

Global Health Forum in Taiwan 2023

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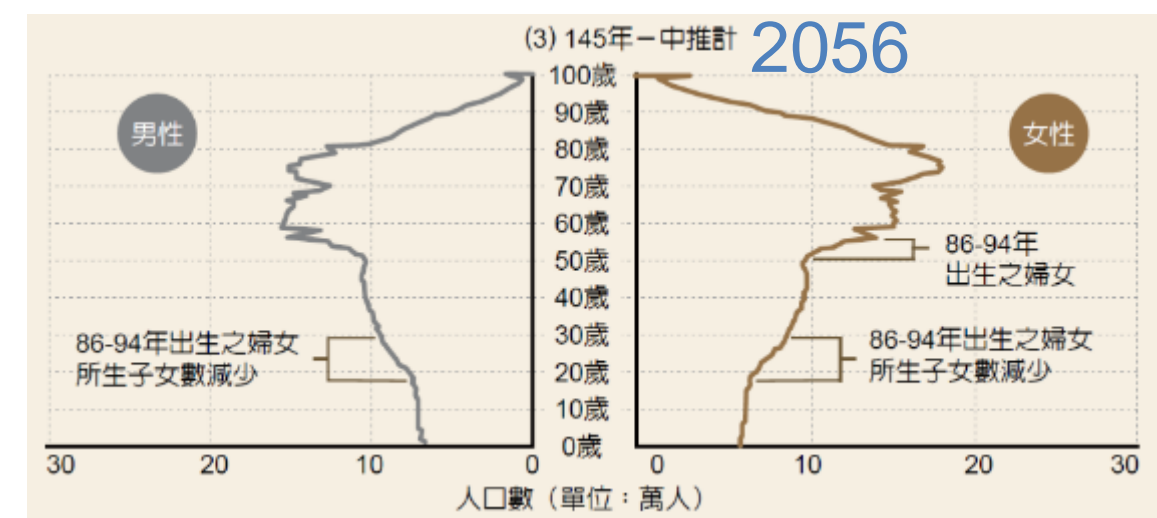
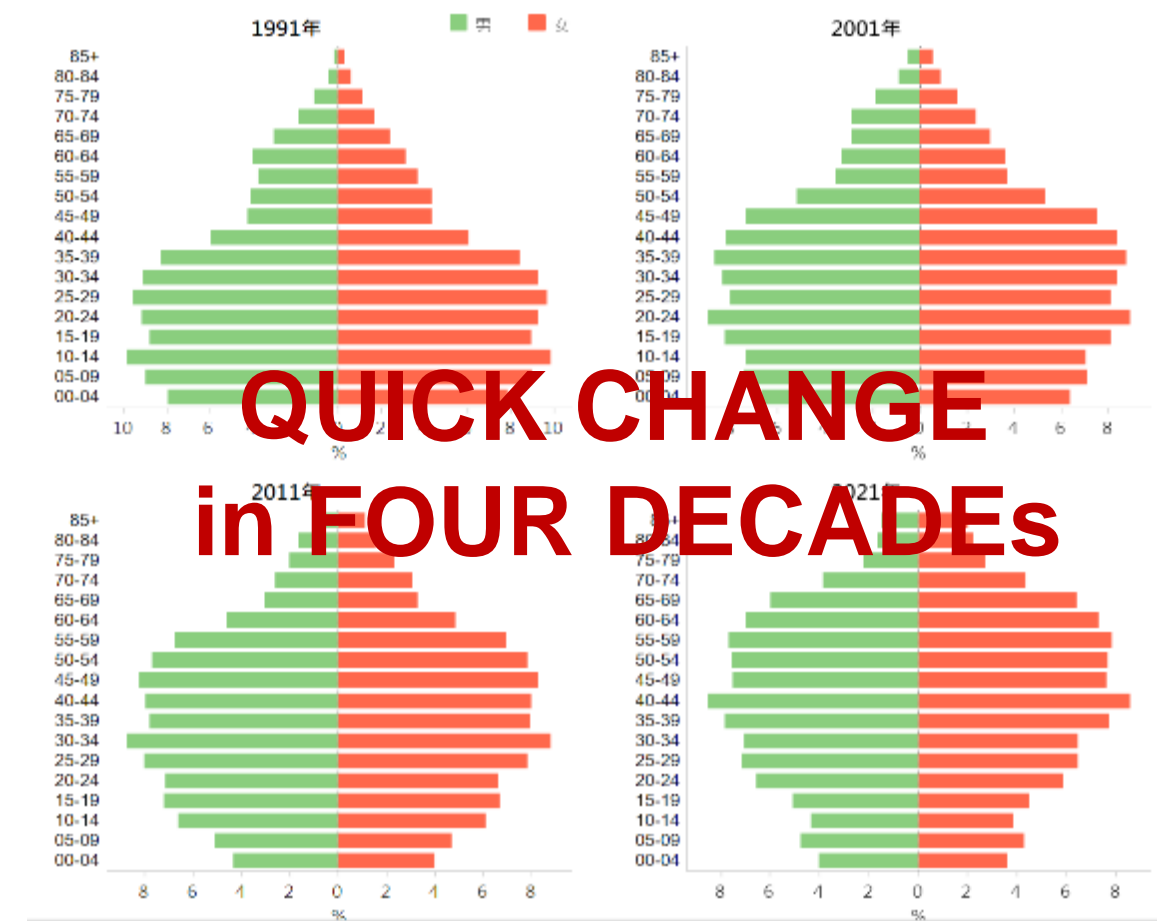
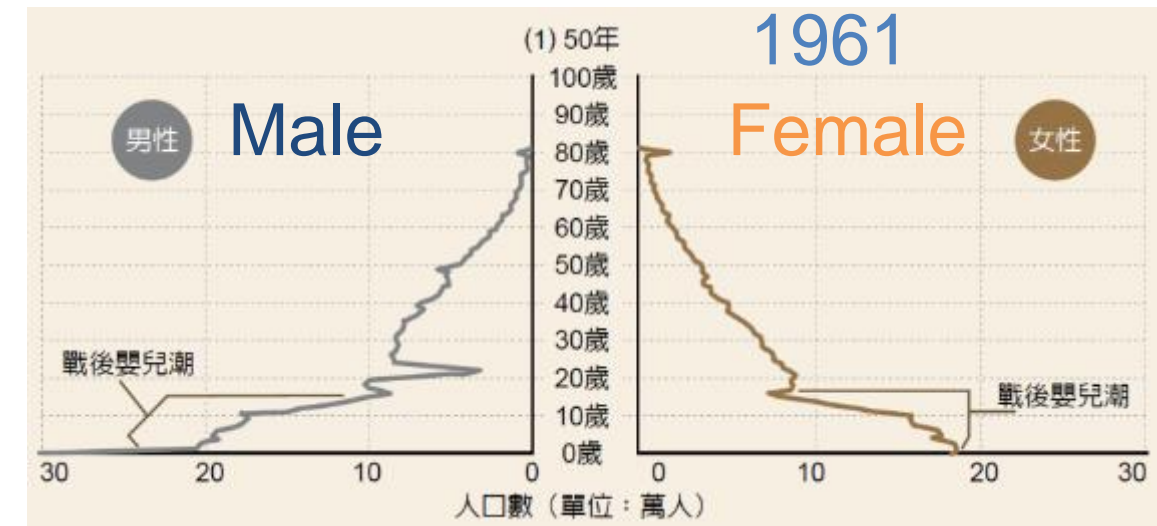
Ubiquitous exergame for the elderly- A tongue-training case study

