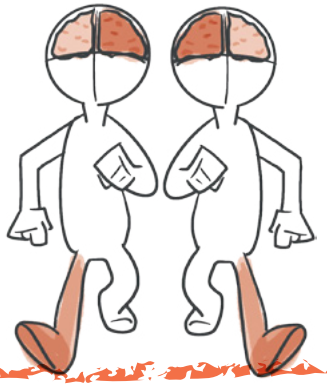


Knowledge 1
brain signal

Your brain sends signal to ask your foot to walk.

Knowledge 2
walking balance

The back of your brain controls your walking balance. “Don’t fall down when you walk.”



Knowledge 3
left-right brain

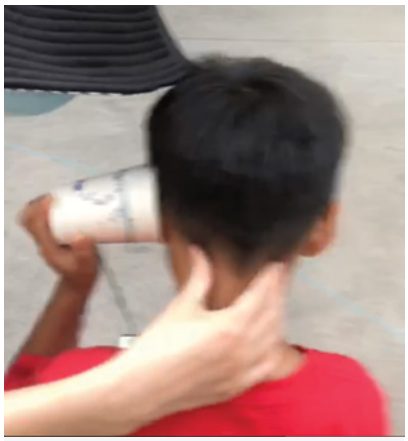
The left brain controls your right leg; and the right brain controls your left leg.

Interesting findings from children and parents

The child (aged 8) is shown this image by his mother. His mother asks him if he likes the signal behind when he is walking. The child mentions yes and replies that is because with the signal, he knows he is walking.

Interesting finding 1

A signal from the brain informs children’s walking.



When teaching the child (aged 7) the balance knowledge, the mother touches the child's back head. The child asks if he can takes his head out of himself. His mother answers no and explains that the child will waddle and is easy to fall down.

Interesting finding 2

Touching can help children know the specific position of the brain; and falling down with the brain taken off inspire the design.

The child (aged 8) unfolds one paper and I explain to her the left-right brain. The child laughs and speaks out her findings “the opposite side”

Interesting finding 3

Children feel interested in the opposite side. Compared to the other two knowledge, this is the easiest for children to find out.

Figure 28: the walking knowledge designed in the iteration

10.3 How to transmit the walking knowledge in the gait test

How to transmit knowledge is to exceed the children's experience. It takes the same function as the interesting parts of the walking knowledge.

In the iteration, three different ways are designed to transmit the walking knowledge to children (Figure 29). The concept can use both free exploration and learning-by-walking. However, creating a surprise is a means without motivating at the beginning.

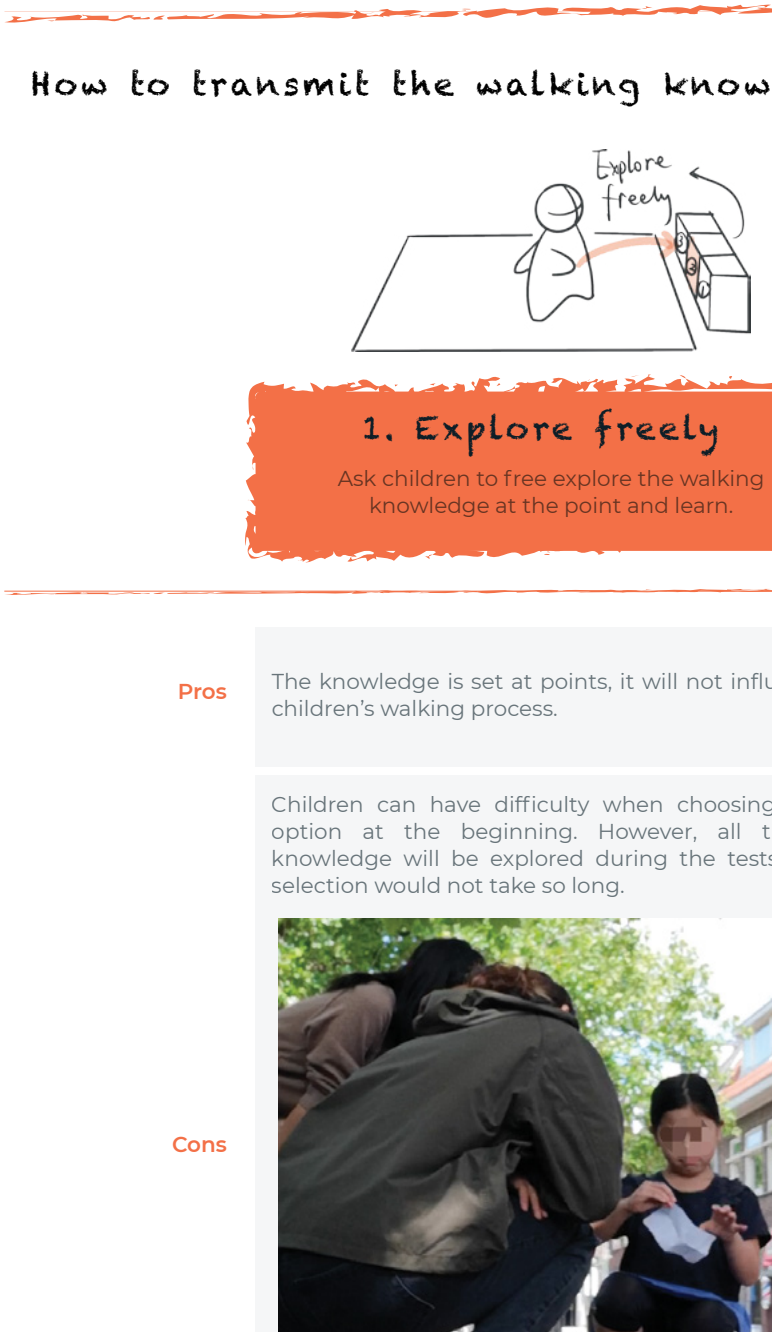


Figure 29: different ways of transmitting the walking knowledge

ledge during the gait test

2. Learn by walking

Use wearable devices to experience first and the knowledge will be taught after trying

3. Create a surprise

Don't tell children anything before walking, and give them a big surprise at the end.

uence

An interactive process can strengthen children's learning. This learning effects can take longer after they finishing the gait test.

g one
he 3
s, the

Wearable devices are not child-friendly. Some children may not want to wear the devices or feel uncomfortable with the devices.

The children don't give any reasons for the walking and there is nothing let them want to do the walking. Therefore, creating a surprise is not a way to motivate children.

king, and the interesting parts of the knowledge are all
on, these can be combined. Exploring the knowledge
hen the interesting parts in the interactive learning.

Interesting parts of the knowledge

10.3 The walking knowledge for other children

Two younger children in the iteration can also find the interesting part of the left-right brain. For younger children, they can be taught and accept the knowledge; however, they are not motivated by the walking knowledge (Figure 30).

The child's is taught the walking knowledge during walking, he is not motivated when taught. He shakes has hands when listening.

Figure 30: younger children with the walking knowledge

Chapter takeaways

1. Asking children learning about the walking knowledge can motivate older children, and the walking knowledge satisfies children in the walking;
2. Interesting parts of the three designed walking knowledge exceed children's expectation and achieve a peak moment of fun;
3. Different ways of transmitting the walking knowledge also exceed children's expectations;
4. Free exploration and the learning-by-walking are the ways to transmit;
5. Younger children can accept the walking knowledge, but they cannot be motivated by the walking knowledge.

Chapter 11

An extra task to motivate younger children

This chapter introduces the extra task that is used to motivate younger children. This extra task is easy for children to finish, feasible with the easy walking. And the task is coherent with the entire walking process. A list of tasks is presented and can be designed for younger children.

11.1 Define the extra task

With the iteration results, I conclude four types of tasks. I find that this extra task must make children feel easy and fun, so that the extra task motivates children, and doesn't disturb the gait test (Figure 31 & Figure 32).

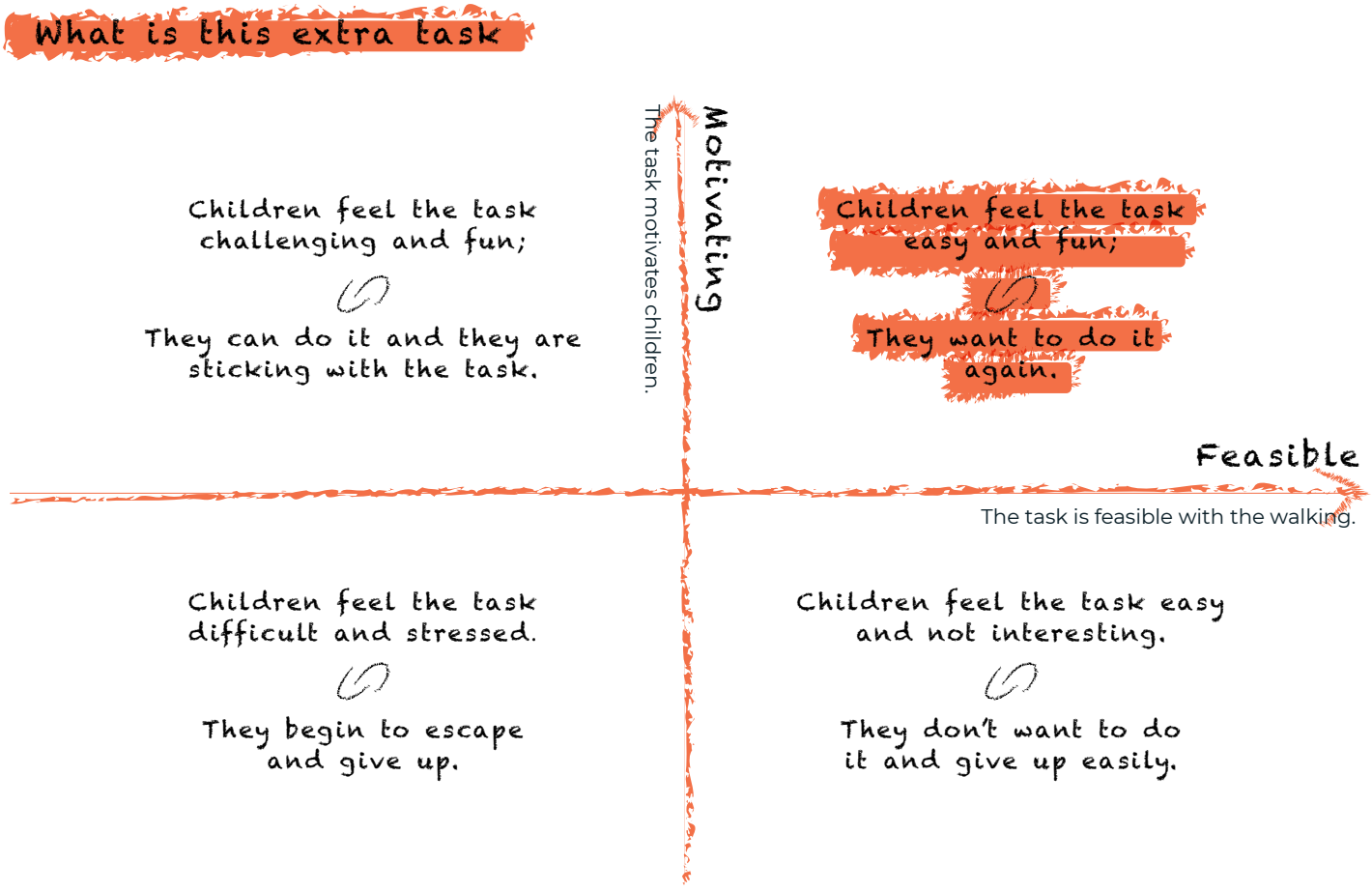


Figure 31: define the extra task

Evidence

The child considers this shape matching is a challenge, after she take one piece from one point to the other, she squats down and sticks on matching the shape. She stops the walking task.

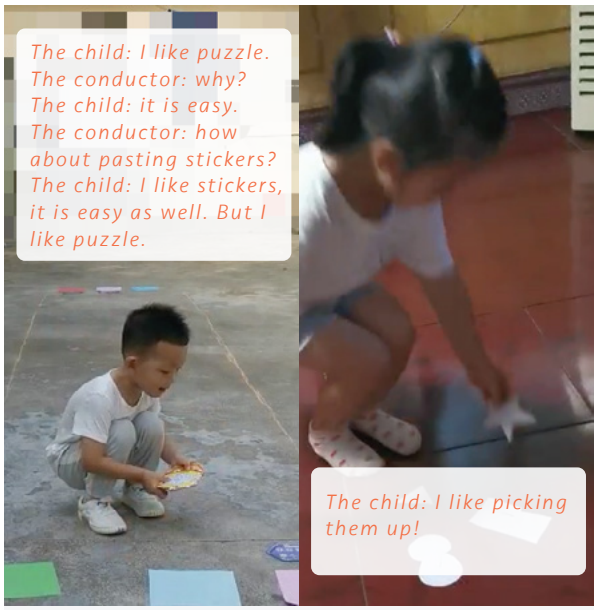
The child is asked to walk and have a high five with parent at the point. She is motivated and see a higher clapping as a challenge.

The child feels this monkey is hard to imitate. He squats down, walk away, and just doesn't want to imitate the monkey.

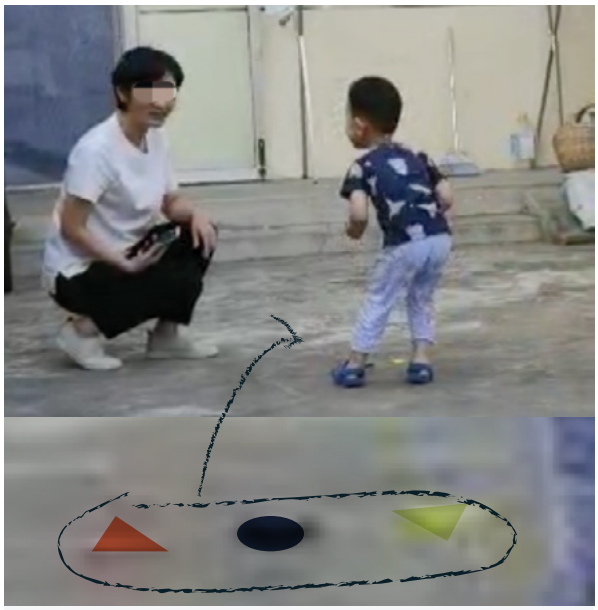
The child is asked to walk and rounding up the rope. He sticks with the rope and sometimes, even forgets where he walks. He finally gives up the rope and through them away.

Figure 32: different tasks performance for children during walking

Motivating



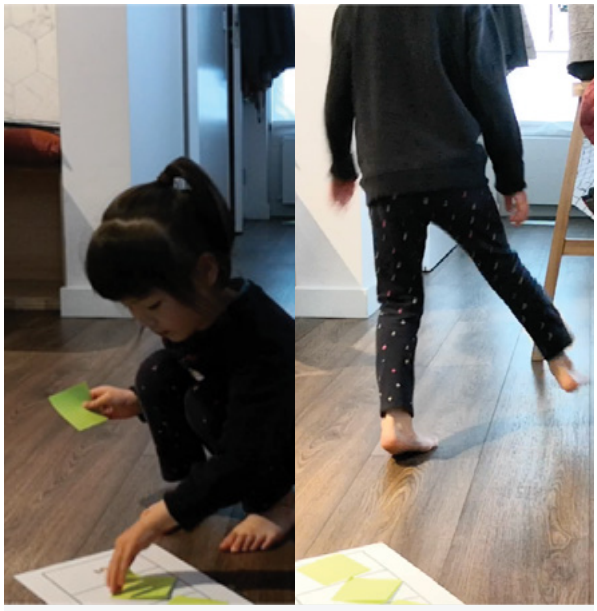
The puzzle task here is actually a collecting behavior, and children feel the collecting easy and both of the children this collecting task.



The child is asked to transfers 3 objects from one point to the other point separately. He feels fun with this transferring and requests to do it again by himself.

Feasible

The task is feasible with the walking.



After the child finishes the pasting, she walks away independently. This task doesn't motivate her.

The task is easy. But he is not motivated by the task. He just need finish the task. He accelerates his last walking and jumps to finishes the last pasting.

11.2 A list of extra tasks

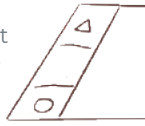
From the iteration results, a list of extra tasks can be concluded for younger children. This task can be designed at the gait mat points and aligns with the walking task (Figure 33).

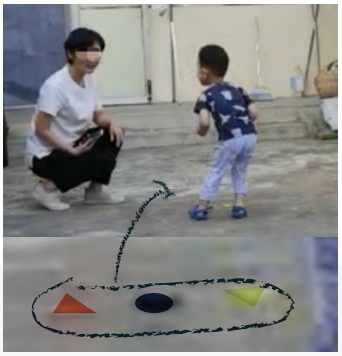
Some of the tasks, matching and pasting stickers, are not easy and fun to children, but they can be improved with the iteration results; some tasks, turning and walking imitation, only align 1 or 2 times of walking. A story or some variations can be designed for six times of walking.

Transferring the objects

Comment Picking up the objects is the reason that children are motivated.

Improve /Adjust The objects in hand can influence the gait test; Small and light objects is required to transfer.





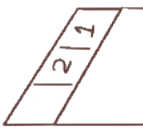
The task is easy for the child (almost 4) to finish, and the child feels fun when transferring the objects. He is motivated and wants to do it again.

The child (almost 4 objects. The heavy child's striding, and small steps.

Matching

Comment Compared with the easy task, a challenging task motivate children more easily. However, children are easily sticking to the challenge.

Improve /Adjust Link-link the same objects are a challenging task in low level, children would not stick on it for a long time.

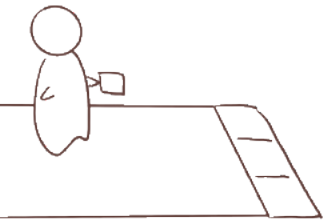


This matching is concave-convex; the child (age 5) sticks to matching the shapes perfectly.

The child (age 4) is given s paste on sheet. She sees t matches the stickers aside this matching later severa

Figure 33-1: a list of extra tasks for the gait test.

Fun Easy



4) walk with heavy objects stops the d the child walks in

Collecting puzzle pieces

Fun Easy

Comment Picking the object up is the reason that children are motivated. Collecting for a completeness also motivates children.

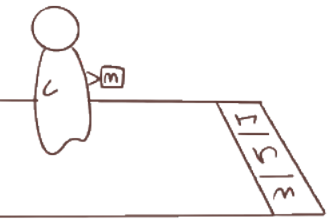
Improve /Adjust As doing puzzles (matching) can also be a challenge to stick to, it is requested that only collecting happens during the gait test. Doing puzzle is after the gait test.

The task is easy for the child (age 4). The child seldom finishes a entire walking test. With collecting, he finishes.

The child (age 4) is angry when his mother breaks a complete puzzle. The child like to keep the complete.

The child (age 5) sticks to matching the two pieces of puzzles first, then walk.

Fun Challenging



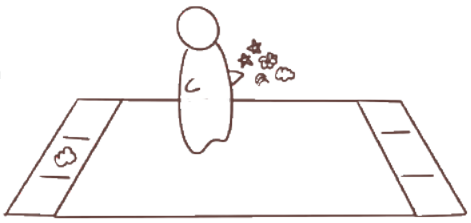
some number stickers to he numbers on sheet and e independently. She plays l times with more stickers.

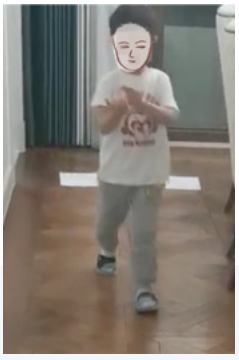
Pasting stickers

Not interesting Easy

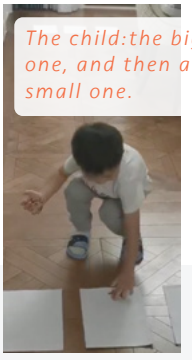
Comment Pasting the sticker for 6 times cannot motivate children, but it is easy to finish and takes an advantage of slowing down the walking speed.

Improve /Adjust The stickers can motivate children, fun stickers can be used for children.





The child (age 4) selects the stickers when walking; his speed slows down. Normally, he is a child that is easily over motivated and runs.



The child (age 4) is motivated by the stickers, instead of the pasting.

Turning and avoiding objects

Fun Easy

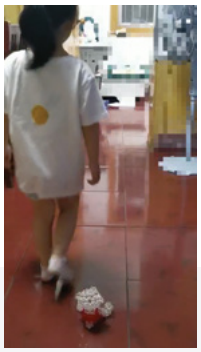
Comment Turning motivates children for lots of reasons. It creates a moment of being dizzy; it is perceived as walking in circle and connects the single directional walking; it can also be a fun task of avoiding obstacle.

Improve /Adjust Not all the children can be motivated by turning, other fun elements can be designed, such as choosing obstacle a preferred obstacle for turning.