Outline

- 1. Inclusive design - public environment**
- 2. Needs for exercise everywhere**
- 3. MusicTongue (舌肌律動) Development**
- 4. Results and Discussion**

Taiwan changing society

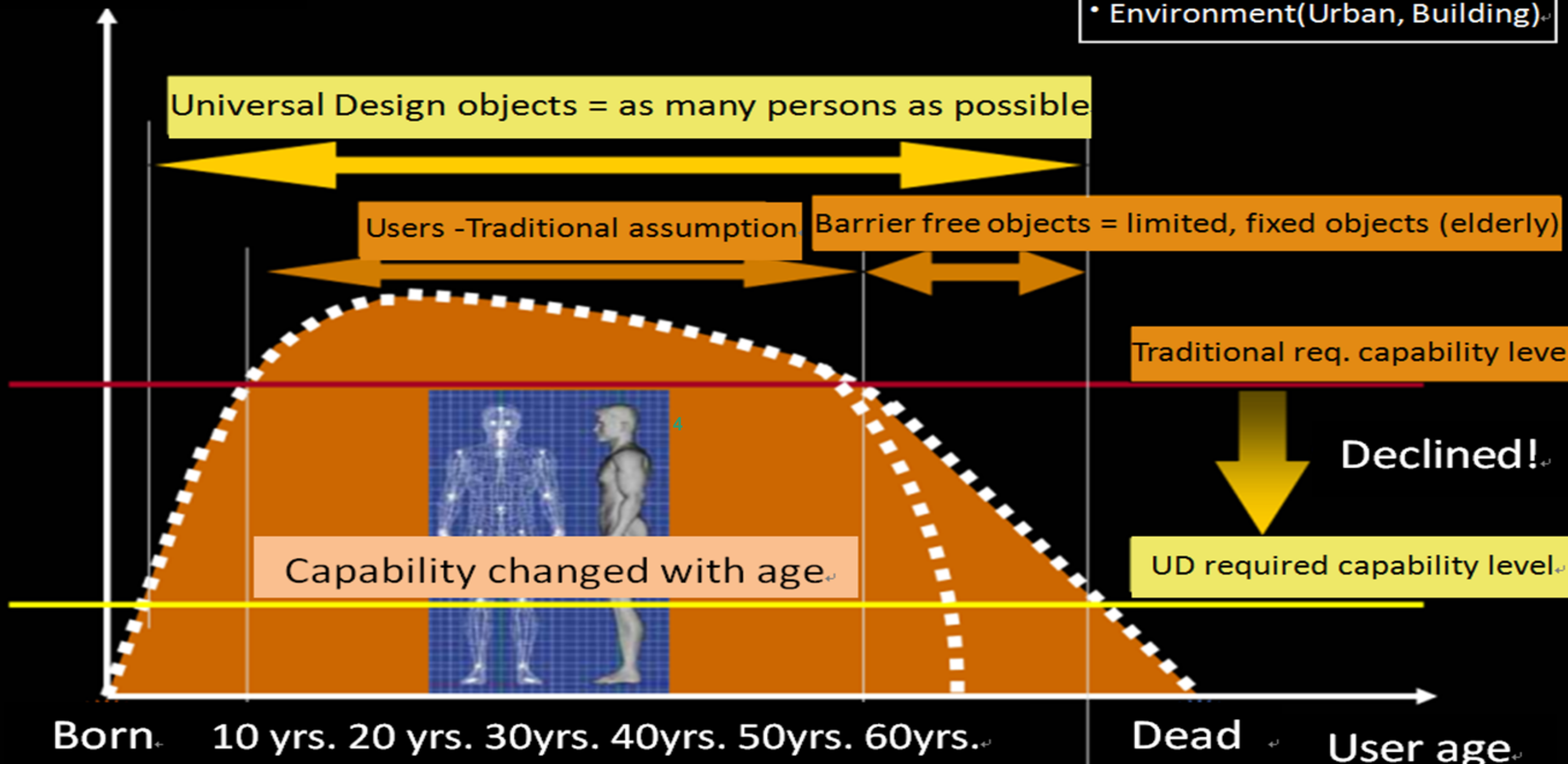
- Analyzing recent developments
 - marriage-related behaviors
 - fertility-related behaviors
 - mortality rate
 - life expectancy at birth
 - international immigrant
- Taiwan is moving into an Super-aged society (2025)
 - Decline.
 - school-aged population
 - working-aged population
 - Rise
 - the population of middle-aged and older workers



Barrier-free approach in UD

User capability

- Mono (Product)
- Environment (Urban, Building)