The child (age 4) always thinks walking test as rounding, he is motivated by it and feels fun of being dizzy.

The child (age 7, as older child) uses some cans in his first test. In a new test, he still likes turning and imagines avoiding cans when turning.

The child (almost age 4) is not motivated by turning and doesn't feel it fun.



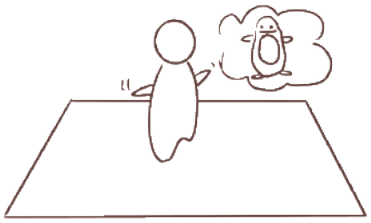
The child (age 5) likes to choose her toy as the obstacle and starts her walking.

Walking imitation

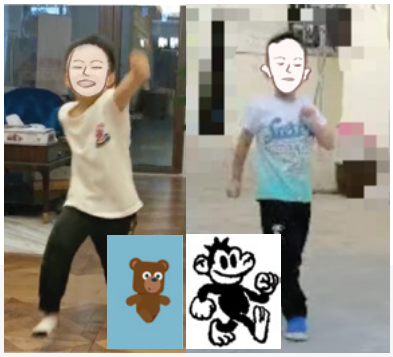
Fun Easy

Comment There are different types of walking imitation, walking in an exaggerated posture can motivate children a lot. Children feel easy and fun with human-like animal walking; and children feel easy with the human walking.

Improve /Adjust Walking imitation is a short task for 1-2 times of walking, different animals are needed for 6 times of walking. A story such as jungle walking can be used to combine all the imitation.



This walking postures are exaggerate, children easily detects the exaggerate part and imitate. And they feel fun with these walking.



These animal walking is easy for children to finish.and the animals motivate children, they feel fun with the walking.

Children see this walking and feel it easy to imitate, but children are not interested in walking; children are not motivated by the walking.

Figure 32-3: a list of extra tasks for the gait test.

11.3 Extra tasks for other children

For older children

In children's developmental stage, they cannot be motivated by these extra tasks. They need to be challenged to motivate (Child expert 2, Chapter 3) and those tasks are too easy for older children.

For younger children with low walking capacity

These children can be treated as younger children; however, some extra tasks are not friendly to them. With walking support, it is not convenient for them to pasting or collecting in hand.

Another task is ideated with the animals, which is sending animals back to the jungle. It can be designed as a mission for children. With the mission, they can be motivated to finish the task; their efforts are appreciated at the end, which also corresponds to their current motivating ways.

Energizing is ideated by all the children. Once the children are tired with the walking, ask them to eat something.

> *The kid: Then, let them sit down first, eat something, and then drink some water, and do the test.*
>
> *Mama:...(repeat what the kid have said)*
>
> *The kid: they can also listen to a story, play toys...*
>
> *(Iteration 6, Appendix A7)*

Chapter takeaways

1. The extra task is designed for younger children;
2. The extra task should make children feel easy and fun;
3. Making children fun means that children is motivated by this extra task;
4. Make children easy so that children can continue the extra task and the walking at the same time;
5. A list of tasks is concluded for the conceptualization;
6. For older children, the extra is too easy to motivate them;
7. For children with low walking capacity, another extra task of sending animal back is ideated;
8. Eating something to energize is ideated for those who get tired with walking.

Chapter 12

The instruction design

The gait test is a task and needs children to finish in success. In this task, children's independent behavior needs to be prevented for careless mistakes.

In the ideation session, ideas on taking action spontaneously are asked. In the iteration, I realize that spontaneous behavior happens after children are motivated (Figure 34). Ideas, in fact, are guidance for children.

This chapter introduces the two different ways that can be used to ask children to finish walking, instructing at points and mindless guidance.

12.1 Instructed and guided walking

In the desired situation, two different ways are explored to ask children to finish the task, instructing children at each point or guiding children minglessly during walking.

Instruction to each action

Ideas of designing the instruction are mainly observed. Parents, as test conductors, have more experience with instructing children smoothly. From the observation, I find that the most confirmed and timely instruction corrsponds to one action (Figure 35). Therefore, at each point of the gait mat, instructions need giving; and the instruction is timely given after the previous action is finished.

Mindless guidance

Compared with focusing, listening to, and understanding the instruction, it is easy for children to follow guidance, such as patterns on the ground. However, some guidance influences children's natural walking. After the iteration, mindless guidance is designed; this mindless guidance has two features; it is in the forward direction with a distance from children (Figure 36), and it is instantly disappeared before children can touch it (Figure 37, page 72).

The child is asked if she can imitate the monkey; she is suddenly motivated and starts imitating. Then, she finishes her walking in relax, while I am preparing the next video material. She looks at me and feels nothing to do; therefore, she walks again sponstaneously and finishes the other round of 6 times' walking.

Figure 34: a spontaneous behavior after being motivated

The walking instruction to children

One instruction corresponds to one action.

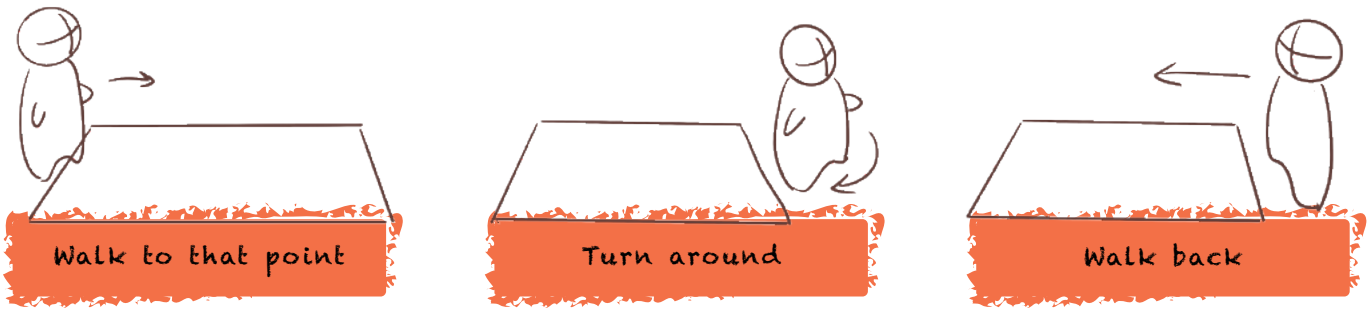


Figure 35: timely and confirmed instruction to children

Mindless guidance: direction

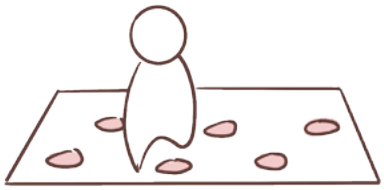
The child (age almost 4) follows one peer to walk, with his head turned. This will influence the gait test and is not accepted.

The light point, as a guidance, is on the ground and close to the child. The child walk with his head down. This is not accepted in the gait test.

This paper sheet, though on the ground, keeps a distance with the child. It guides the child with a forward direction. This guidance will not influence the gait test.

Figure 36: the direction of the mindless guidance

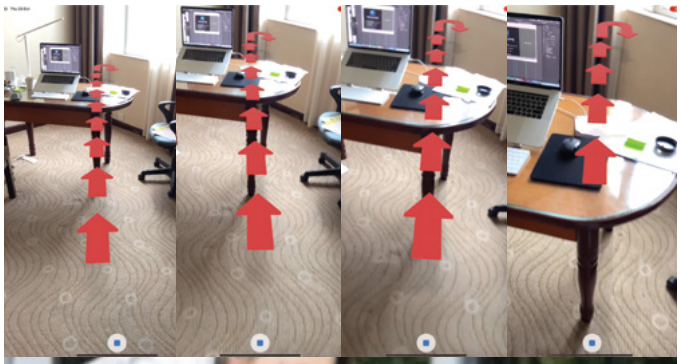
Mindless guidance: time frame



Solid guidance

With the solid patterns on the ground, the child (age 4) becomes independent with selecting and jumping. Obviously, it influence the gait test.

Instant guidance



A instant pattern is made by Reality Composer (IOS AR kit). The child holds the phone, is guided by the arrows in AR environment, and walks forward and naturally.

Figure 37: timeframe of the mindless guidance

12.2 Instructed or guided walking

The instruction at points or mindless guidance can both be designed for children. Nevertheless, the mindless guidance, as a visual guidance, attracts children easily, and takes an advantage of decreasing children's understanding efforts (Figure 38).

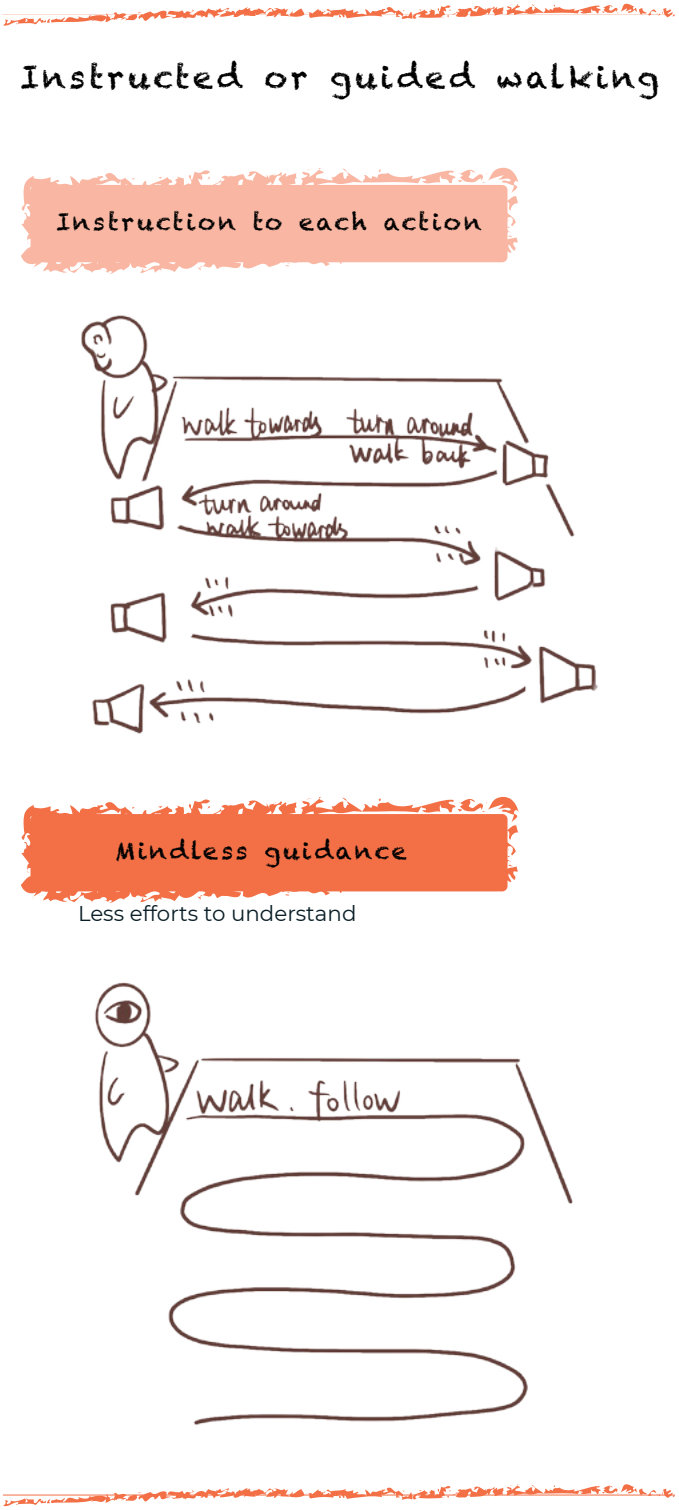


Figure 38: comparison of the two different instructions

Chapter takeaways

1. Instruction to each action or mindless guidance are used to instruct children in a confirmed and timely;
2. The instruction to each action is to give children the instruction for each action separately immediately after the children finish the previous action;
3. The mindless guidance is a straight forward guidance in front of the children and timely disappeared;
4. The mindless guidance takes advantage of decreasing children's understanding efforts during walking.

Chapter 13

Iteration synthesis

Figure 39 synthesizes all the design solutions and design effects taken during walking.

Design solutions

Children's gait test experience	Walking process of 6 times' walking	Dynamics with the test conductor Being motivated	
Older children		Asking older children to learn about their walking can motivate children and satisfy them in the walking. Interesting parts of the walking knowledge and ways of transmission can exceed children's expectation.	
Children in between	Children are neutral about the task and the gait test can be informed as a task. Extra task in the gait test diverts children's attention from mere walking, so as to induce a more natural walking.	Once the in between children don't feel nervous, they change suddenly to the older children or to younger children, which depends on their development.	Two diffe children: - The inst one beha - Mindles a distanc finish the
Younger children		An extra task is designed to motivate children. The extra task is an easy and fun task, and aligns with the entire gait test. A list of tasks are already improved in iterations and can be used.	
Younger children with lower walking capacity	Younger children with lower walking capacity need more times of walking to collect footsteps in good quality. As one time walking can collect 2-3 gait cycles for analysis; 6 times of walking can be enough for these children.	- They can be treated as younger children with the same task, or another mission task of sending animals to the jungle can be used. - Idea from children: eating something can energize and motivate them to walk.	

Design effects as patterns in the experience map

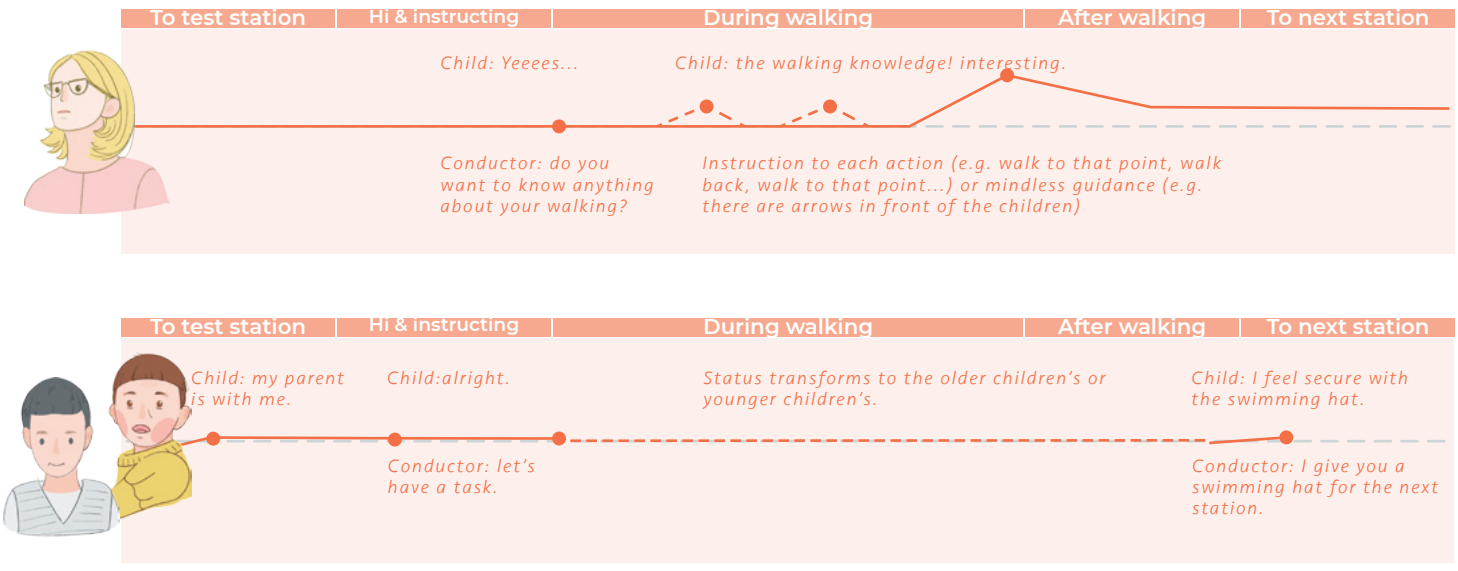
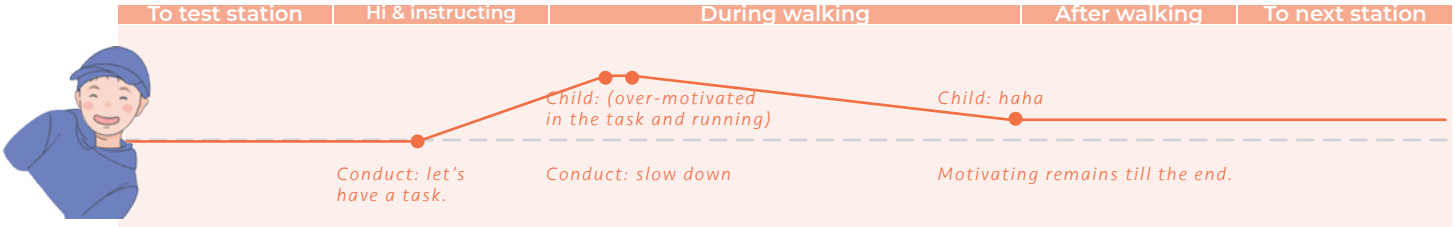
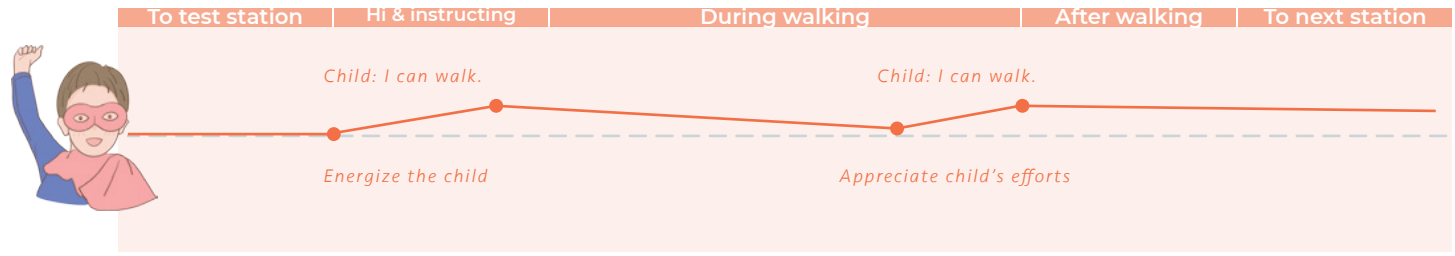


Figure 39: Iteration synthesis of the design solutions and design effects

Dynamics with the test conductor Being instructed	Perception of the hallway	Initial perception of the test stations
erent ways can be designed to instruct truction at points is one instruction to avior. ss guidance: a forward guidance, with ce from children can guide children to e walking.		Company or attachment are to overcome children's insecure feeling; Parent's or virtual peer's company is proper at the gait test station; a swimming hat, as an attachment is for the photogrammetry test station.
	Once children is motivated by the extra task, they will not distracted by the environment.	
	Once children is motivated by the extra task, they will not feel tired of the gait test and refuse walking	



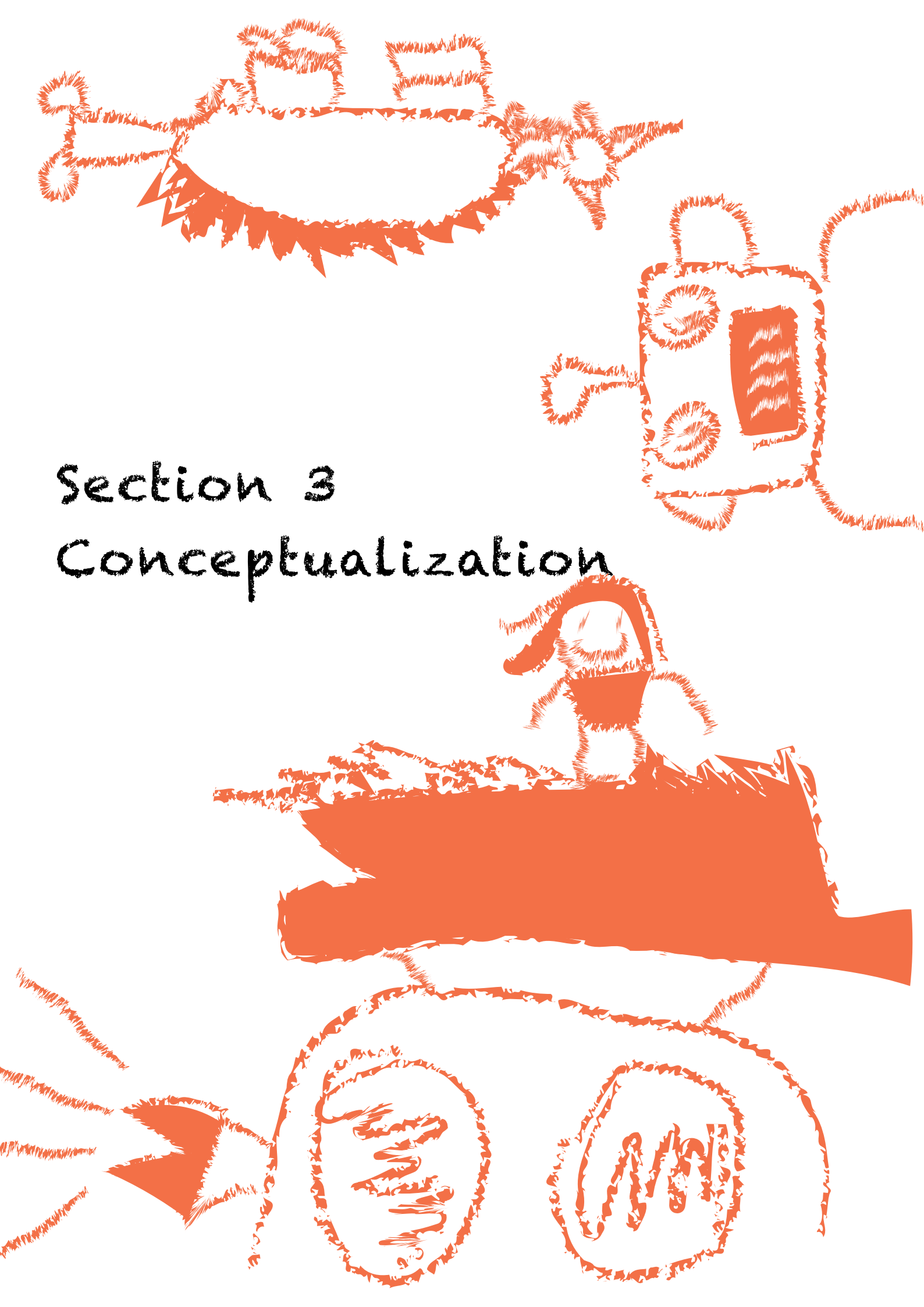


Bridge between section B and C

Section B finds the design solutions to the current problems at the gait test station. With the solutions, design patterns are also concluded in the experience map, to show the design effects clearly.

In Section C, the conceptualization is to combine all the design solutions into one concept.

Section 3
Conceptualization




I teach you,
do it like me!
Like me!

Chapter 14

3 concepts

As solutions has been found for different types of children, it is time to combine all the solutions into the concepts into the concept.

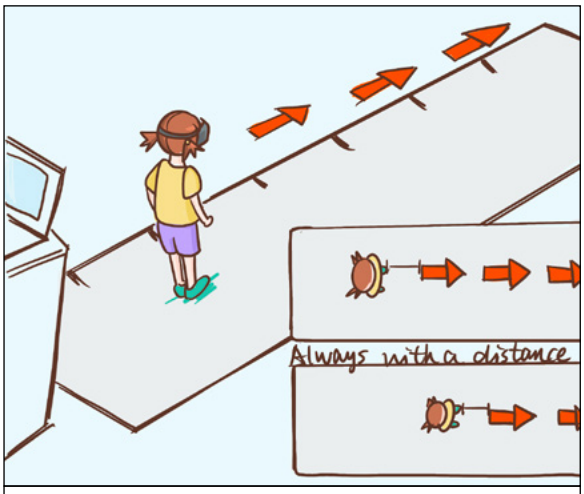
3 concepts are designed based on the interation conclusion. The storyboard of the 3 concepts are shown here.

Concept 1 AR guidance game

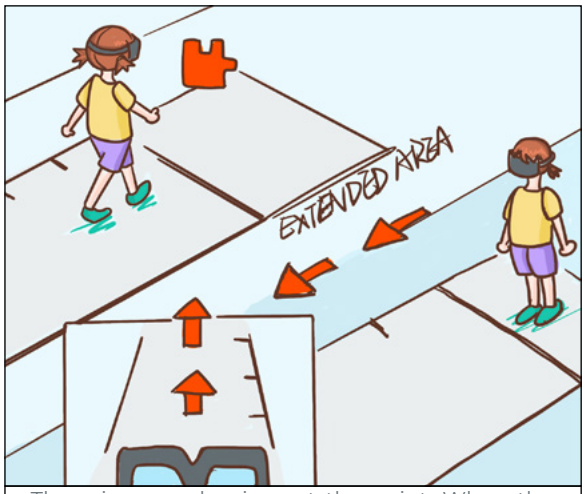
Keynote:

1. Combine all the solutions in one concept for all children.
2. AR Tool for mindless guidance.

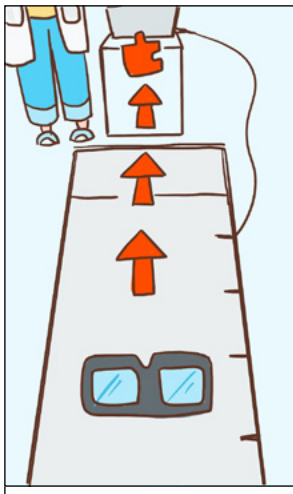
The child is in the break, setting up the gait test information on the gait



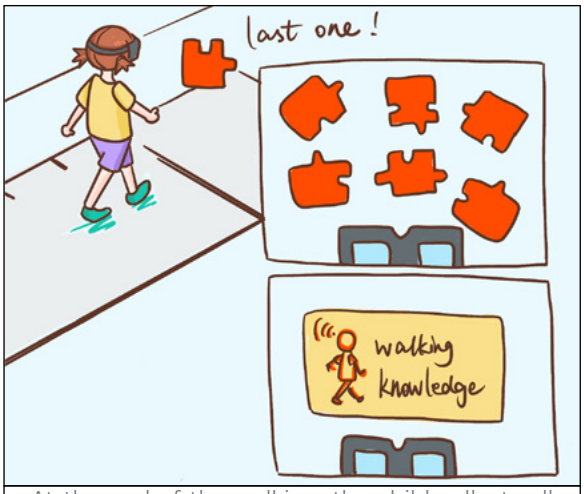
The child follows the guidance and walks. As the guidance arrows always keep a distance and in the child's forward eyesight, these do not influence the child's walking.



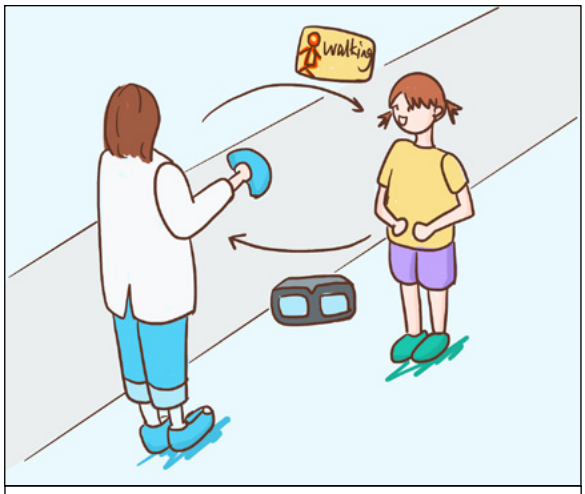
There is a puzzle piece at the point. When the child closes to the puzzle pieces, it is "eaten" by the child and collected. Meanwhile, new arrow guidance pops out to guide the following walking.



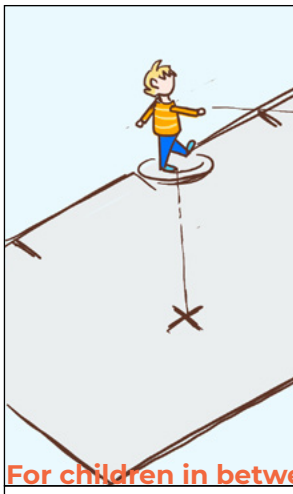
When the child is wal captured by the softwa watches the child's wal footsteps on the laptop s



At the end of the walking, the child collects all the puzzles pizzles, and the puzzles assemble automatically. The child finds the brain-walking knowledge and knows the reason for testing gait in the brain lab.

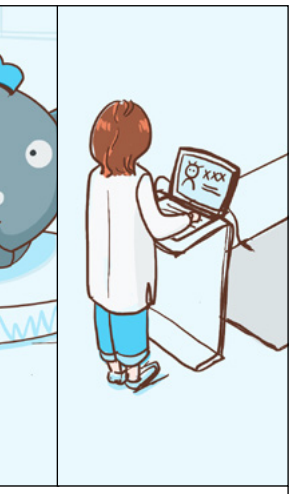


The conductor helps the child take off the AR glasses, gives the child one cardboard of the real walking knowledge, and asks the child to go to the next photogrammetry test station.

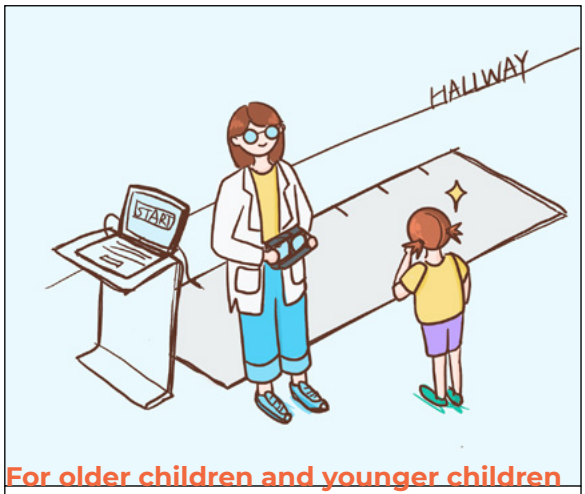


For children in betwe

For children in betwee different, a peer is anima is used to induce their na

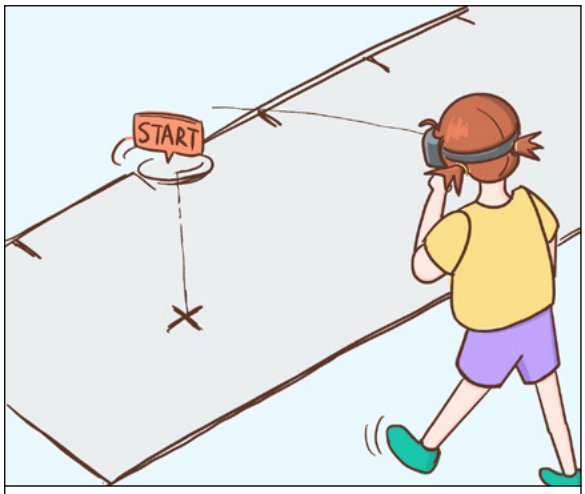


and the test conductor is
and inputting the child's
mat's software.

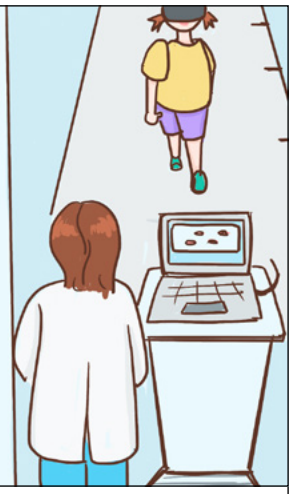


For older children and younger children

This child comes to the test station. The test conductor welcomes the child and helps the child to wear the AR glass.



In the AR environment, the child is asked to stand on the initial point. The conductor introduces the child to a task: following the arrow guidance and finds out the walking knowledge.



king, her footsteps are
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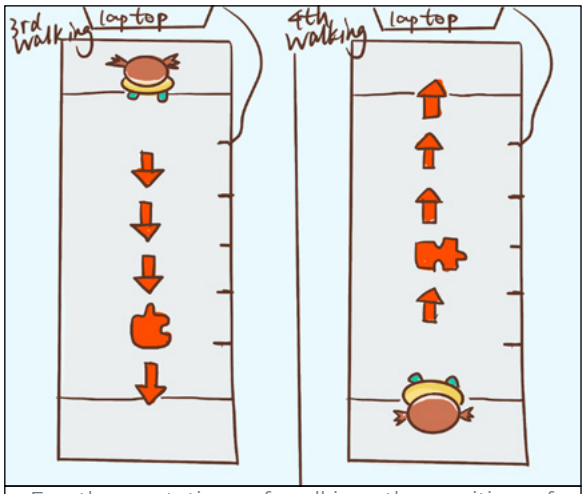
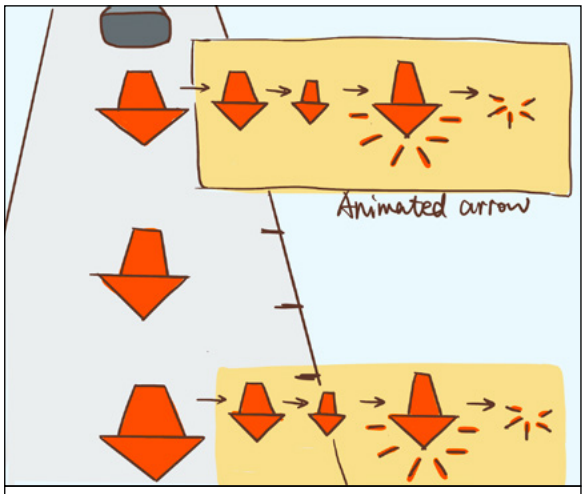


For the next time of walking, the position of the puzzles pieces changes. This difference slows down the child's walking. As the child is immersed in AR, the test conductor's "slow down" instruction cannot affect.



Another change happens near the end of the walking. These variations of the arrows keep slowing down the child.

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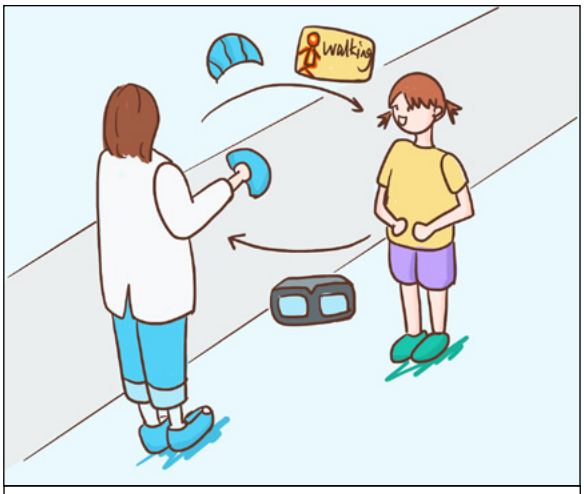
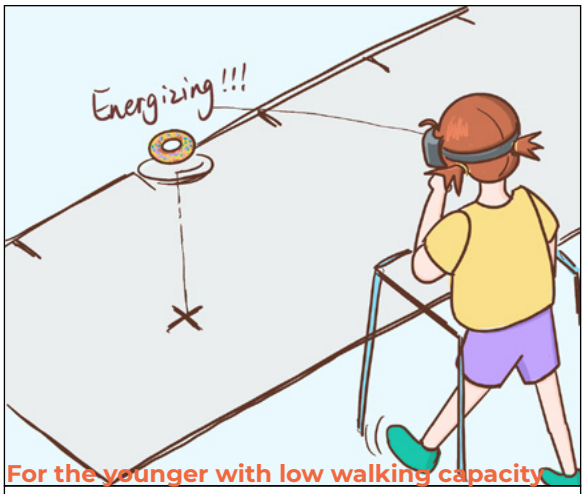


An extra swimming hat, as an attachment, is given to children in between to help them overcome the insecure feeling of the photogrammetry test station.



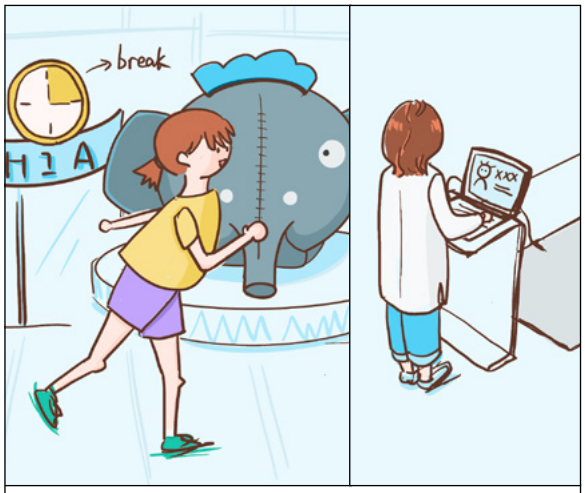
For the younger with low walking capacity

For younger children with low walking capacity, they are treated as younger children of collecting puzzle pieces. But the initial point is different, which is food for energizing.

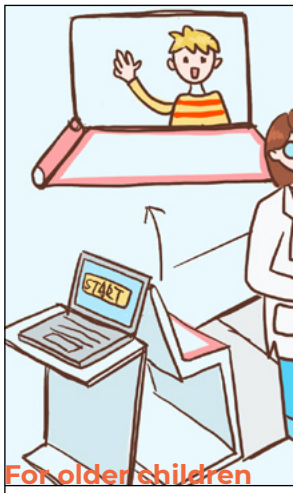
Concept 2 Walking story with peers (animals)

Keynote:

1. Seperate tasks for different types of children.
2. Instructions at points
3. Tangible interactions

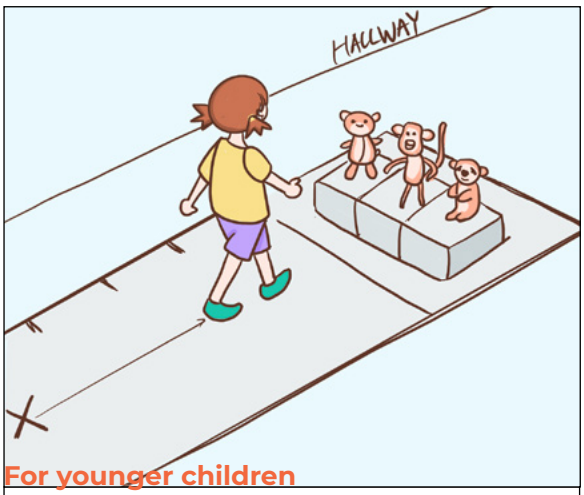


The child is in the break, and the test conductor is setting up the gait test and inputting the child's information on the gait mat's software.



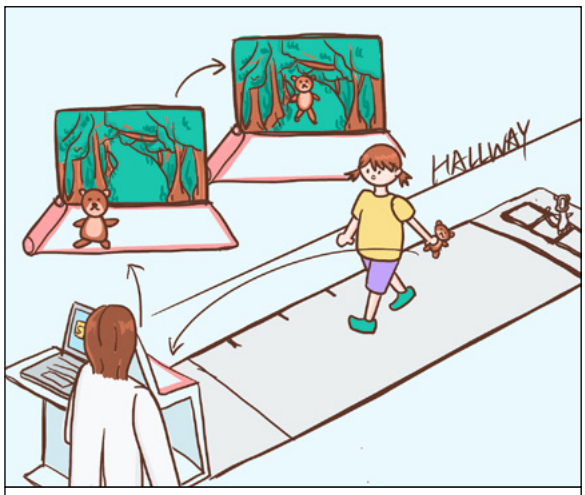
For older children

The conductor welcome station. There is one in point, and a peer welcon

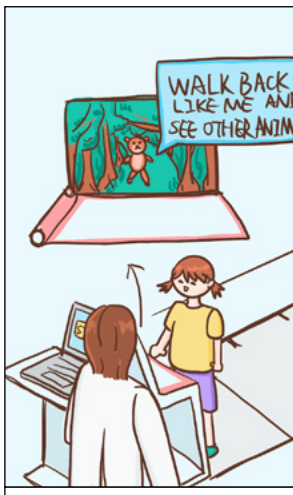


For younger children

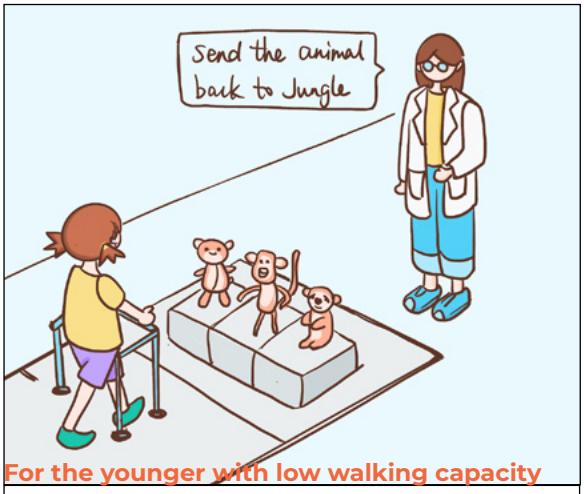
For younger children, animals are set at points. They are given the task of picking up one animal each time and learning its walking.



The child picks up one animal and walks to the interactive screen. When she puts the bear on the screen, there is one bear that comes out from the jungle.

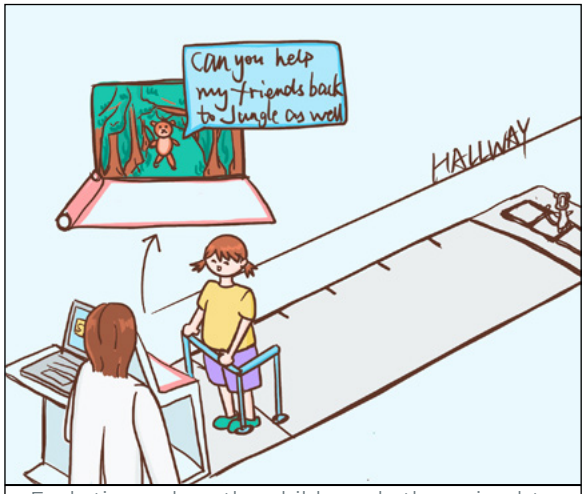


After walking to the f speaks to the child to w child listens and follows.