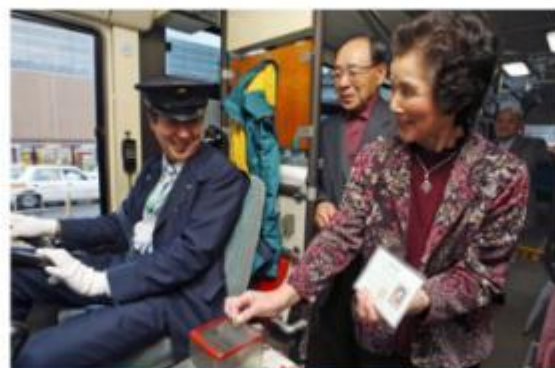


Aged friendly in eight domains

8 interconnected domains of urban life



Community and health care



Transportation



Housing



Social Participation



Outdoor Spaces and Buildings



Respect and Social Inclusion



Civic Participation and Employment



Communication and Information

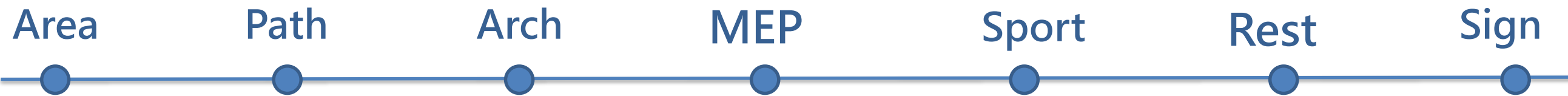


The Global Network for Age-friendly Cities and Communities

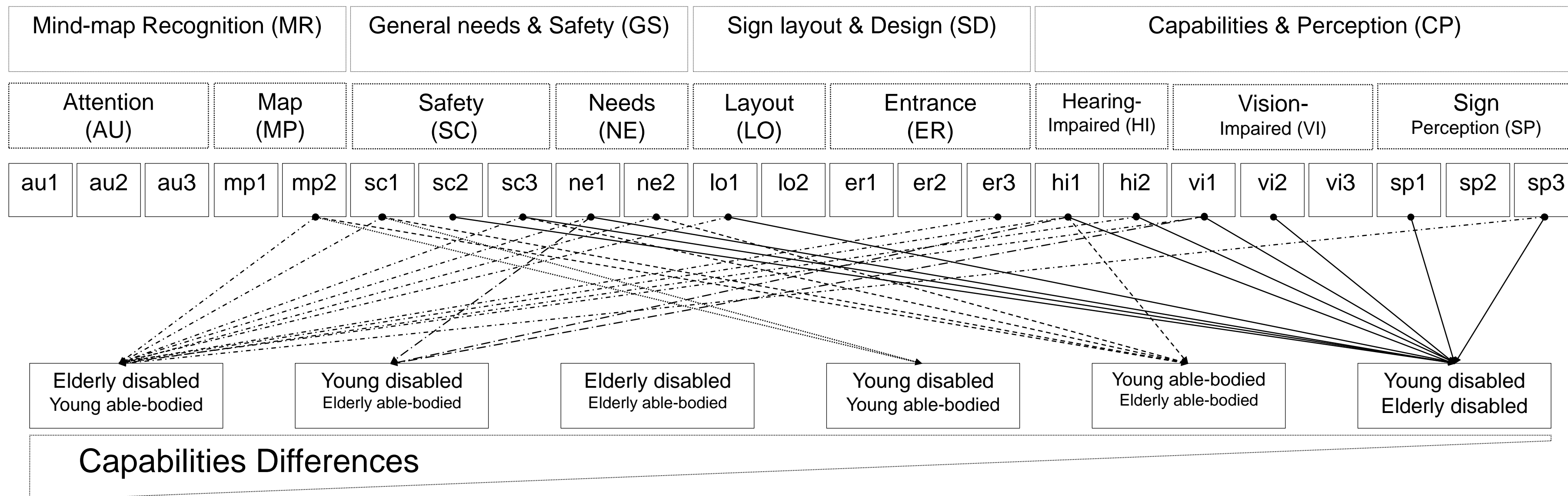
Looking back over the last decade, looking forward to the next



Case Study in Taiwan Urban Park



Relationships among different capabilities users & signage settings at park



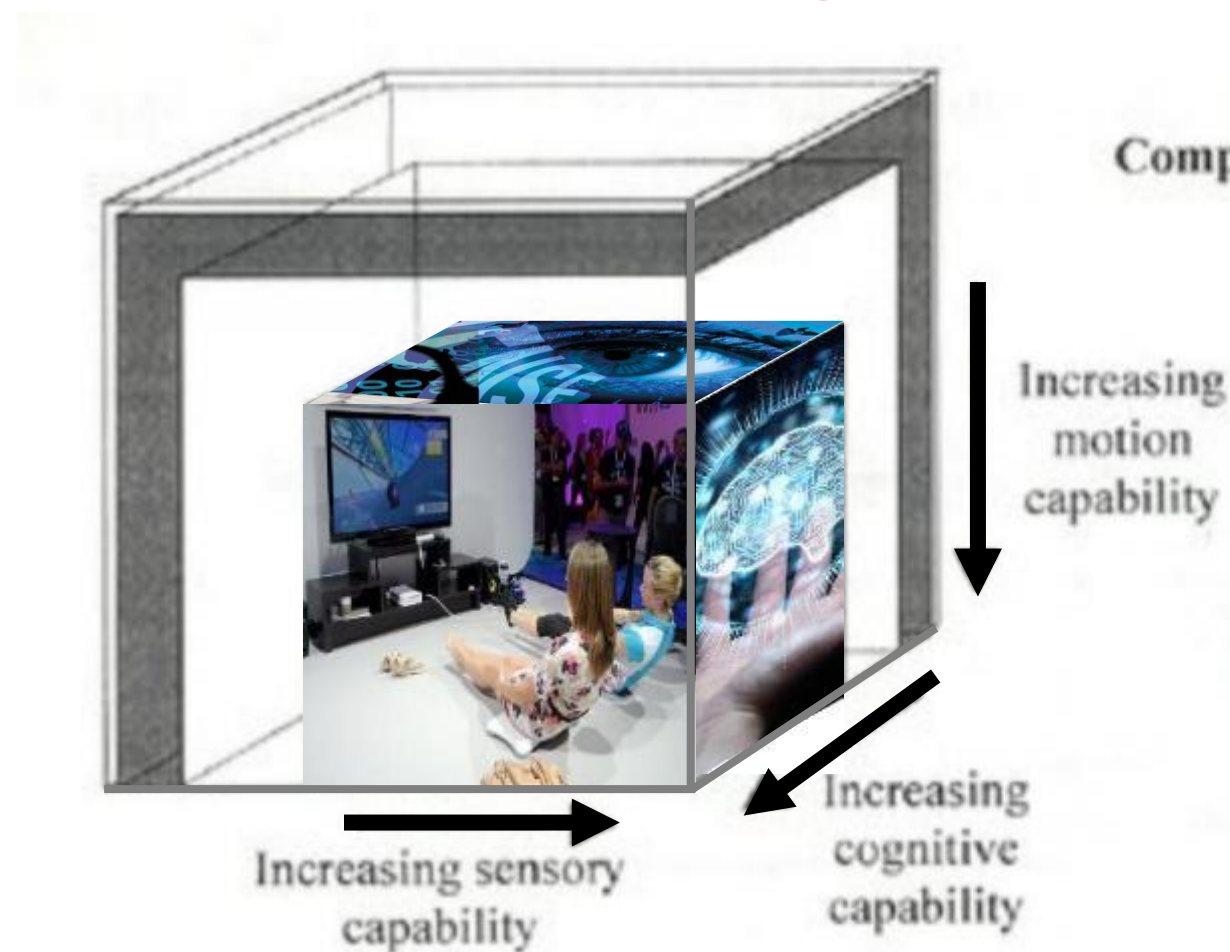
- The needs to enables compromise in design to allow for **shared use of facilities** and **flexible constraints** to suit the **maximum range of clients**.
- It is advised that future researchers employ different **assistive devices** for the disabled with differing ages and capabilities, and to **develop physical-psychological models**.