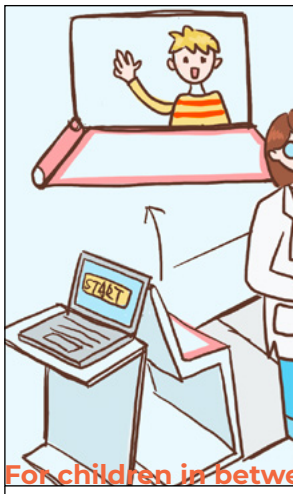


For the younger with low walking capacity

For younger children with low walking capacity, they are given the task of sending animals back to the jungle.



Each time when the child sends the animal to the jungle, the corresponding animal on the screen says thanks to the child. The child keeps motivated by the appreciation and finishes the entire walking test.



For children in betwe

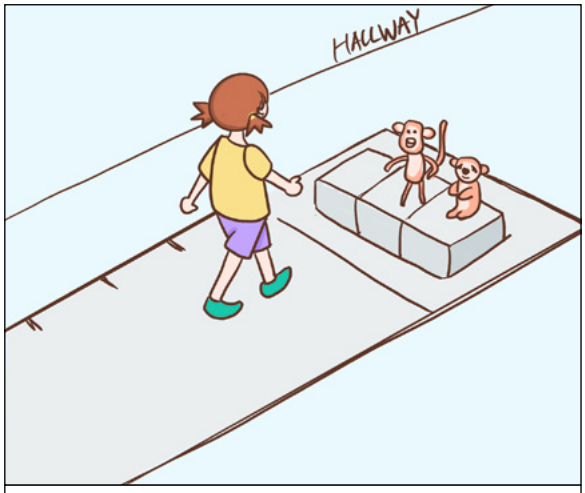
For children in between peer on the screen helps feeling; and they are inf animal imitation or explo

es the child to the test
teractive screen at one
nes the child as well.

The child is asked to explore the walking knowledge with the tangible cardboards and the interactive screen.

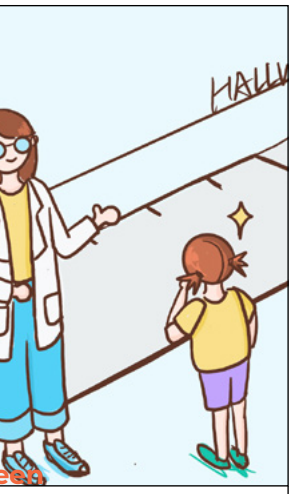
The child selects one cardboard and put it in the interactive area. An animation pops out to explain the knowledge. The child explores three times and finishes 6 times of walking.

ront stage, the animal
alk back as it walks; the

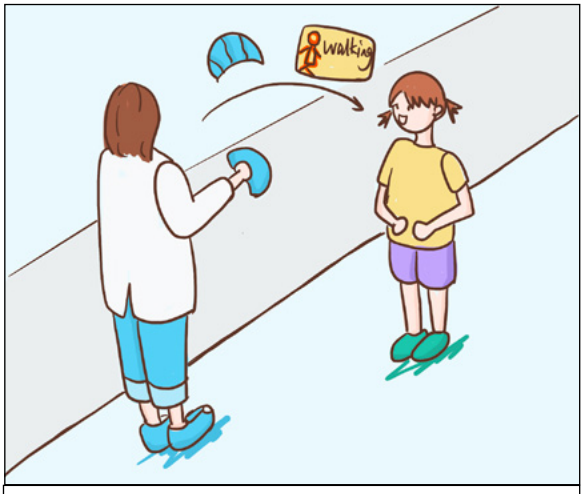


The child imitates the bear's walking and walks to the point with tangible objects. She then picks up another animal for another round of walking.

The last time, the child only sends an animal back, and the three animals pop out together and have a final cheer that they all walk in the jungle.



n, in the beginning, the
s overcome the insecure
formed to do a "task" of
oration knowledge.

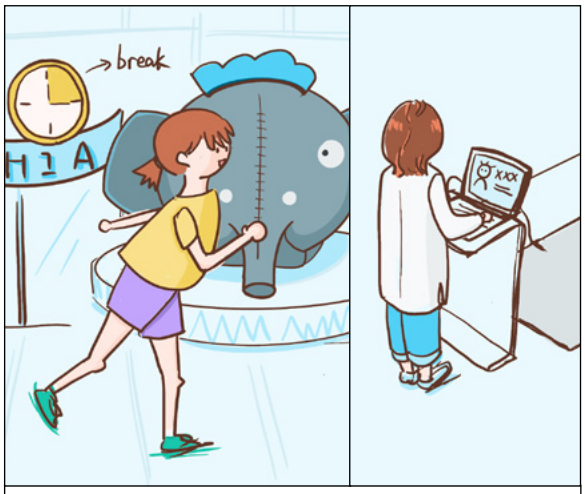


Still, they have a swimming hat given at the end.

Concept 3 Random surprise

Keynote:

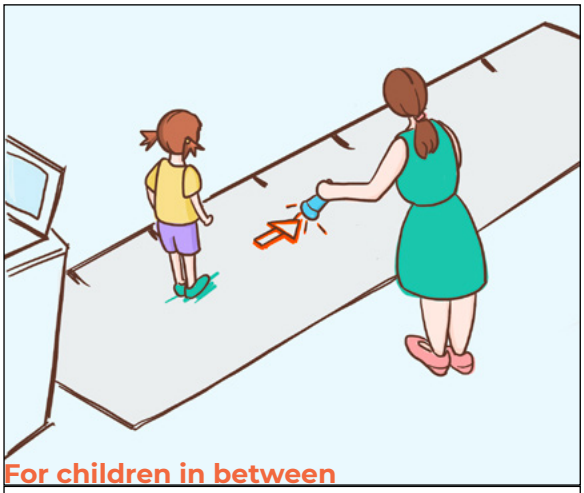
1. Separate and flexible concepts for different types of children
2. Low cost tool for easy implementation



The child is in the break, and the test conductor is setting up the gait test and inputting the child's information on the software of the gait mat.

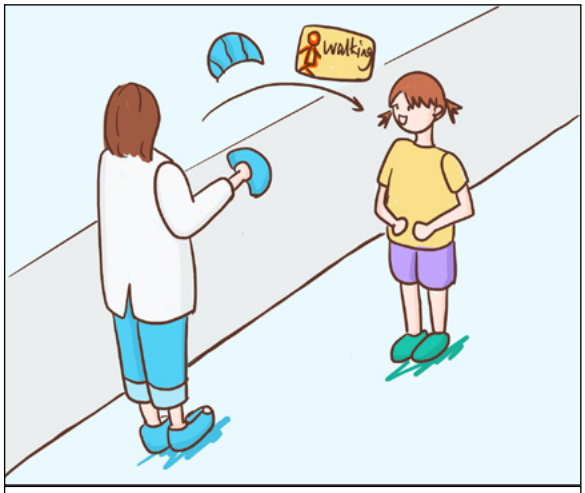
For older children

The test conductor welc
parent is invited to join i
the child.

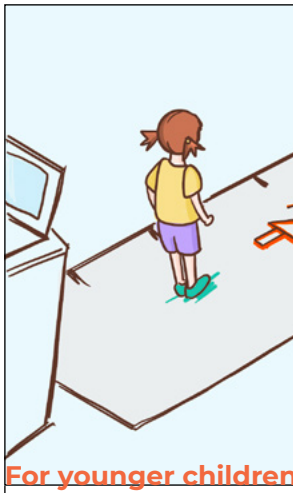


For children in between

For children in between, they are accompanied by the parent in the entire test; and the child's attention is diverted by following the guidance and the parent.

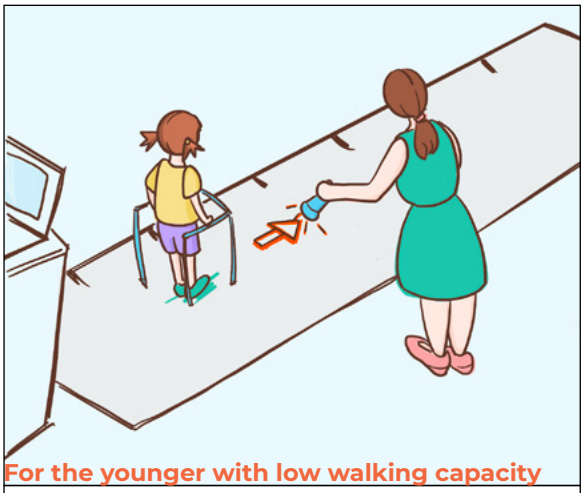


A swimming hat for them at the end.



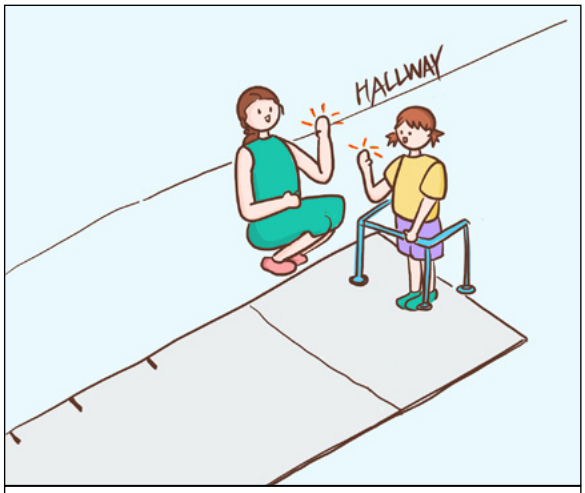
For younger children

For younger children,
various changing pattern



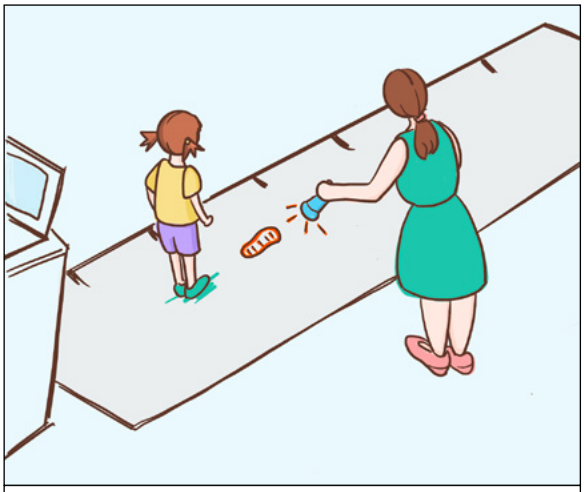
For the younger with low walking capacity

For younger children with low walking capacity, they are treated as younger children.



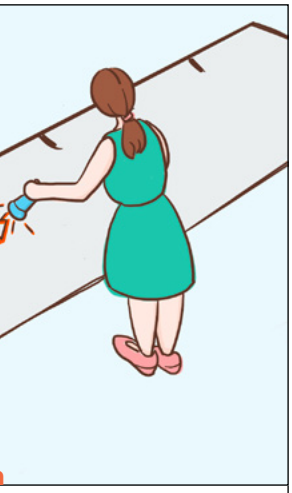
However, at the point, the turning is changed to a high-five, so that children are encouraged at the point and keeps walking.

omes the child. And the
n the test, together with

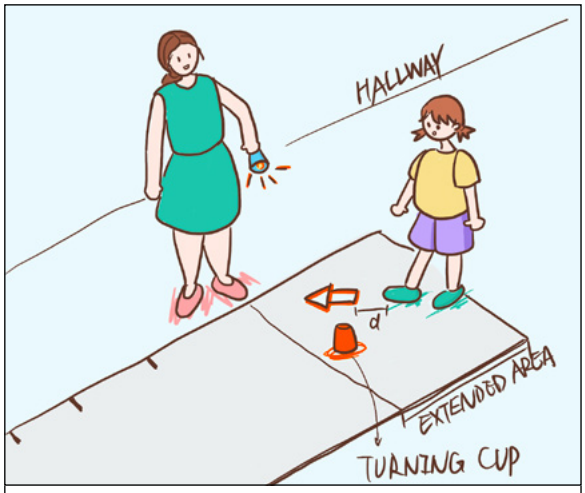


Laser light with foot pattern guides children, and the child is asked to walk and think of how the brain controls walking.

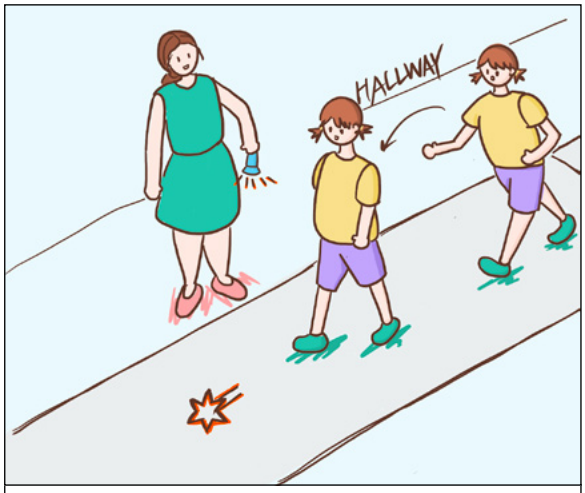
After the child finishes the walking, the walking knowledge is taught directly by the test conductor.



they are guided with
ns



And at the point, an obstacle is used for turning and make the guidance more coherent.



Once the child is over motivated or not motivated, a pattern is switched to keep their walking during the walking.

Chapter 15

Concept evaluation

The concepts are firstly evaluated by the iteration conclusion in Section 2, to check if all the design solutions are considered.

The test conductor's influence and the gait test are evaluated with the hospital, including two physical therapists, one staff in GenR. The concepts are shown in videos (Appendix A9); as the storyboard and videos are presented in different forms, there are some miscommunications. Therefore, the evaluation results are influenced a bit (Appendix A10).

Figure 40 shows the evaluation process.

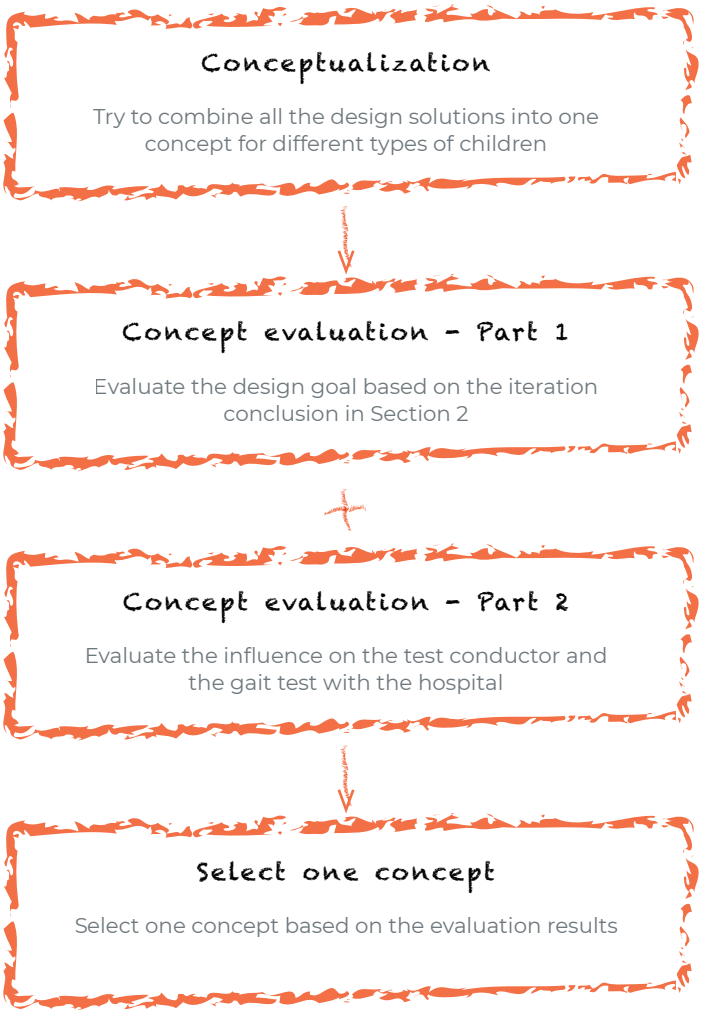


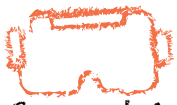
Figure 40: evaluation process

Selecting one concept

The evaluation results are concluded in Figure 41. Concept 2 is selected as the final concept because it achieves the design goal mostly. However, Concept 2 has a strong influence on the test conductor and the gait test. Based on the evaluation results, modifications are made to decrease the influence.

The modifications include:

- The instructing: the current complex is complex for children, and it will take extra effort for the test conductor. Therefore, the instruction should be simplified.
- The sequence of the animal imitation: the current animal imitation is randomly selected, but some animal walking, such as monkey (gorilla), will excite children quickly and influence their natural walking. Therefore the sequence of the animal imitation should be modified.



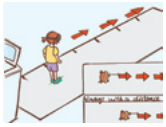
Concept 1
AR guidance game

Design elements

Induce children's natural walking

Children in between

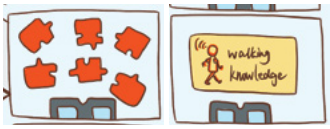
- Task collecting puzzle pieces is given and diverts their attention from mere walking;
- One peer walking at initial point and the swimming hat help them overcome the insecure period.



Motivate children

Older children

They are motivated by asking to explore the walking knowledge, and the knowledge is given at the end.



Younger children

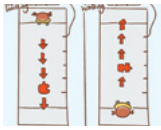
Task collecting puzzle pieces is an easy and fun task to motivate them finish the walking. The puzzle pieces is collected automatically without disturbing walking.

Younger children with low walking capacity

They are treated as younger children. A little difference is designed. A donut at initial point is to motivate and energize them to finish the entire walking.

Instruction to children

The arrows in the AR environment guide children's walking.



Design effects

Achieving the design goal

	--	-	+	++	Interpretation
Finish walking naturally		■			All the design elements are included (Chapter 9). But mentioned by one physical therapist, children with balance problems rely on visual input and may be fearful or even unable to walk in AR.
Achieve a moment of fun			■		For the older, achieving the knowledge meets the expectation and achieve fun (Chapter 10). The younger (with low walking capacity) is motivated by the extra task and gain fun from it (Chapter 11).
Learn something		■			Older children are only given the knowledge after walking, but they don't learn the knowledge at that time. Younger children (with low walking capacity) cannot learn as well.
Confirmably and timely instructed			■	■	The mindless guidance can already guide them to finish the entire walking (Chapter 12).

Influence on the test conductor

Fluently instructing

			■		No comments from the two physical therapists. One stuff in GenR mentions she doesn't think it will interfere the test conductor's working a lot.

Influence on the gait test

Footstep recording

			■		Two therapists mention the arrow must be in front of children with their head forward. The AR arrows achieve the effects.
Other influence	■	■			The hospital supervisor mentions that children with visual problems can feel dizzy with the AR environment.

Figure 41-1: concept evaluation

Concept 2
Walking story
with peers (animals)

Design solutions

Induce children's natural walking

Children in between

- They can choose the extra task "exploring the walking knowledge" or "animal imitation";
- One peer, saying hello, at the start and the swimming hat help them overcome the insecure period.


Motivate children

Older children

They are motivated by asking to explore the walking knowledge, and the knowledge is interactively shown and exceeds their expectations.


Younger children

Task animal imitation is an easy and fun task to motivate children.


Younger children with low walking capacity

Task sending animal back to the jungle is designed especially for them, with the appreciation on their efforts.

Instruction to children

All the instruction are shown and given on the screen.

Design effects

Achieving the design goal

	--	-	+	++	Interpretation
Finish walking naturally			■	■	All the design elements are included (Chapter 9).
Achieve a moment of fun			■	■	As the knowledge is interactively shown, older children exceed their expectations, and therefore, achieve fun (Chapter 10); younger children achieve fun from the animal imitation (Chapter 11). The younger with low walking capacity are not known yet.
Learn something			■	■	Older children learn the knowledge during walking; animal imitation can also be the learning knowledge for the younger. There is no learning for the younger with low walking capacity.
Confirmably and timely instructed		■			All the instructions are given at one time for multi reactions, which is not timely (Chapter 12).

Influence on the test conductor

Fluently instructing

	■	■			Mentioned by one physical therapist, the concept is complicated for children, which will influence the conductor's working fluency.

Influence on the gait test

Footstep recording

		■			Mentioned by one physical therapist, the child will persist on walking like the monkey, which will influence on their walking.
Other influence		■			Mentioned by one physical therapist, the excitable children may get progressively aroused, which will influence their cognition process a lot.