Inclusive Design Cube and Cares by Whom

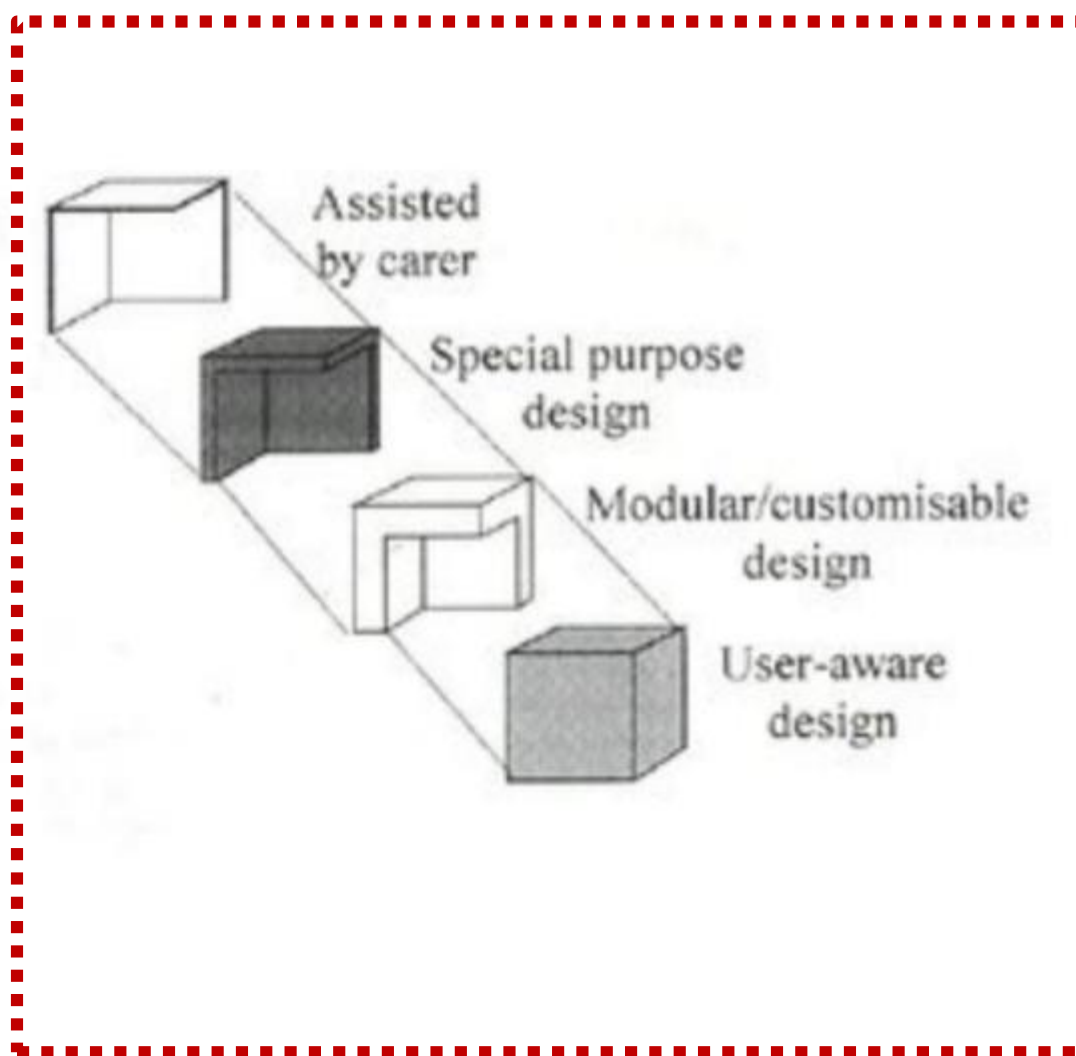
Motion



NEEDs



Comprises:



Perception



Cognition



CAREs

Inclusive Design reflected in Environments

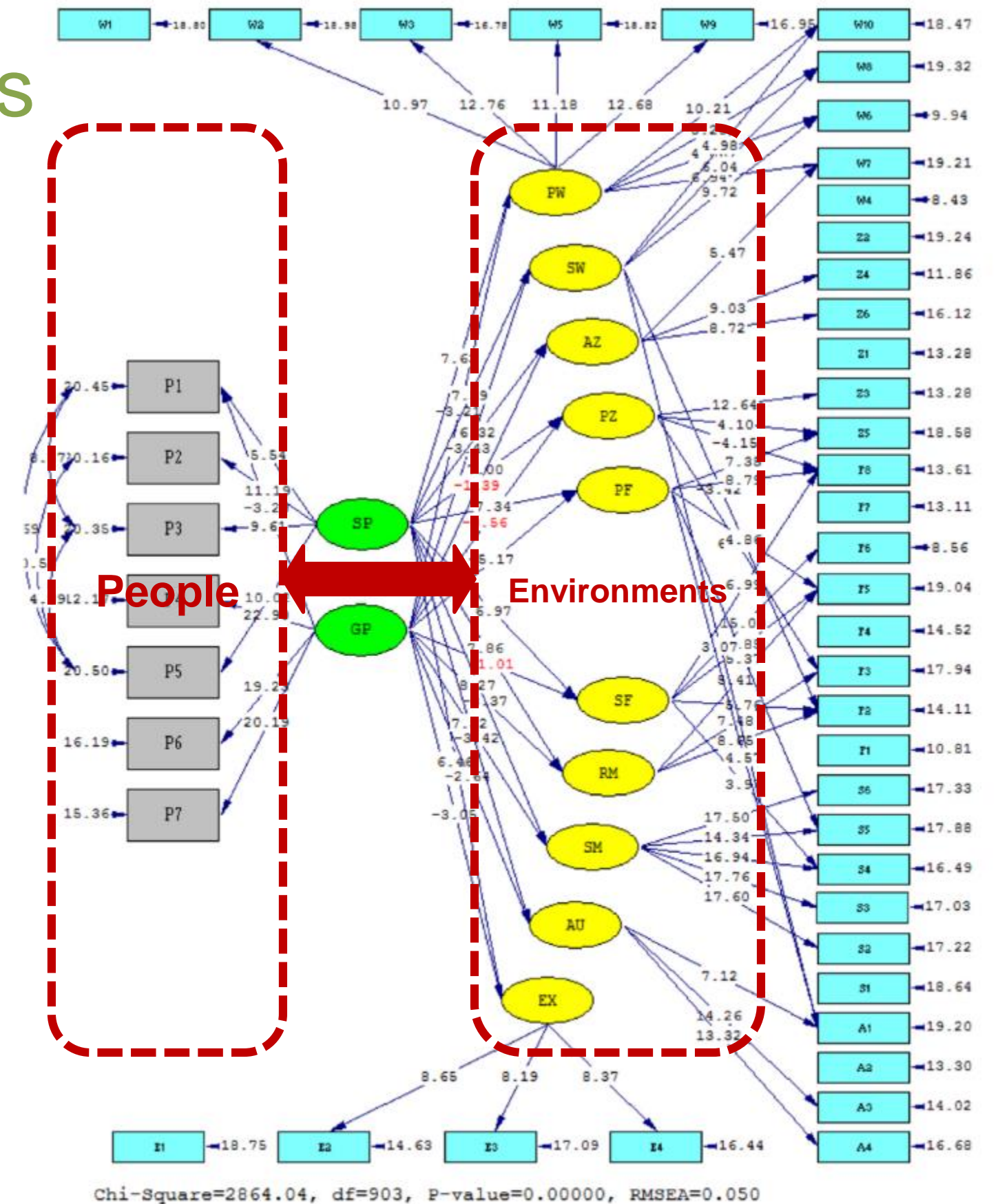
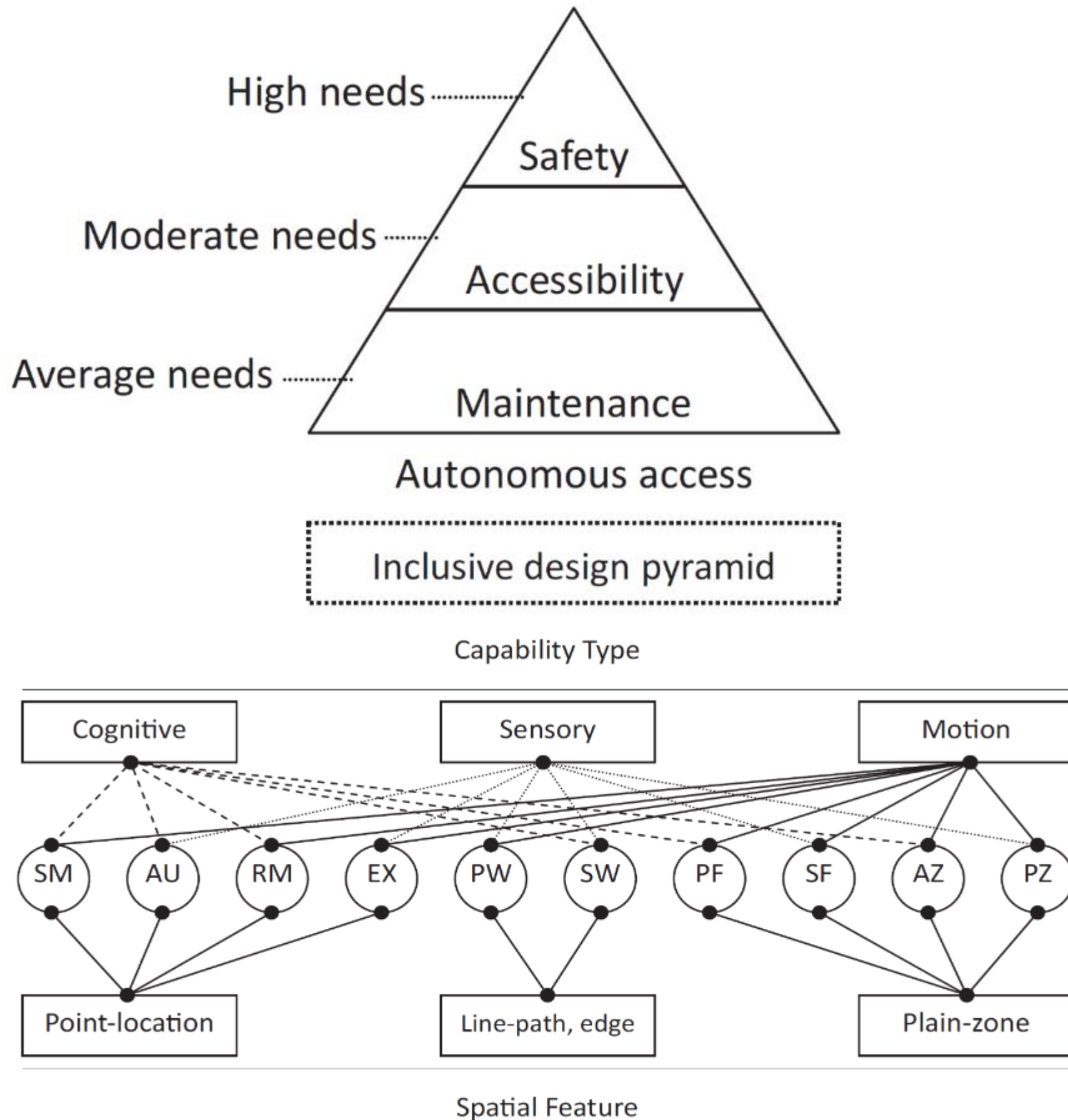
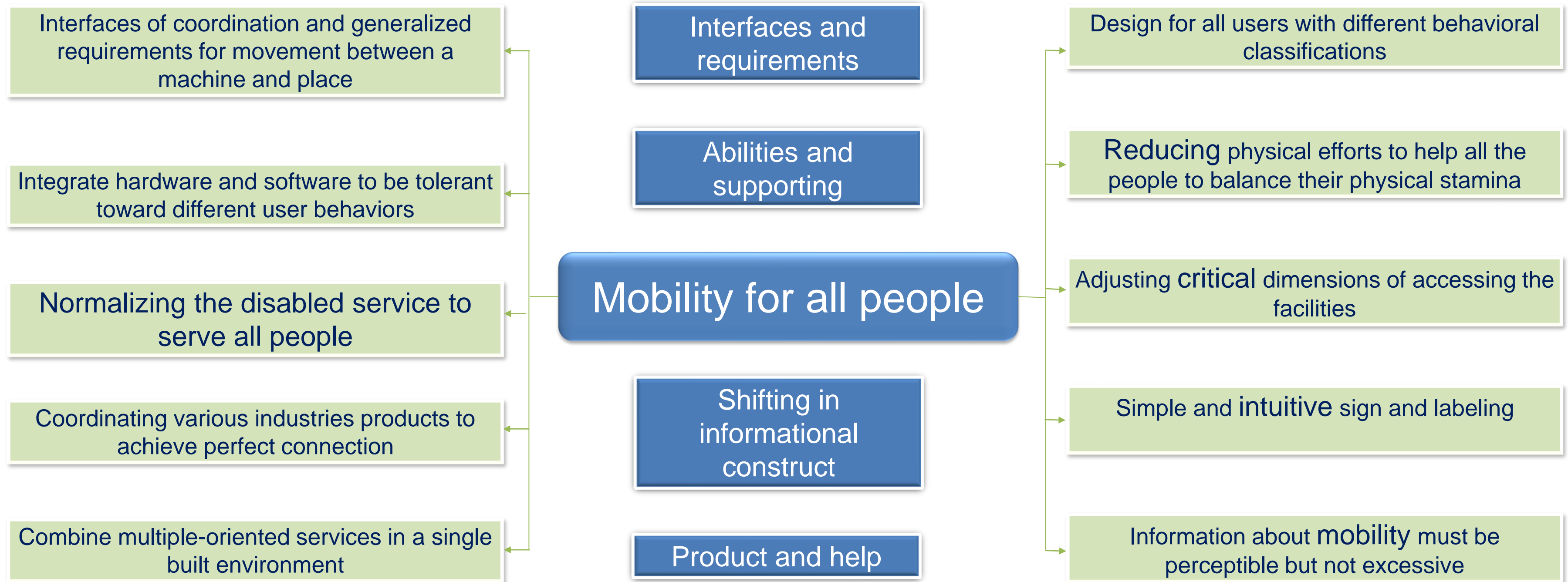