Figure 41-2: concept evaluation

Concept 3
Random surprise

Design solutions

Induce children's natural walking

Children in between

- When walking, their attention is diverted by following the laser light guidance;
- Parent's company and the swimming hat help them overcome the insecure period.


Motivate children

Older children

The child is motivated by asking how the brain controls the walking. At the end, the knowledge is orally taught to exceed their expectations.


Younger children

Turning at points is the easy and fun task to motivate children.

Younger children with low walking capacity

They are treated as younger children, but turning is replaced by high-five as a child-friendly way.

Instruction to children

The parent with laser light as mindless guidance instructs children's walking.

Design effects

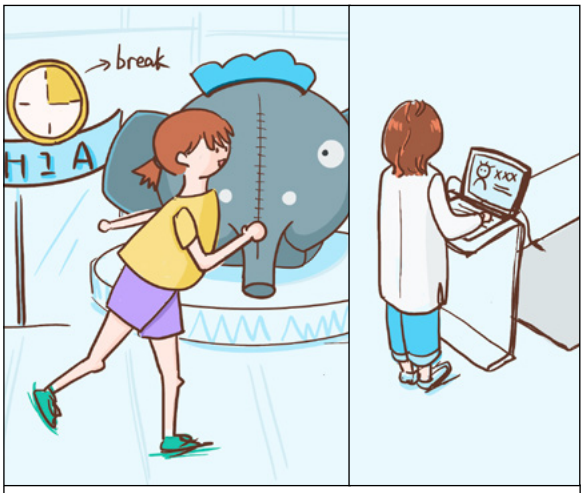
Achieving the design goal	--	-	+	++	Interpretation
Finish walking naturally		■			Though the guidance is not an extra task, it might divert children's attention. However, the child can also be more nervous as the pattern speed changes and they have to adjust the walking speed.
Achieve a moment of fun		■			Older children can achieve fun from the knowledge (Chapter 10); the younger can achieve fun from the turning task; however, not all the younger can achieve fun from it (Chapter 11); the younger can achieve fun from the high-five (Chapter 11).
Learn something			■		Older children can learn the walking knowledge at the end (Chapter 10); there is no learning for the younger (with low walking capacity.)
Confirmably and timely instructed			■		The mindless guidance can already guide them to finish the entire walking (Chapter 12).
Influence on the test conductor Fluently instructing			■	■	Mentioned by one physical therapist, the influence is low.
Influence on the gait test Footstep recording	■	■			Mentioned by one physical therapist, the walking speed will be more or less imposed by the guidance, and the bending head interfere the walking process.
Other influence			■		Mentioned by one physical therapist, the influence is low.

Figure 41-3: concept evaluation

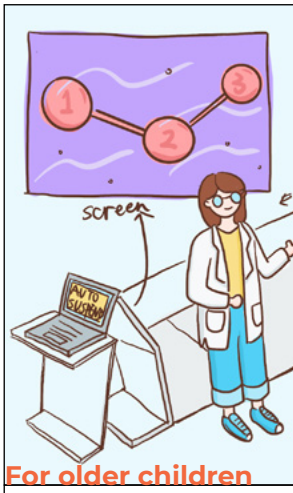
Chapter 16

Final concept

This chapter introduces the final concept and the key modifications from the selected Concept 2.

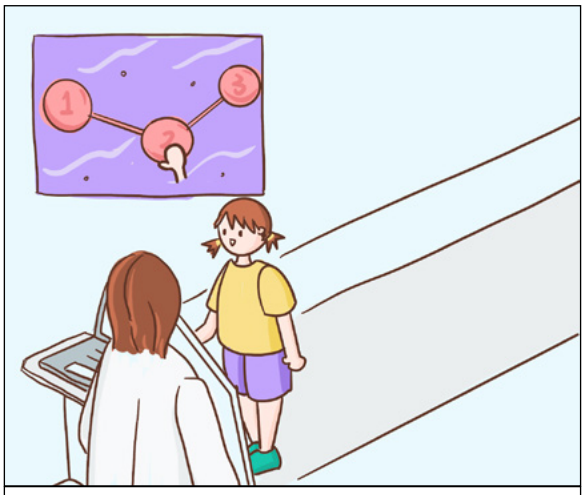


The child is in the break, and the test conductor is setting up the gait test and inputting the child's information on the software of the gait mat.

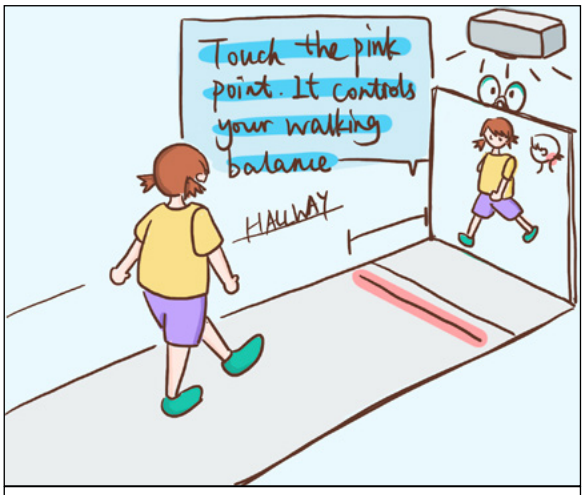


For older children

This older child is welc
would like to know about
lab. The child is motivate

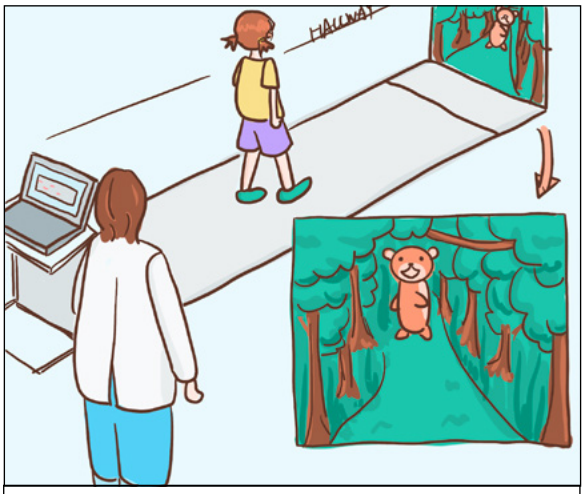


The child then is instructed to walk back. In front of the screen, she selects the 2nd knowledge.

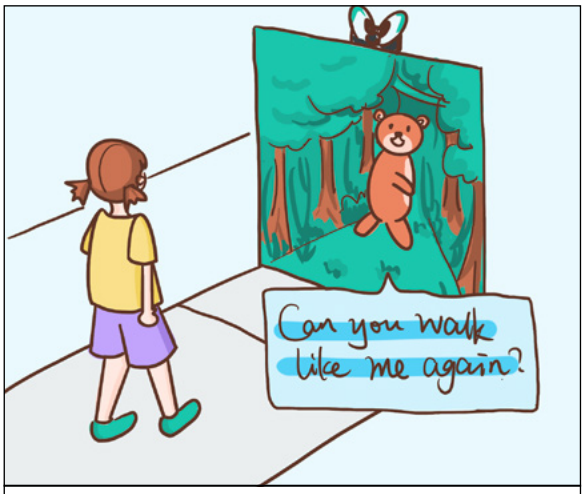


The same with the first interaction, the child learns the 2nd knowledge.

And this is the prior know
3rd button on the screen
has five times of walking

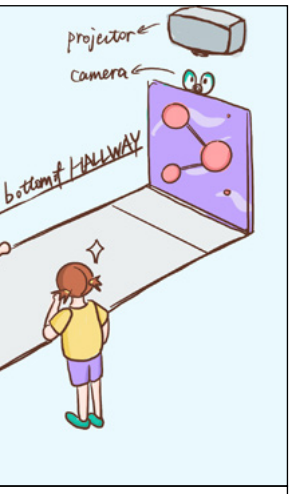


The child imitates the bear's walking to the wall. When she walks close, the bear walks from the jungle.

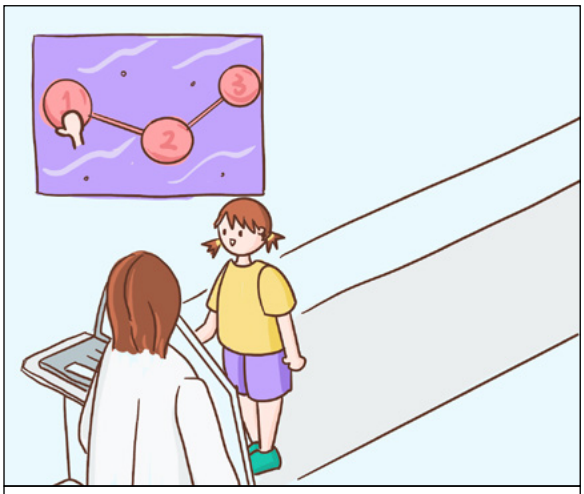


The bear then stands in front of the child and asks the child to imitate its walking again. As the child is motivated, she is willing to imitate again.

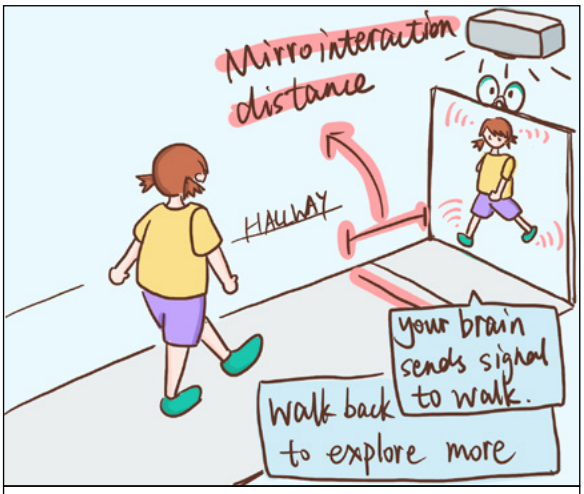
Some younger children
this moment, the condu
down a bit, "slow down, t



omed and asked if she
t the walking in the brain
ed and says yes.

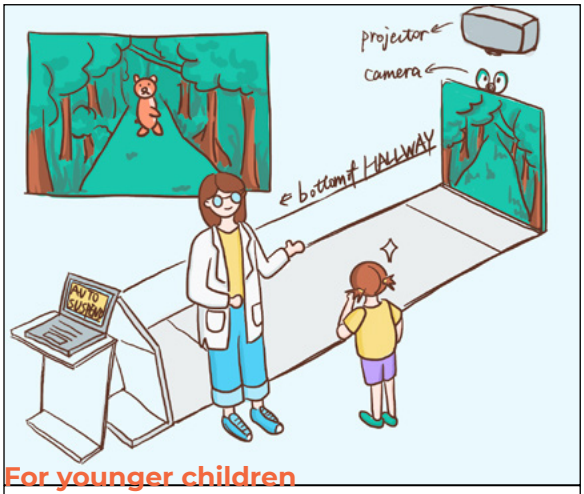


The child comes to the screen and begins to explore, the number indicates the sequence, and there is no hesitation to select.



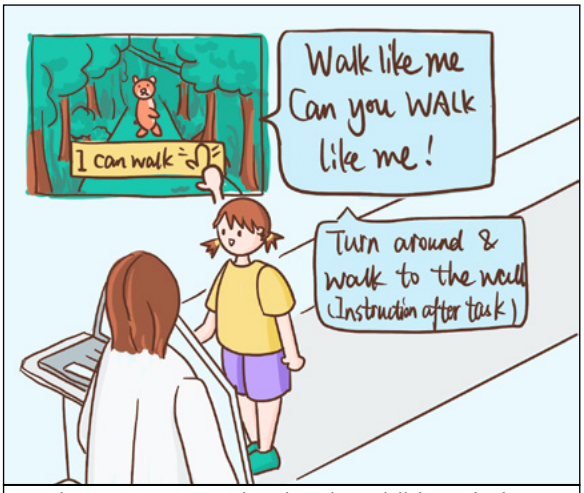
The child is then instructed to walk to the projected wall. When she walks close, the interaction is triggered. The child shows on the wall, and the 1st knowledge shows with her.

wledge after clicking the
n. And in total, the child
.



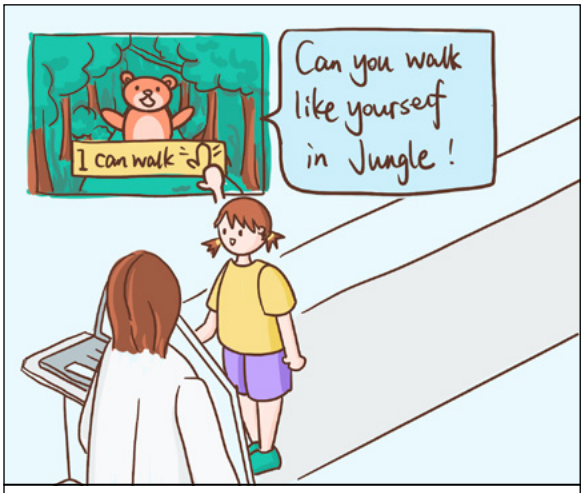
For younger children

This younger child is given a task of animal imitation with her entire walking.

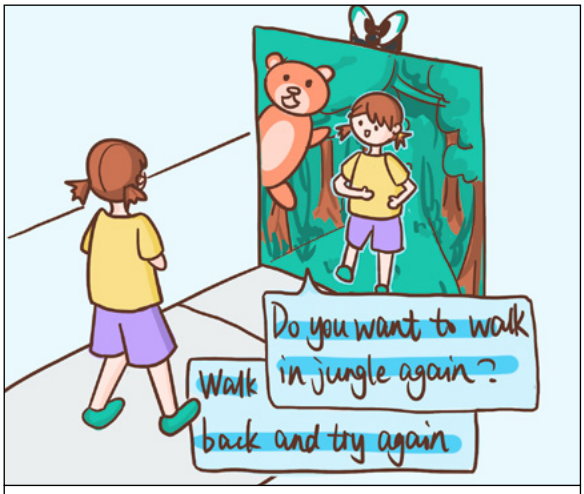


A bear comes and asks the child to imitate. The child feels it fun and easy. She accepts this task and walks to the other point. There is an instruction of turning around and walking to the..., which always follows the given task.

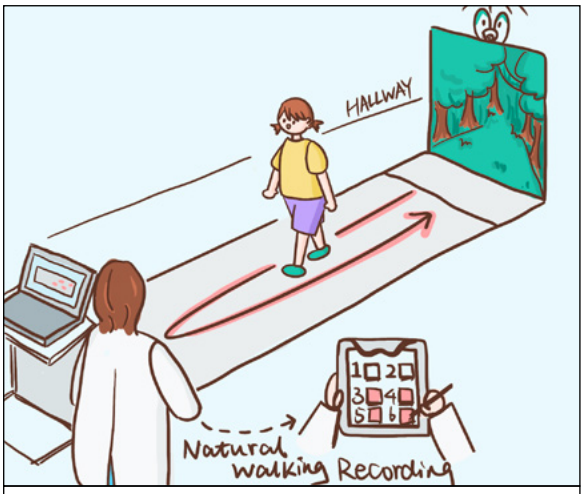
are easily motivated. At
uctor asks them to slow
he bear is walking."



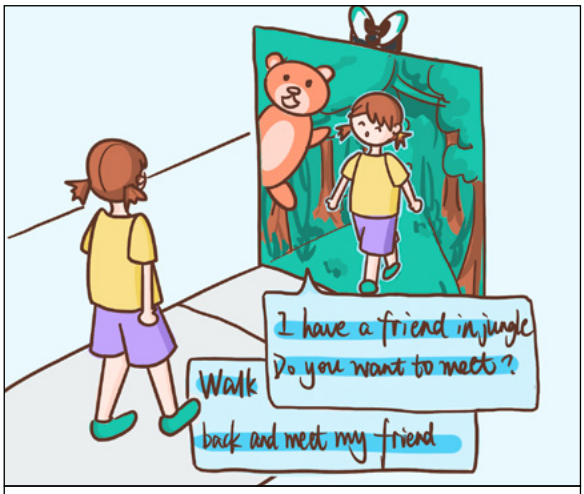
For the next time of walking, there is a tricky design. The child is asked to walk like herself. This is where her natural walking starts.



This time, when she walks to the wall, she shows in the jungle. The child is asked to walk back and walk in the jungle again.

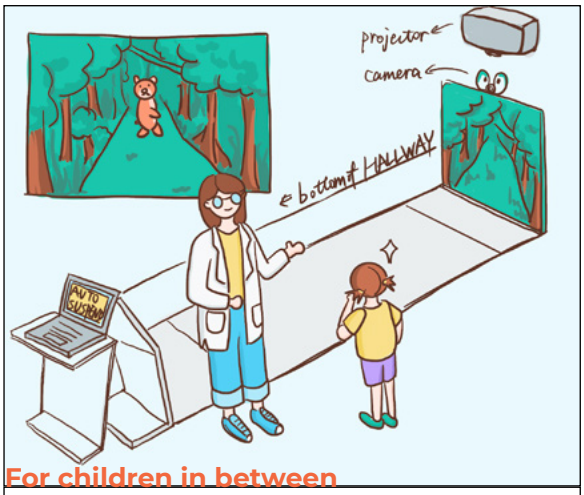


The child walks back and walks to the wall again. As these is the child's natural walking, the test conductor records it, so that the valid footsteps can be filtered later.



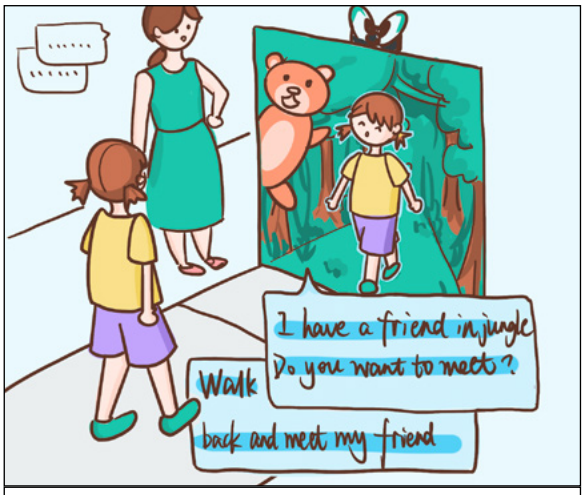
Another round when the child comes to the wall, the bear asks the child to walk to the screen to meet its friend.

The child walks back a motivated by the gor posture, and accept this



For children in between

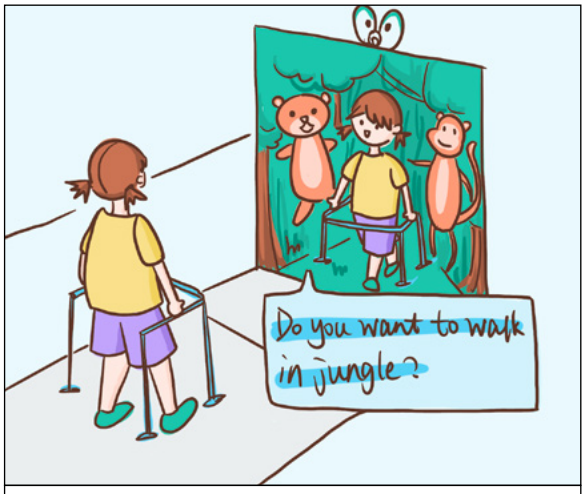
For children, in between, they can choose to have more fun or learn something. In animal imitation task, the first bear imitation diverts their attention from the pure walking; bear is also a company.



The bear thanks the child and asks the child to send the animal to the jungle. The parent helps the child turns around, and the child walks back.

At the end, the swimm next test station.

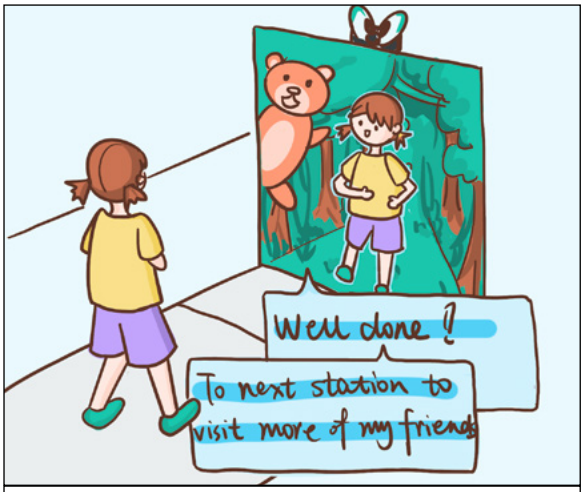
The bear thanks to the child and asks the child to send the animal to the jungle. The parents helps the child turns around, and the child walks back.