Fig. 2. Path of user inclusive needs in park facilities. Notes: SP= People with special needs; GP = General public; PW= Passageways; SW= Safety precautions; AZ = Active zones; PZ= Passive zones; PF= Primary service facilities; SF = Secondary service facilities; RM = Restrooms; SM = Signs and maps; AU = Auto-sensing facilities; EX = Entrance and exit; P1= The elderly; P2 = Pregnant women; P3= Children; P4 = Adolescents; P5= The disabled; P6= Foreigners; P7= Normal people; E1 = Accessible entrance; E2 = Identification of vehicular access; E3 = Road blocker/bollard; E4 = Entrance visibility; W1 = The width of pathway; W2= Paving materials; W3 = Even pathways; W4= Curbs; W5= Seating areas along pathways; W6= Railings and fences; W7 = Bicycle lanes; W8 = Gutter covers; W9= Outdoor stairs/steps: types and materials; W10 = Handrails; type and size; Z1 = Flower beds/hedges; Z2 = Adventure playgrounds and sports field equipment; Z3 = Outdoor assembly areas; Z4 = Outdoor dining areas; Z5 = Shady rest areas; Z6 = Parking areas; F1 = Washbasins; F2 = Toilets; F3 = Doors; F4 = Drinking fountains; F5 = Litter bins; F6=Phone booths; F7 = lights for pathways; F8=Rescue buttons; S1 = Maps/guides; S2= Recognition of sign/image; S3= Readability of letters on sign; S4= Contrast between font color and background on signage; S5 = Location of signpost; S6= Size of signpost; A1 = Lamps with automatic sensors; A2 = Intelligent navigation devices; A3 = Automatic sliding doors; A4 = Automatic sensor taps.

Mobility requirements for all people





MusicTongue 舌肌律動 : Tongue - Training Game

Tongue-training Arcade App for middle-aged and elder people

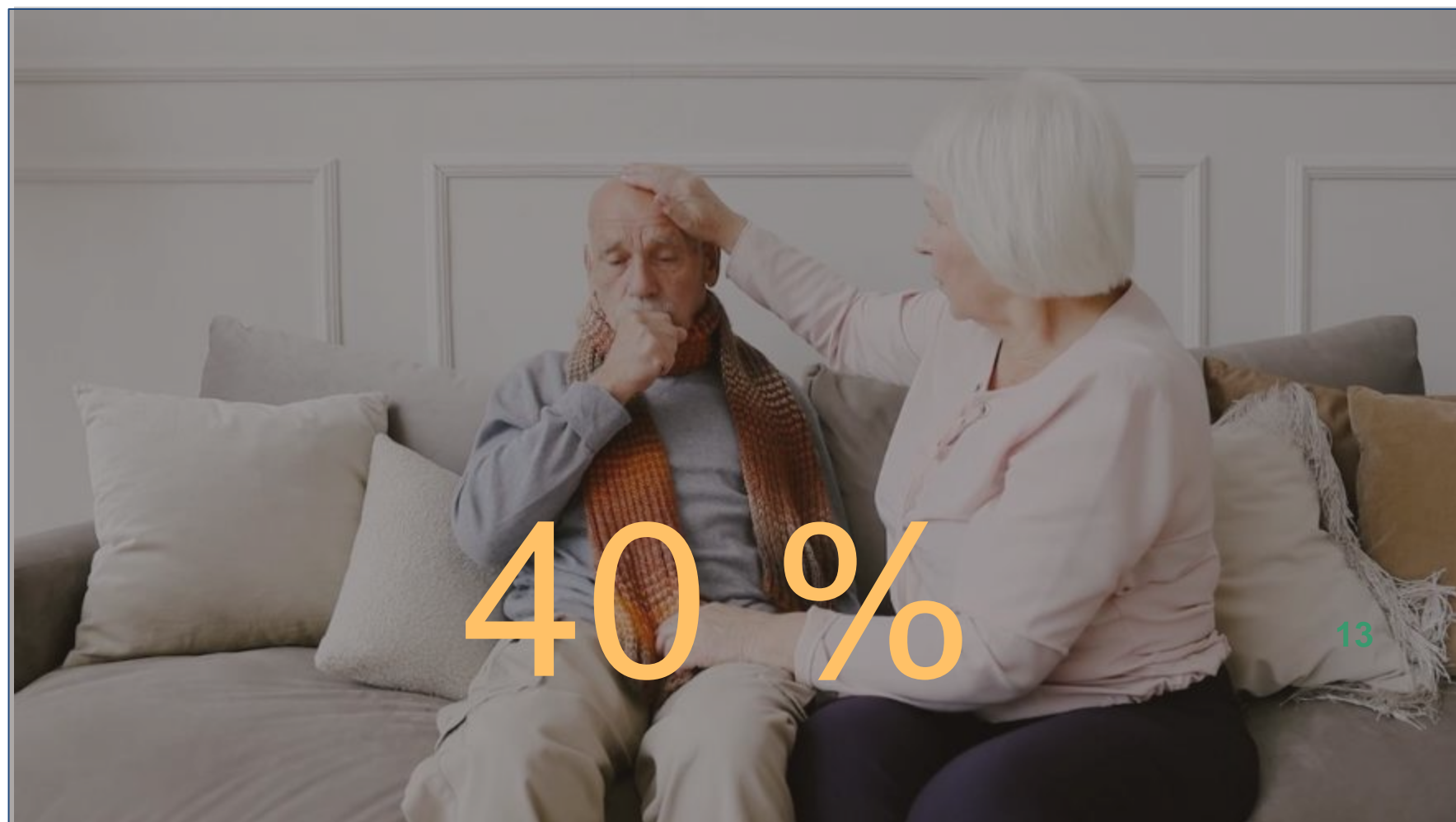
Team Member : CHIA-HSU HUANG 、 KUAN-CHU SU 、 CHENG-CHUN PENG 、 TSAI-XIAN SHAO