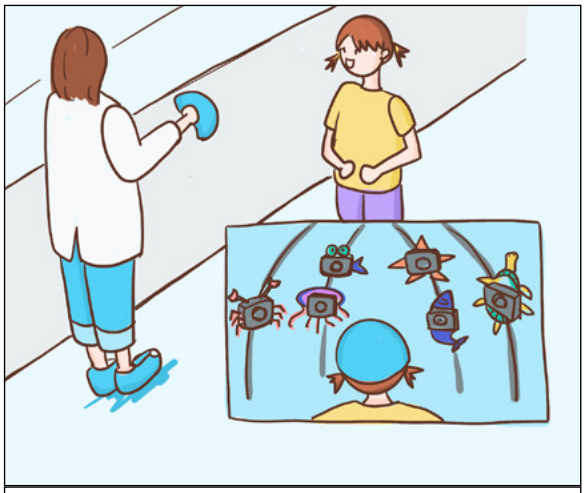
The child sends the gorilla back, as well. She is appreciated and is asked if she wants to walk in the jungle.

The child walks back an finishes the entire 5 tim to leave the mat at the e

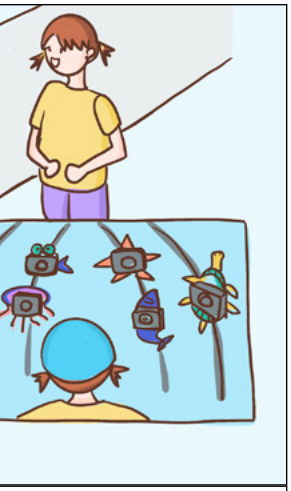
nd meet gorilla. She is illa's exggrate walking task.



The child finishes the gorilla imitation, and this is her last walking. The bear asks the child to the next station to meet more friends.



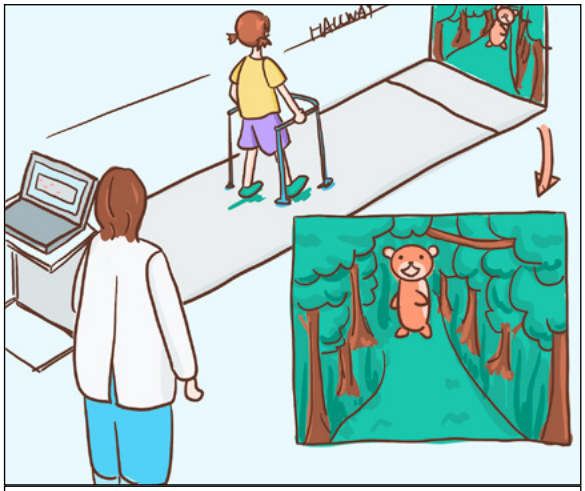
A swimming hat is given at the end. At the photogrammetry test station, the cameras are decorated as ocean animals. These is a connection between the two test stations.



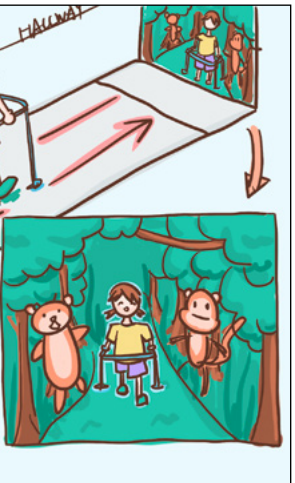
ing hat is given for the

For the younger with low walking capacity

This child, as they cannot imitate animal, is given a mission task of sending animals back to the jungle.



She firstly send the bear to the jungle, and when she walks close to the wall, the bear walks out.



d to the jungle. The child es of walking, and asked nd.

Key modification

In addition to the instruction and the sequence of the animal walking, some other modifications has been made.

Replacing the implementation tool

The implementation tool is replaced from the interactive board to the projector display for the following reasons:

1. The current interactive board has the interaction on by hand, while it doesn't relate to children's physical walking that much. The mirror walking, as tested with children, can generate the interaction more physically on the full body;
2. Walking without objects in hand make children more relaxed;

   The kid: Because there is nothing in hand, and I use feet to walk and I feel relaxed.

3. As mentioned by the hospital supervisor in the concept evaluation, she also concerns the objects in hand influence the gait test itself.

Invite parents to participate

As the tasks and the instructions are mixed in the concept, it takes time for children to understand and continues.

And the test conductor has no time switch between the two points to explain it to children. Therefore, the parent can be invited, stands at one point to tell children what' going on in the concept, and instruct children. In this way, there is no need for the test conductor to switch the position. And the test conductor can stand at one point, checking the capturing footsteps and explain it to children at the same time.

Creating similiar experience journey for all the children

The design pattern in the experience map shows that different children has the peak moment at different stages during walking. Older children

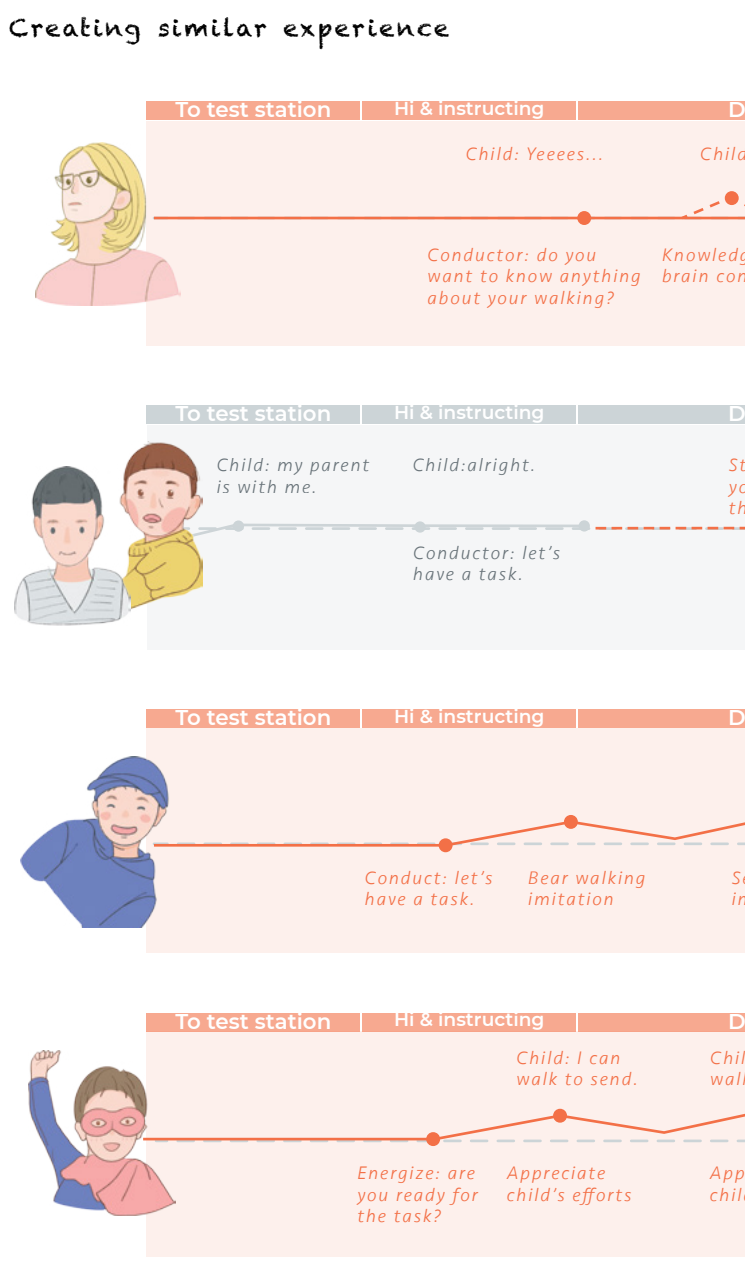
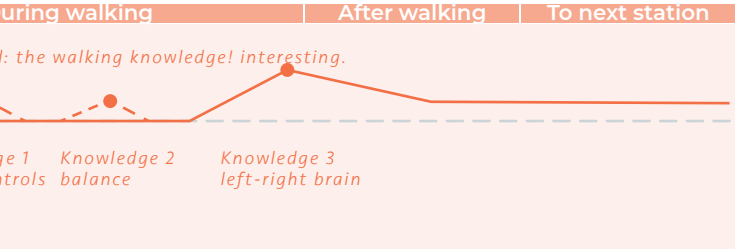
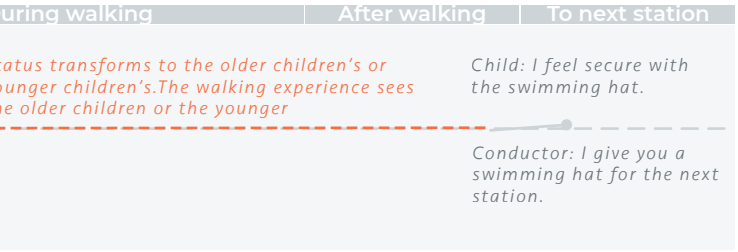
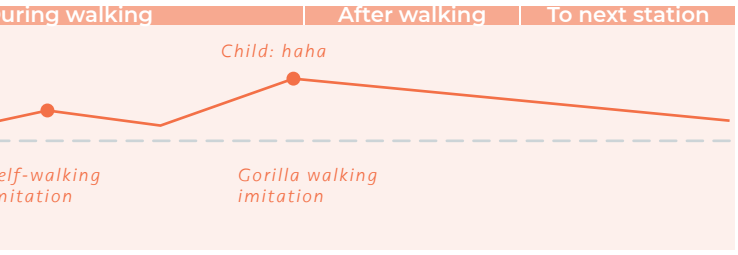


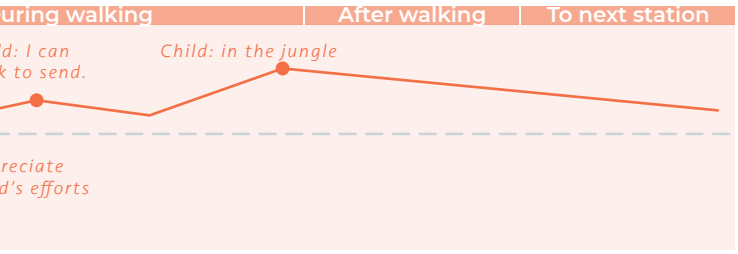
Figure 42: creating similar experience for children in different tasks

have the peak moment at the end, while younger children (or with low walking capacity) have the peak moment at the beginning. The final concept make the this moment more unified in the 3 tasks(Figure 42).









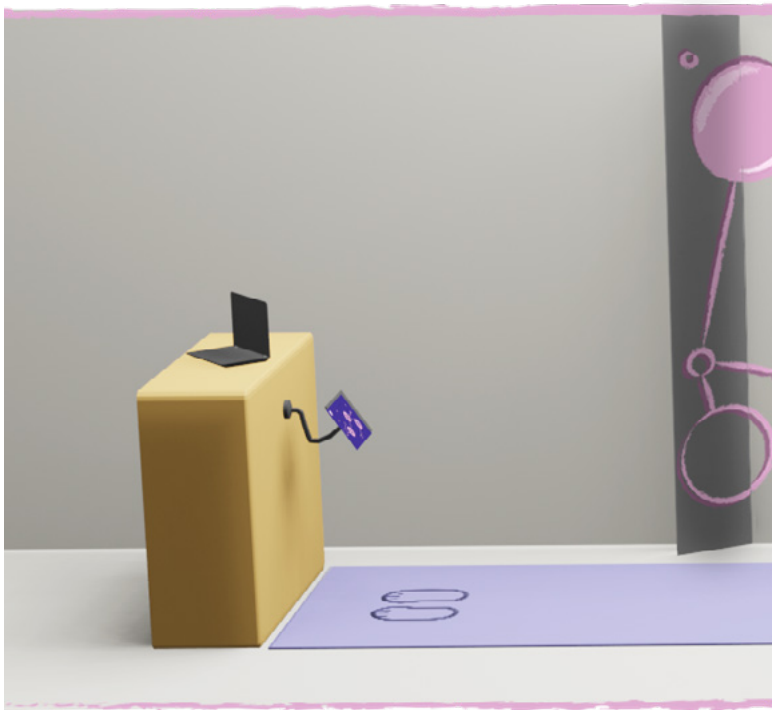
Chapter takeaways

1. The final concept is implemented with the projector display.
2. Parents are invited to instruct chidlren at one point, so as to share test conductor's work;
3. Similar experience is created in the different tasks.

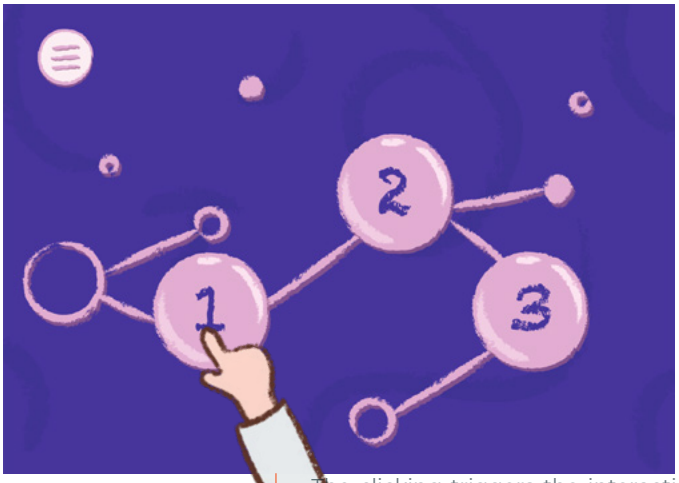
Chapter 17

Final concept 1 design for the story

There chapter presents the key interfaces in the final concept. The interfaces are on one tablet and one display wall.

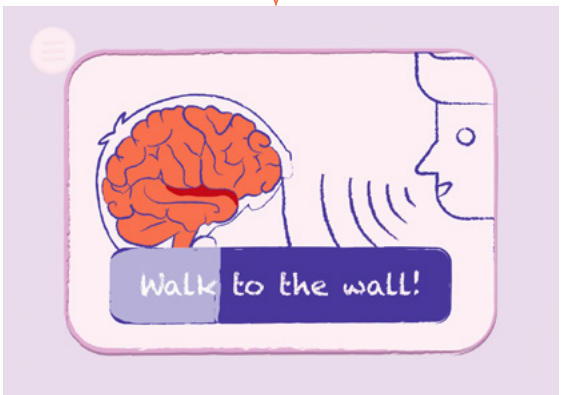


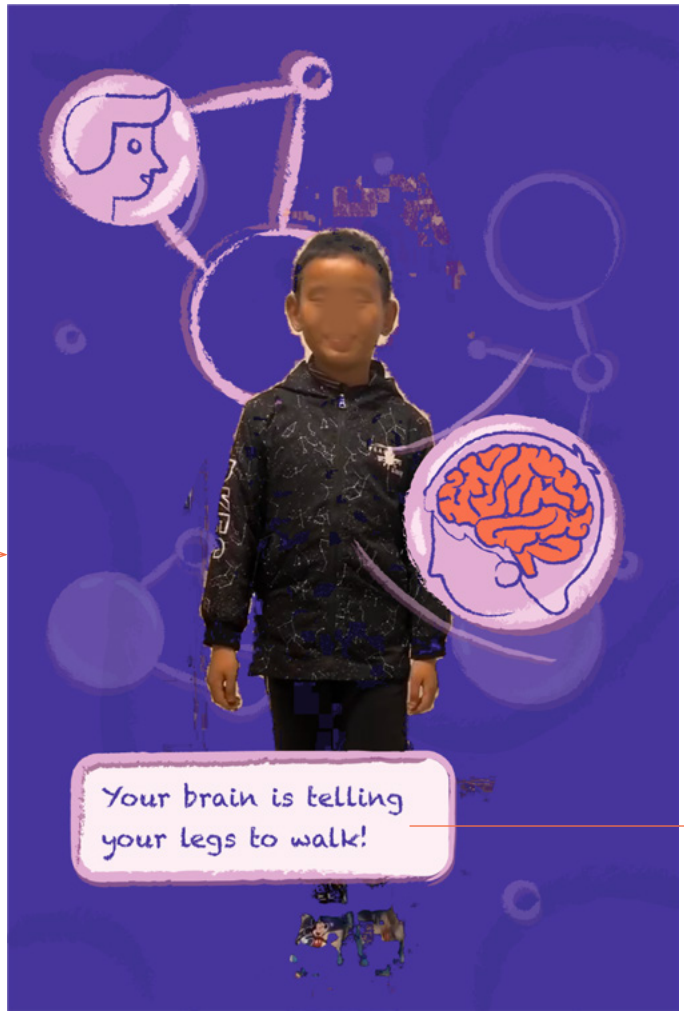
17.1 The walking knowledge for the older children



The clicking triggers the interactions of the 1st walking knowledge at the other point.

After clicking, the screen turns into a non-clicking mode for seconds.





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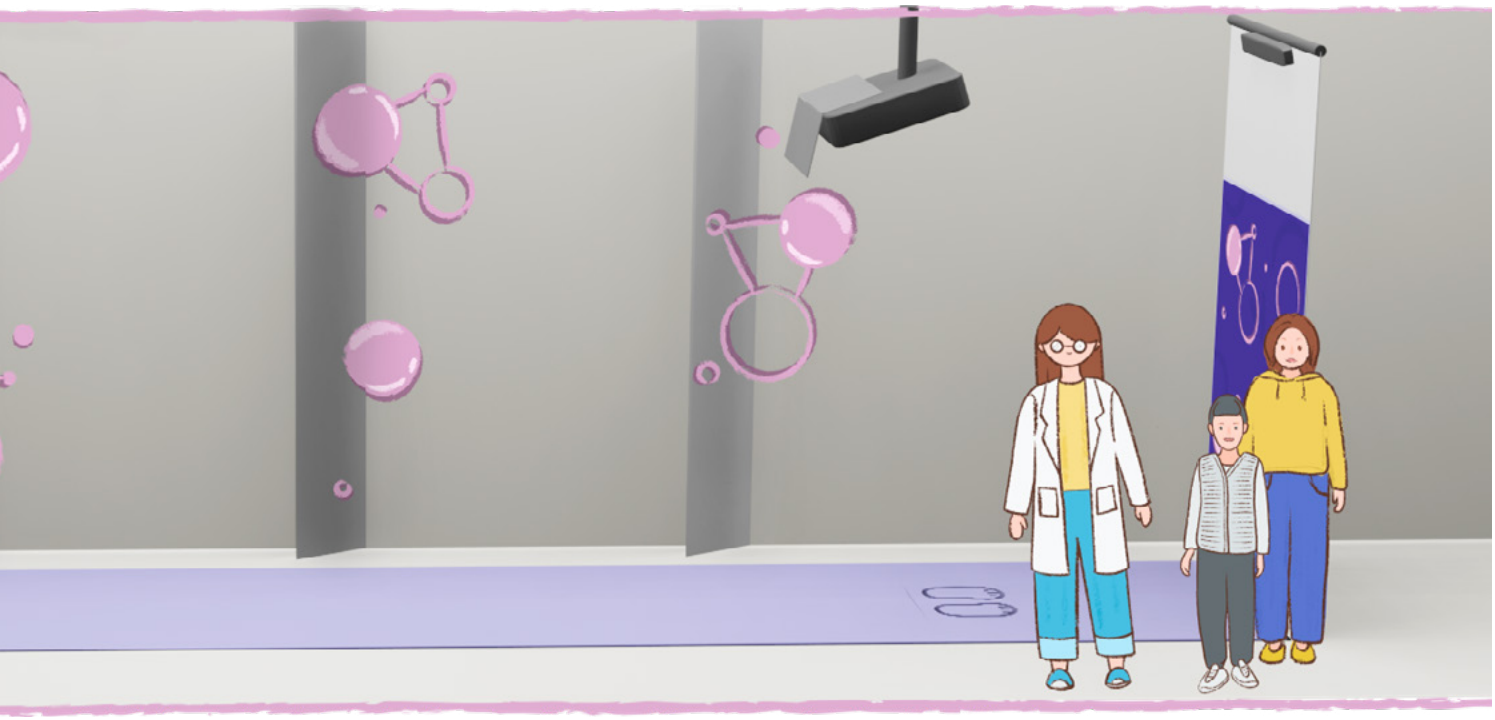
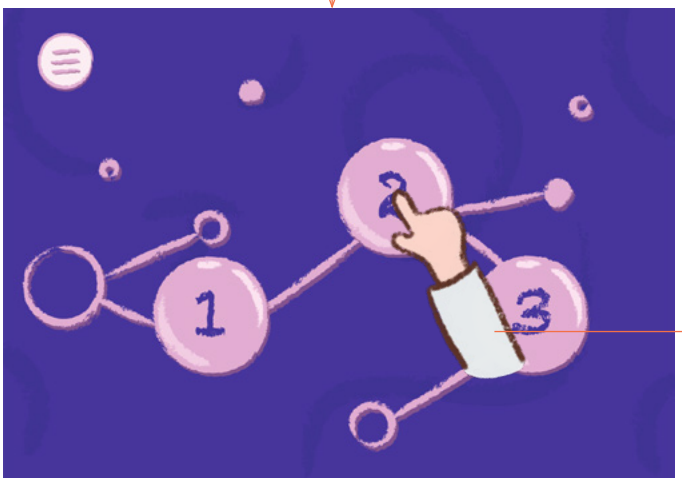
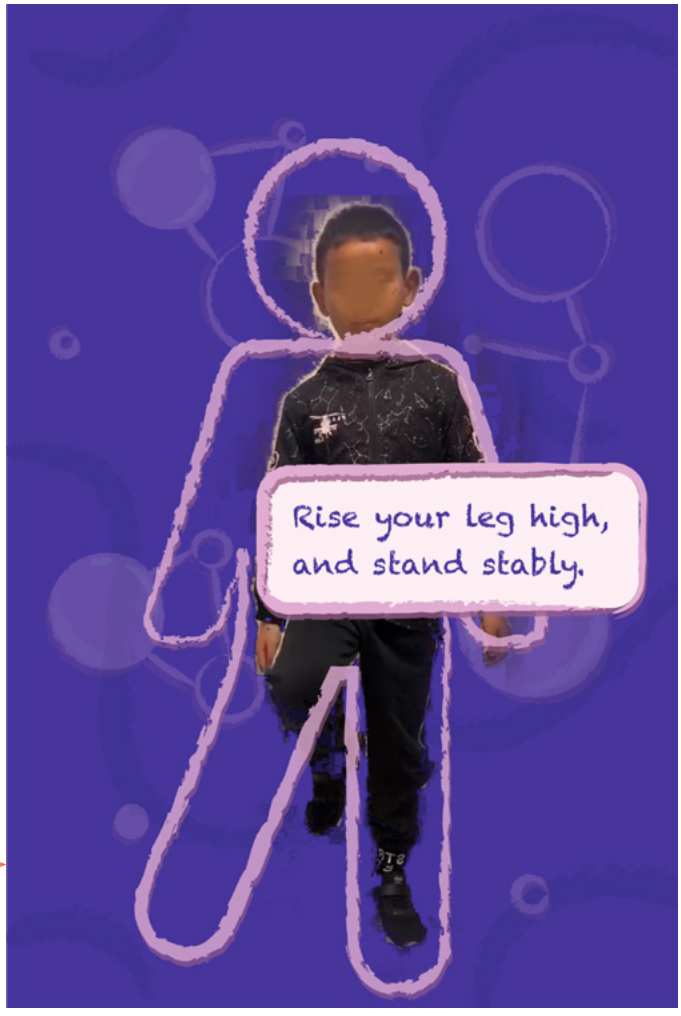


urn around, and
alk back for more.

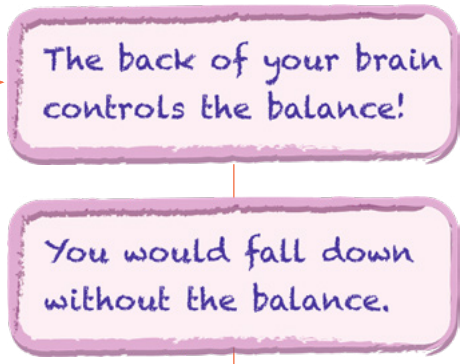
ntence follows the
edge after seconds.

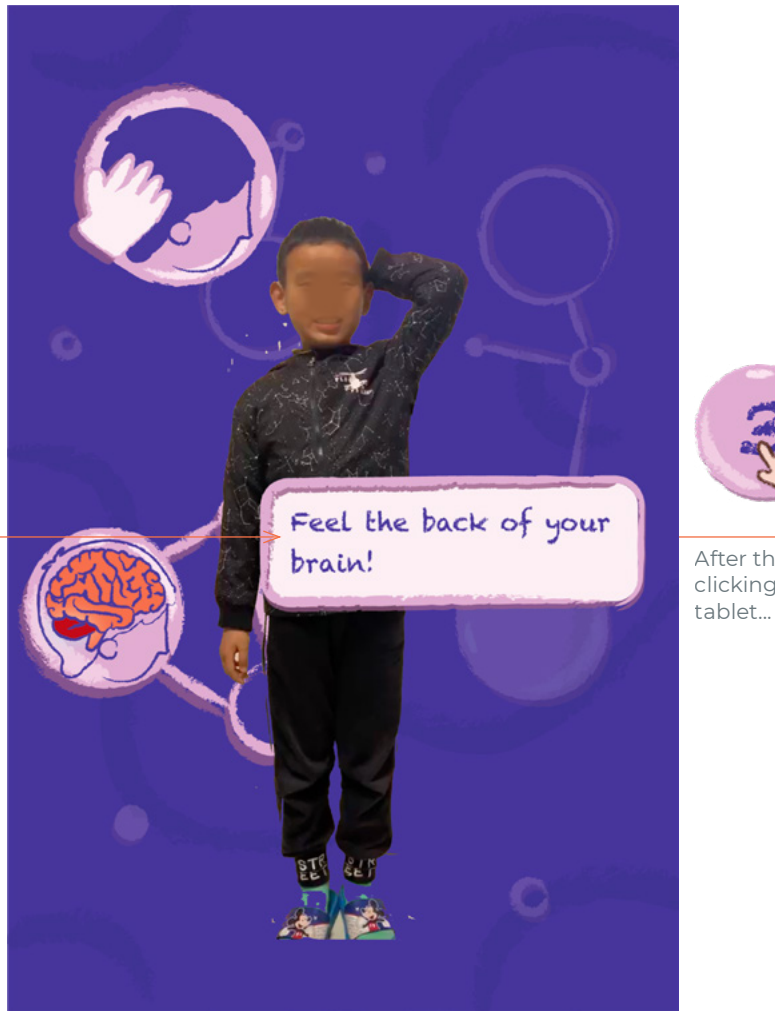
The tablet is ready for next clicking after the non-clicking mode.





The stories continues with the changing sentences.

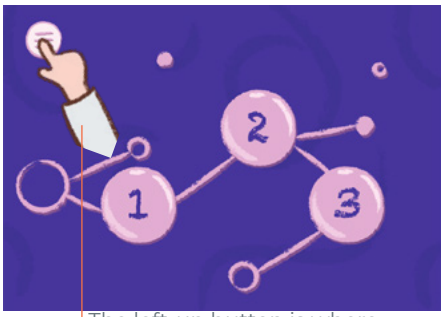




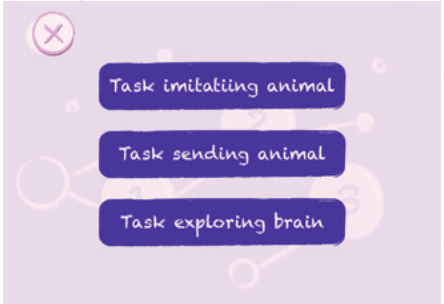
After th clicking tablet...

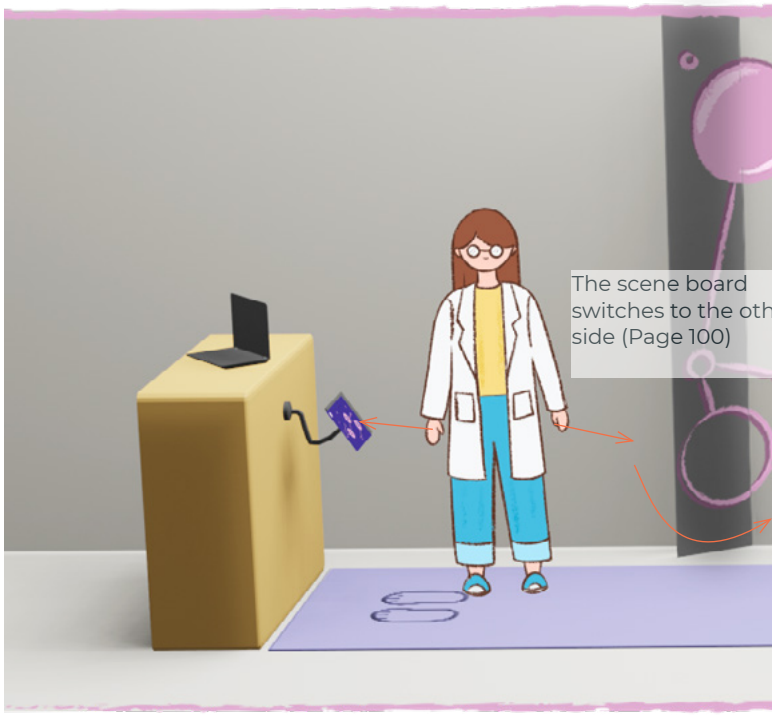
17.2 Scene change

When the next child wants to have another task, the test conductor switches the set up.



The left-up button is where to change the task.



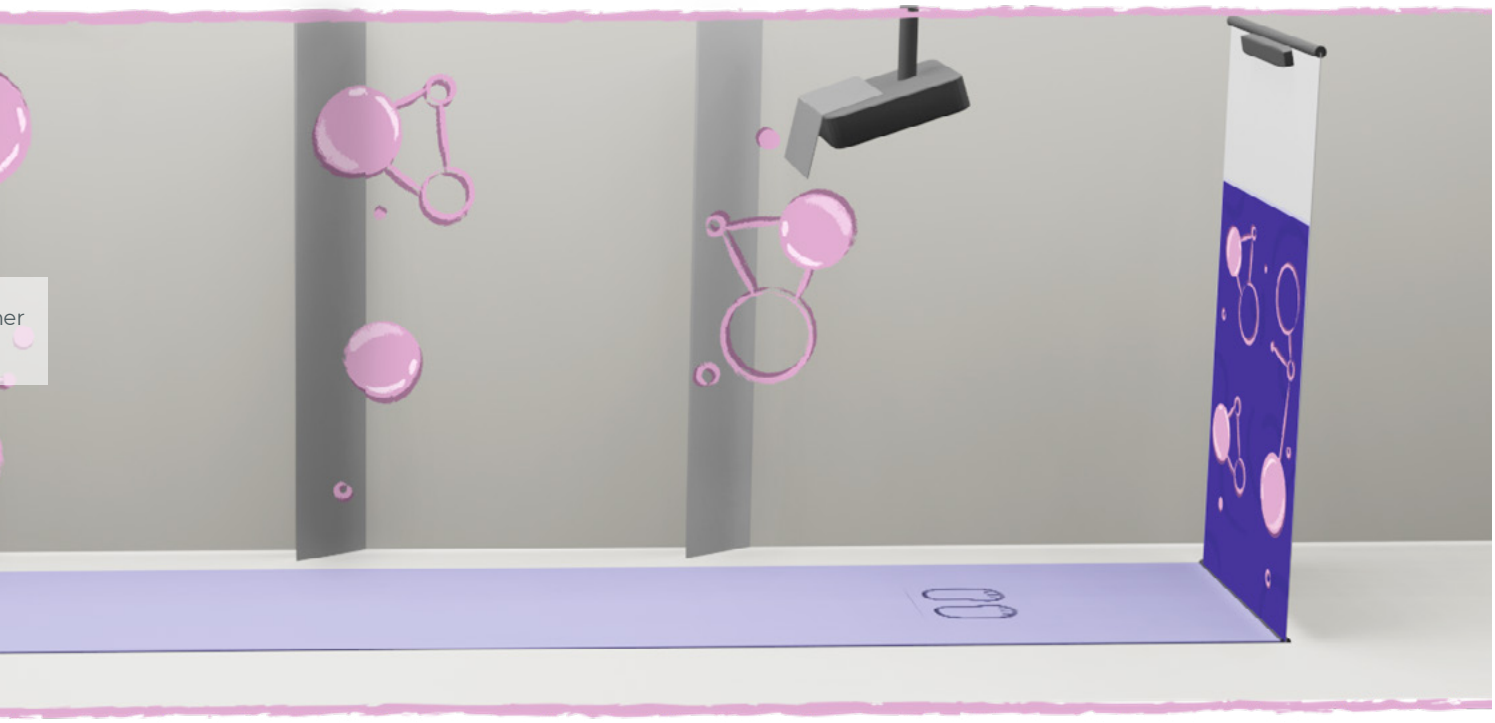


The scene board switches to the oth side (Page 100)

And the right brain controls the left leg.

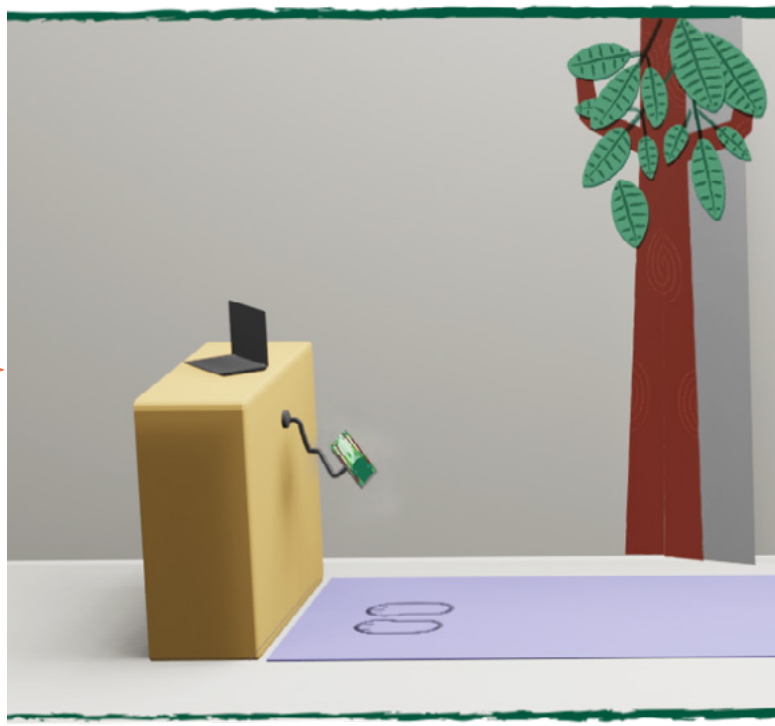
You know all about walking!

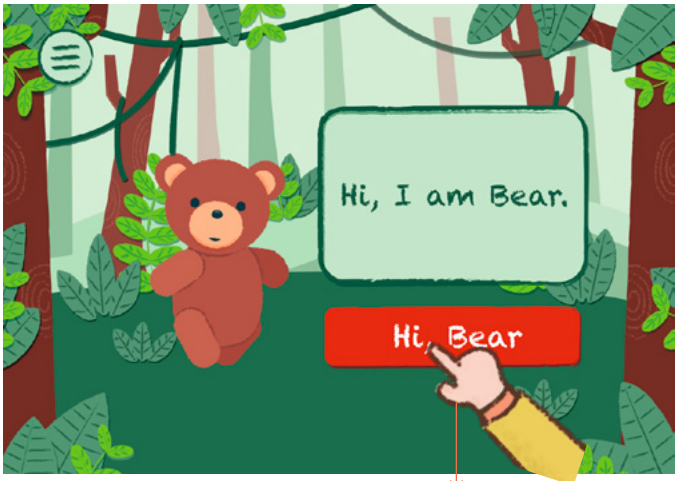
The walking process ends

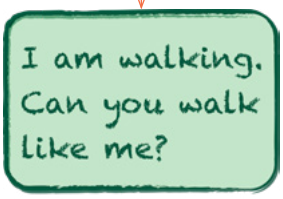


17.3 The animal imitation for younger children

The scene has already changed to jungle.







The tablet turns to the non-clicking mode for seconds

The display is triggered at the other point.

The
is rea
next
after th
clicking

tablet
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clicking
ne non-
mode.

Non-clicking mode for seconds

The display is triggered and the camera records the child and shows the child on display.

Non-clicking mode for seconds

The display triggered

The
is rea
next
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The walking process ends

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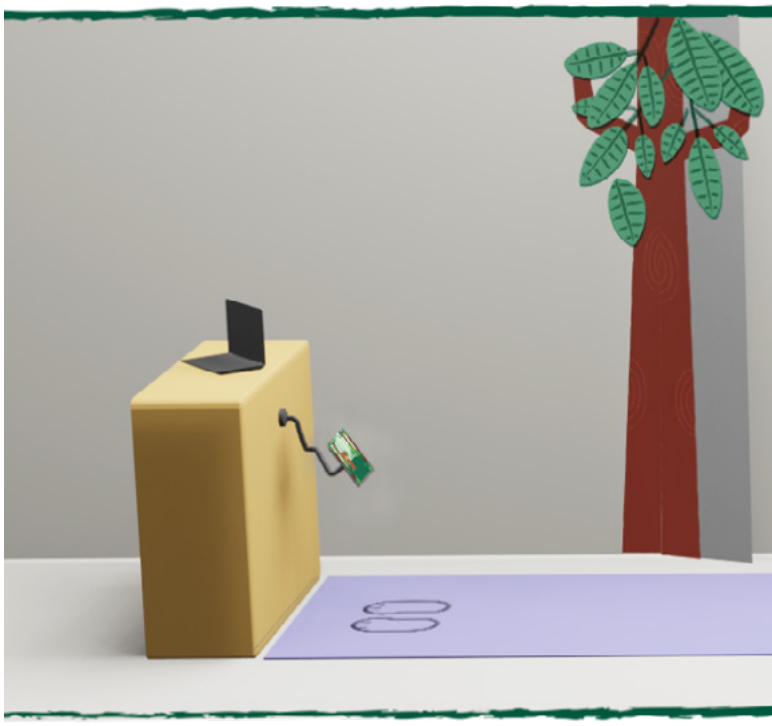
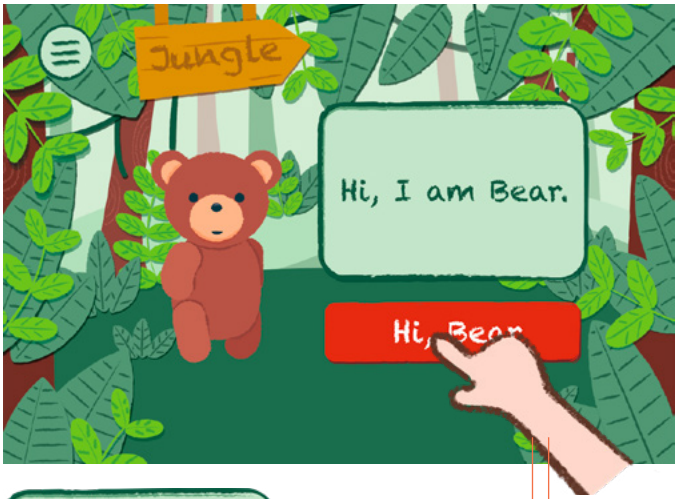
mode.

The display triggered

Non-clicking mode for seconds

17.4 Sending animals





Non-clicking mode for seconds

The display triggered

The
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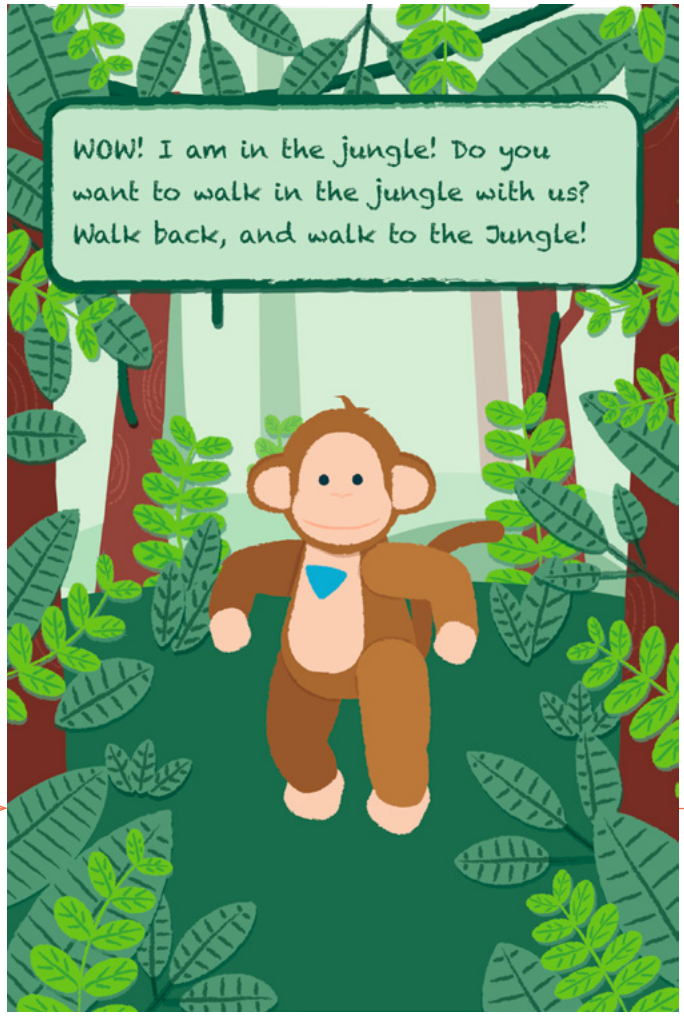
Send Gorilla to the jungle!