Advisor : **Prof. KO-CHIU WU** 、 Prof. KUEI-RU CHOU

Technical Specialist : CHUN-JUNG LAI (Ninth Games Studio) 、 SHU-HUA KAO 、 KOKI IBUKUROL



Problelem : Dysphagia Population



Average in 60+ Elder

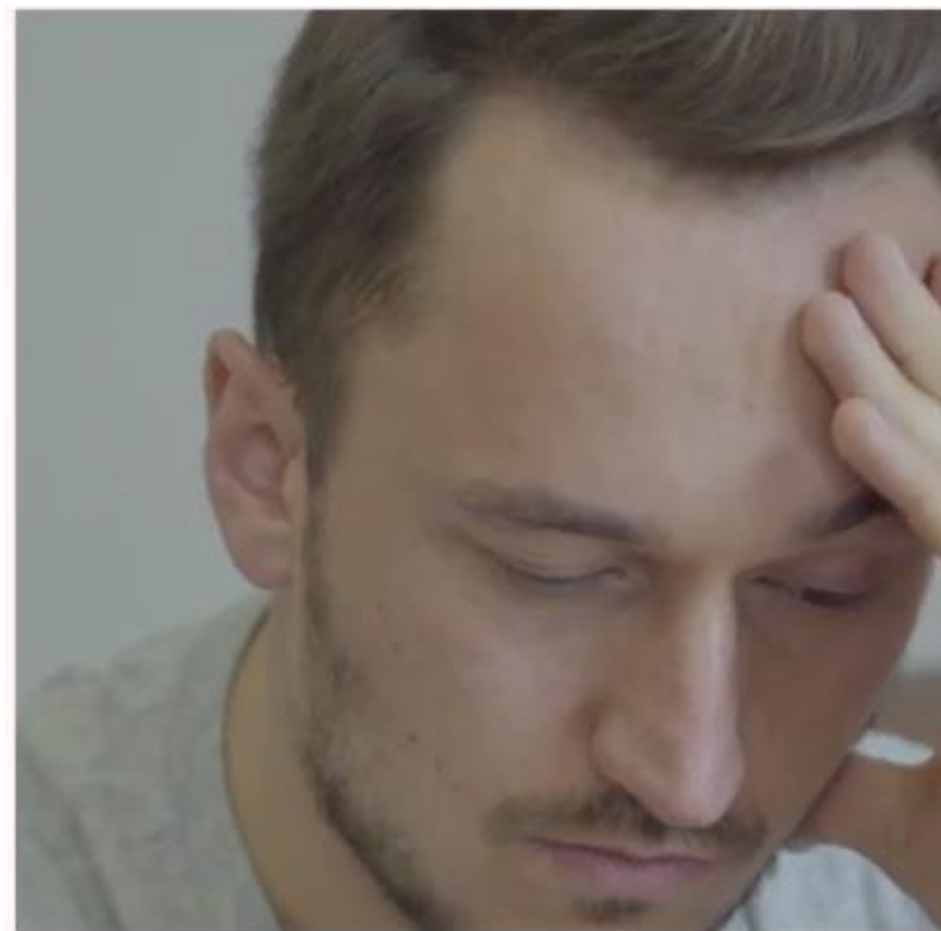


Nursing home Resident