Non-clicking mode for seconds

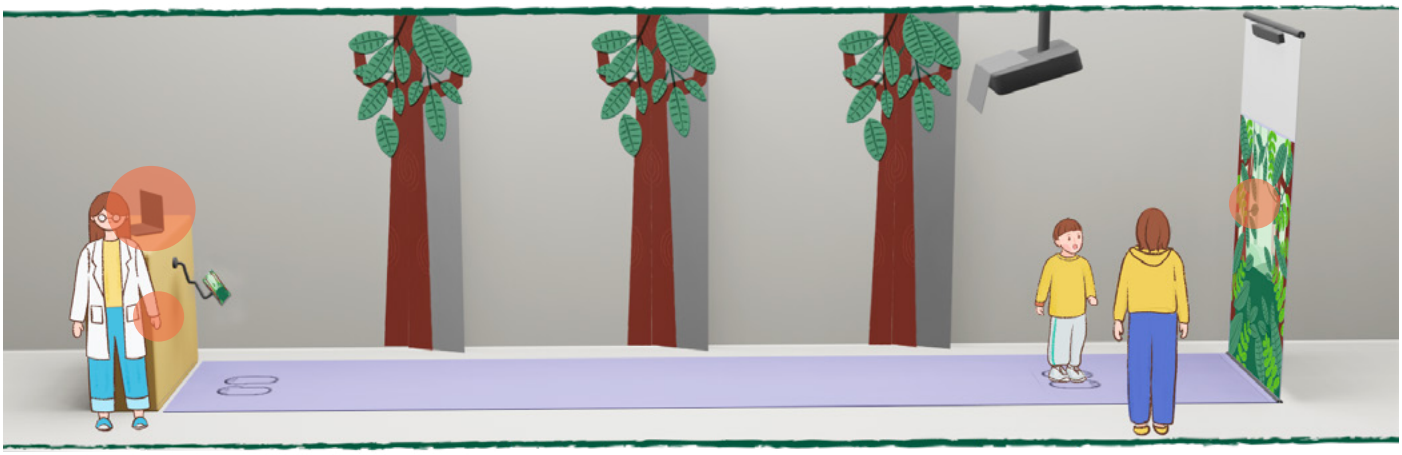
The display triggered




Thank you for sending Gorilla and me to the jungle!
Glad to help!
Visit us in the jungle!
Go to jungle!
Walk to the jungle!
The display triggered
Non-clicking mode for seconds


WOW! You meet Gorilla and me in the jungle! Let's go to the ocean to meet more friends!

17.5 Test conductor's work and parent's participation



Checking the footsteps on software

During children's walking, the test conductor stands at one point near the laptop, and glances at the software from time to time to ensure the software is working.

Recording children's natural walking

In the task sending animal and exploring knowledge, have five times of natural walking in the entire gait test, while in the task animal imitation, children have four times of natural walking out of 7 times of walking.

With this difference, the test conductor has to record the children's task and their natural walking, for further data filtering and analysis. Figure 43 is the record sheet for the test conductor.

Explain the concept and instruct

The child listens to the story. As the story is simple, the parent and the test conductor can quickly understand. Therefore, the parent and the test conductor follows the story and instruct children.

As parent is the expert of their child, the child can easily instructed by their parent. As to the test conductor, they are willing and confident to give the instruction, which is kept in the final concept.

Footstep recording sheet

	Date of recording		2020/11/11	Test conductor						
	Child name	Sequence number on software	Test time	Task Type (walking knowledge/animal imitation/sending animal)	Mark each child's natural walking						
					1st	2nd	3rd	4th	5th	6th	7th
1	Yeh	XXXXXXXX	10:00	Animal imitation (Imi)			✓	✓	✓	✓	
2											
3											
4											
5											

Figure 43: the sheet for the test conductor for recording the natural walking

176.6 Final service blueprint

Figure 44 shows the final service blueprint of the gait test.

Compared with the present service blueprint, there are three main changes:

1. With the concept, the walking duration prolongs from around 30 seconds to about 3 minutes. As the gait test is already short in Child Brain Lab, this will not influence children's one-day journey in the Child Brain Lab.
2. Parents participate in the instruction at one point;

Final service blueprint of the gait test station

Process	To gait test station	Hi & instructing	During walking
Timeline		30s	~ 3 min
The child's test process			
Finishing the task and walking	The child finish the break and on the way with parents.	The child is welcomed and asked to step onto the mat.	The child follows the task and does the walking protoco
Protocol of the gait test		At least 4 times of natural walking can be recorded, with 4-12 gait cycles record (Task walking knowledge - 5 times natural walking; Task animal imitation - 4 times; T	
Parent's and test conductor's flexible instruction			
		The parent and the test conductor stands at two points and give flexible instruc	
The test conductor's working process			
Recording child's natural walking			According to the different tasks, record the child natura walking for data(footsteps) fitering and further analysis
Operating the software	The test conductor input child's information on software.	The test conductor clicks "auto suspend" to start recording footsteps.	The test conductor glances at the recording data on softw when watching child's walking.
Software of the gait mat	Specifying each test	Preparing for start	Recording footsteps from mat

Figure 44: the final service blueprint

3. The test conductor has another work of recording children's natural walking.

	After walking	To photogrammetry station
	30s	
l.	The child is asked to leave the mat.	The child goes to the next station of photogrammetry.
ed and further analyzed. Task sending animal - 5 times)		
citons in the task process.		
al s		
vare	The test conductor clicks "done and save" to save the test results.	The conductor transforms this child natural walking in a digital sheet and sets up for the next child.
	Saving footsteps	Specifying each test

Chapter 18

Final concept 2 design for implementation

This chapter presents the design implementation proposal of the gait test station (Figure 45).

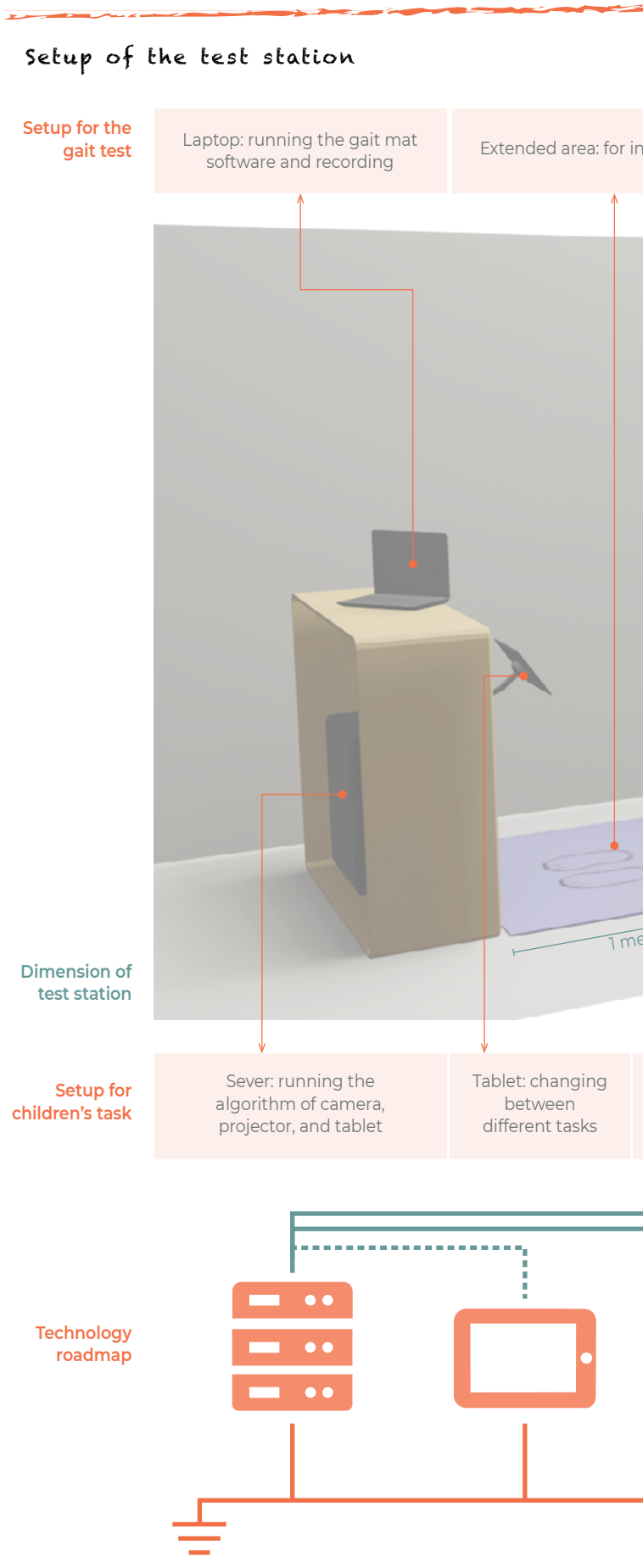
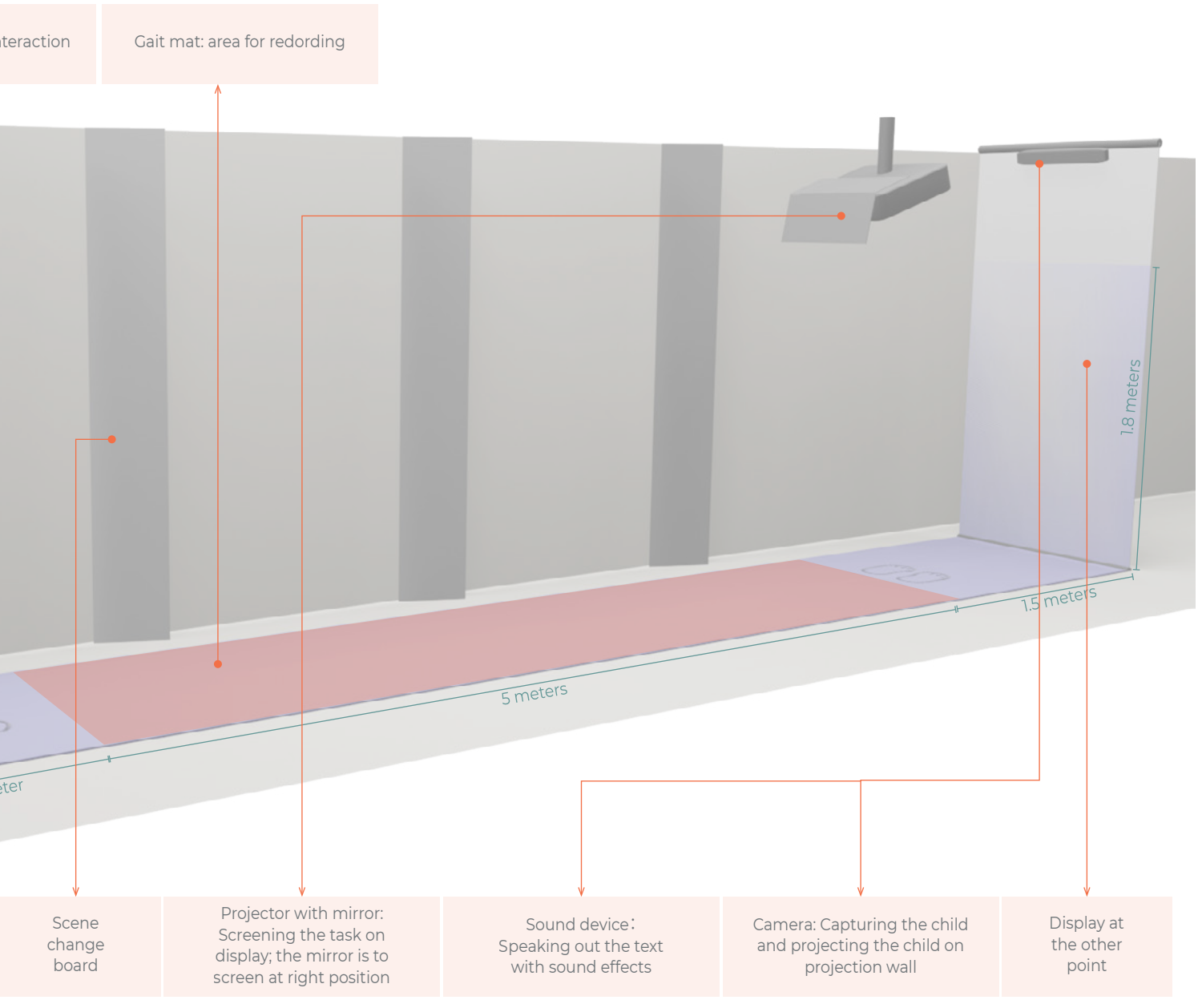


Figure 45: the setup of the gait test station



Scene change board	Projector with mirror: Screening the task on display; the mirror is to screen at right position	Sound device: Speaking out the text with sound effects	Camera: Capturing the child and projecting the child on projection wall	Display at the other point

Charging wire — Wi-Fi connection - - - - - - Server connection wire —

Chapter 19

Final evaluation

Two children participate in the final evaluation at the end. One evaluates the story of exploring the knowledge, and the other evaluates the story of the animal imitation. All evaluation materials are in Appendix A12.

19.1 Evaluation result 1: exploring the walking knowledge

This child is shown the video first, and asks the questions at the end.

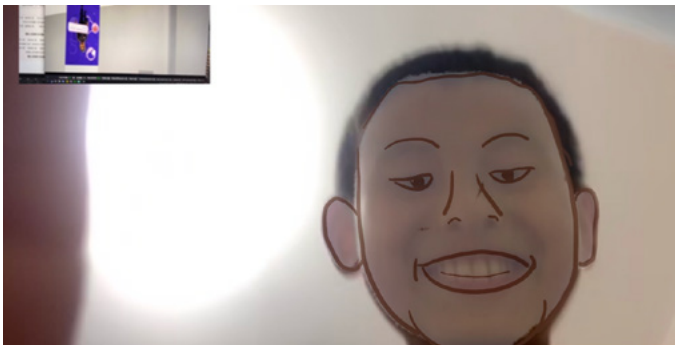


Figure 46: the child is watching the concept video

Induce children's natural walking

The child answers that he feels relaxed with the task of exploring the walking knowledge. He can walk naturally because his nervous feeling has been released.

> *I: When you hear a task of exploring the walking knowledge, how do you feel? Are you feel scared or relaxed?*
>
> *The kid: Relaxed.*
>
> *I: Why?*
>
> *The kid: Because I do the task in a minute! (The tasks in normal)*
>
> *I: What if it is a test.*
>
> *The kid: then I need around 7 minutes*

With the parent and the ocean at the photogrammetry test station, the child's feeling of insecurity decreases. And he is not scared any more.

> *The kid: the space is big and my mom is there.*
>
> *...*
>
> *The kid: I feel scared with lots of machine.*
>
> *I: If there is a swimming hat and some ocean animals, would you be scared?*
>
> *The kid: No, because there are lots of ocean animals and I feel curious about the animals*

Making children motivated and fun

The child is fun with the interactive postures on the screen. As the fun is the result of being motivated (Santos-Longhurst, 2019). Therefore, he is motivated and achieves the fun.

> *I: When you hear a task of exploring the walking knowledge, how do you feel? Are you feel scared or relaxed?*
>
> *The kid: Relaxed.*
>
> *I: Why?*
>
> *The kid: Because I do the task in a minute! (The tasks in normal)*
>
> *I: What if it is a test.*
>
> *The kid: then I need around 7 minutes*

Leaning the walking knowledge

With the given hints, the child answers all the walking knowledge. Still, the left-right brain is the most impressive knowledge for children.

> *I: How about the left-right brain, the left brain...*
>
> *The kid: the left brain controls the right leg and the right brain controls the left leg.*

Instruction to the parent and test conductor

As the instructions to children is left to the test conductor and the parent, if the parent can understand the instruction easily is asked. The parent mentions that she understand the story even in English.

> *The parent: It is quite easy to understand. Just my english is not good.*

Working fluency (design requirement)

With the extra working of instructing more to the child, the test conductor's work is disturbed.

> *The parent: At the beginning, it might be 40-50%, after I am familiar with, I feel there is no disturbance.*

Collect 2-3 gait cycles (design requirement)

As the child feels relaxed, they can walk naturally in the entire test. As it is a 5 times of walking on the mat. 2-3 gait cycles can be collected.

If there is distraction to children (design requirement)

With the design, the child would not be distracted by the hallway.

> *The child: I would not be distracted because there is a camera seeing me. Because the cameras is recording me.*

19.2 Evaluation result 2: imitating animals

Induce children's natural walking

The child answers that he feels relaxed with the task of exploring the walking knowledge. He can walk naturally because his nervous feeling has been released.

In terms of the child's insecure feeling, he mentions that he is scared of the snacks in his imagination, but once the story continues, he is not afraid. He also mentions that he is not afraid of the next test station.

Making children motivated and fun

There are lots of moments in videos, showing that the child is fun (Figure 47). And the child mentions that he wants to walk again, which means that he is motivated in the previous walking, as well.

The child is wathcing himself walking in the jungle.

When wacthes the video, he already rises his arms; and then, he walks with a giggling face.

Figure 47: the child's gait test of imitating animal

Instruction to the parent and test conductor

The child's aunt (the conductor in video) understand the stroy during walking.

The aunt: Once I know the context of two screens, I understand the entire story.

Working fluency (design requirement)

WIth the only work of playing the video to the child, the aunt works fluently.

Collect 2-3 gait cycles (design requirement)

In this test, as the aunt stants at one point and plays all the videos, the child walks 12 times of the walking. In the observation, there are two moments of the child walking naturally (Figure 48). As one time walking can already collect 2-3 gait circles, this child can have enough gait cycles for analysis.

If there is distraction to children (design requirement)

The screen and the sound catches the child's attention, and the hallway environment can not distract children anymore.

The aunt: The screen and the sound catch his attention.

As the bear walks like a human-being, the child walk as his normal walking status.

After he says himself in vieo (on the screen), he walks naturally for the following times of walking.

Figure 48: the child's gait test of imitating animal

Chapter 20

Recommendation and personal reflection

20.1 Recommendation

The story of sending animal

In this project, all the children are normal children. Younger children with low walking capacity are only concluded based on the physical therapist's interview. And there is no evaluation with those children. A evaluation with those chidlren are recommended.

Two test conductors

In the final concept, the parent are invited to participate. However, in this situation, the test conductor still takes different types of work. They are workload is hevay. Therefore, I recommend two test conductor in charge of different work, one is for the data part of the gait test, and the other is for instrucing the child in the story.

Final setup of the gait test station

As this is a project without contacting the real context, the setup of the gait test station is only given as an advice. The most important deliverables is the experience map that is designed for children. With the experience map and the tested ideas under this map, there are different permutation and combination. I give the flexibition to the designer who is going to the real context to set up the station.

For example, I provide a low-cost version of the concept (Figure 49), based on the experience. The story is the same as the final concept. The only difference is that the implementation tools. There is no big jungle on the screen; children are asked to imagine walking in the jungle, and the have rich imaginations to imagine the walking.

Nevertheless, I still recommend a projection display for children's walking in jungle or exploring the knowledge, because it enhance children's experience. It can also motivate children as well (Figure 50).

Figure 49: 3 interactive videos on website Bilibili https://www.bilibili.com/read/cv8263858

This is the first time the child watches himself on the screen.

The child is pointing the bear and gorilla.

Figure 50: The child's reaction of being on the display.

20.2 Personal reflection

I can never imagine that I can heavy a lot in this project, both from the project itself and personal development. I would like to recommend 3 books. They are not referred in this project. However, they give me the meaningful reason to continue my project.

Be critical to the abstract words

I like abstract thinking. It takes the advange of digging the essence. But it interferes the research on reasoning the behavior and blocks me to discover the diversity of the reality.

As children's research is mainly based on the observation, if thinking to abstract, it is easy to bring my subjective feeling. And because of this, when research with children, I keep modifying the previous research conclusion for a more objective ones. This is the hardest part for me in the project.

Moreover, I can also understand thinking in an abstract status presents the inexperience as a design student. It seems that I have understood all the terminologies. However, those are just for the frames of the theory; and in real project, it needs to be defined concretely.

Behavioral design and the meaning of fun

During the project, I have read several books and would like to recommend two books that inspire me.

The first book is <The power of moments> (Chip Heath, 2017). At the beginning of the project, I focus too much on the dynamics of entire gait process and would like to explore some design opportunities there. I totally forget the experience is instant. Only designing for some of the moments is also a design opportunity. The most importantly, children's status changes too fast with such small triggers. It is more reasonable to design some moments for them, instead of considering the entire process.

The other book is <Homo Ludens> (Johan Huizinga, 1983). As a person who seldom have fun, I feel such difficult and meanless for design the pure fun, until I find a explanation of fun, aardgkeit in Dutch, and Art & Wesen in German. Fun cannot be analyzed, and all the logical explanations are powerless.

Personal development

I can feel I put too much subjective feeling in the project as playing with children reminds me too much of my childhood. I am super happy to develop with children togeter.

I learn and understand a lot from children's behavior. I can never feel so impressive with the association, the intension of some behavior such as facing the difficulty, or the feeling of insecurity. Or even being instructed, as I am independent for too long.

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