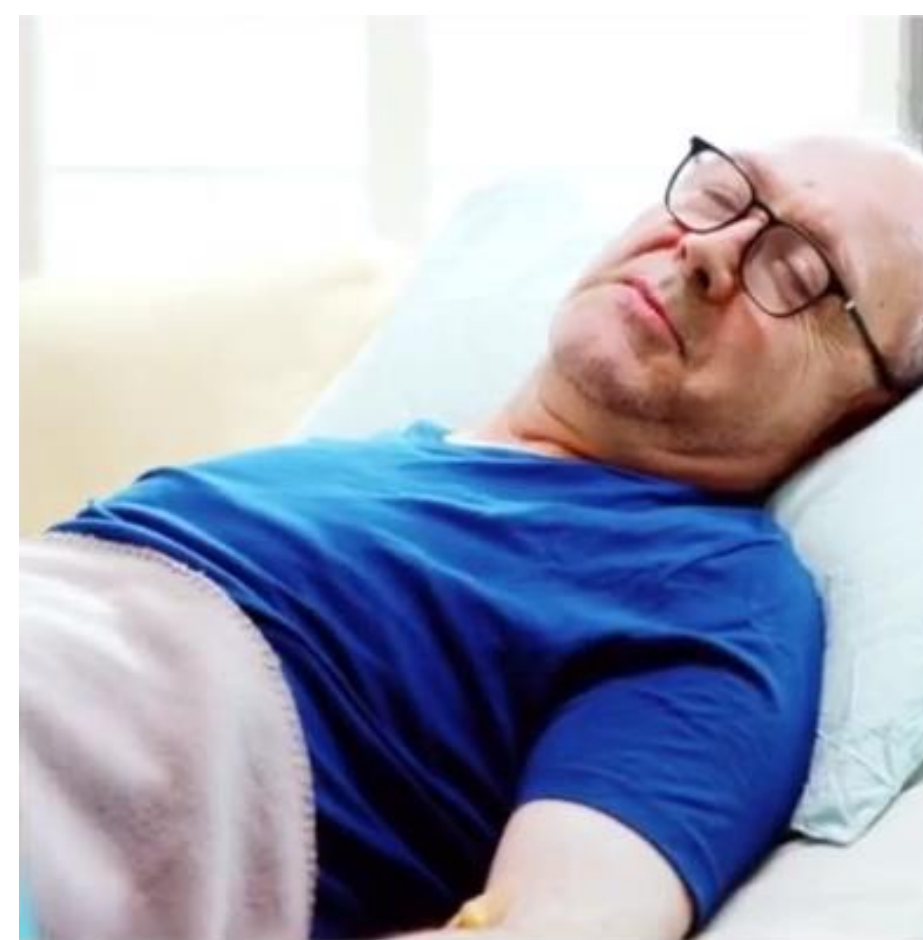
Swallowing Difficulty/Dysphagia May Result...



Choking and Coughing



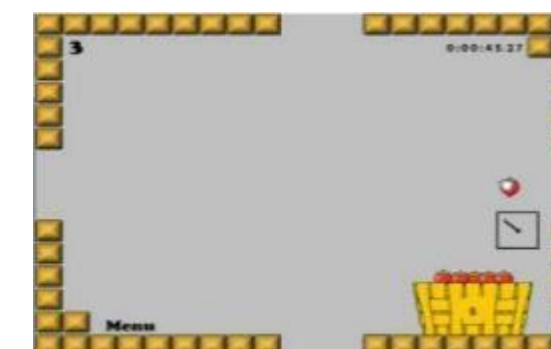
Difficulty in Communication



Aspiration Pneumonia

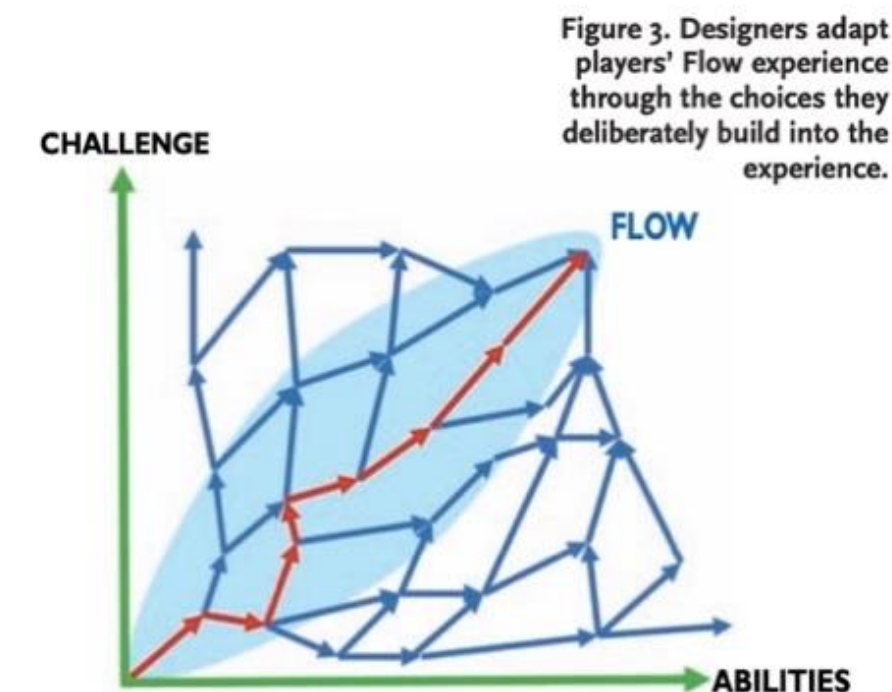
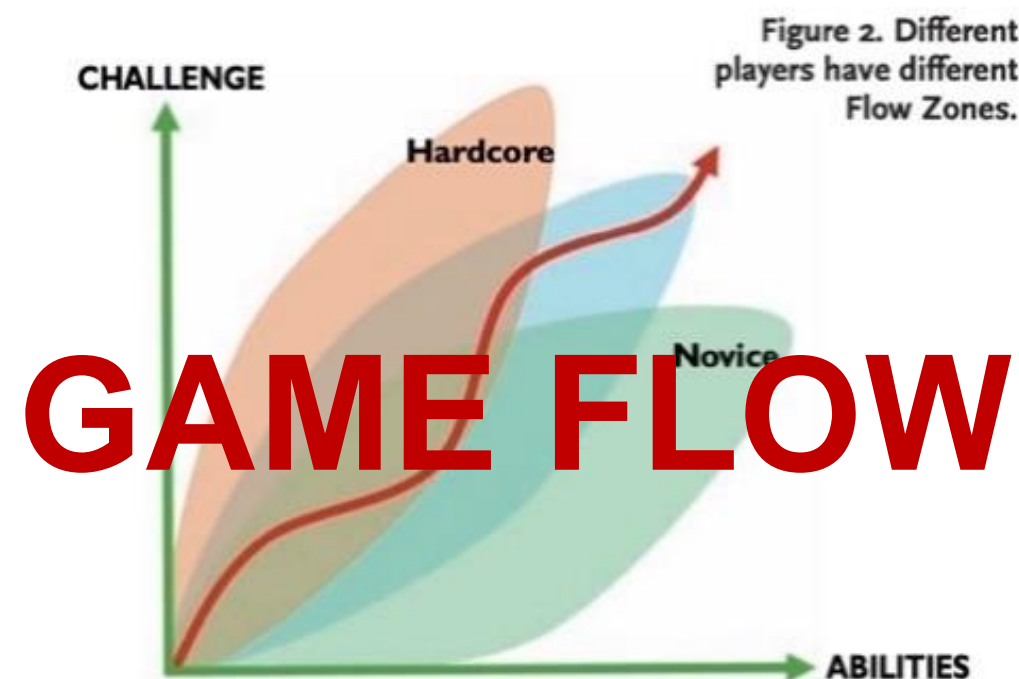
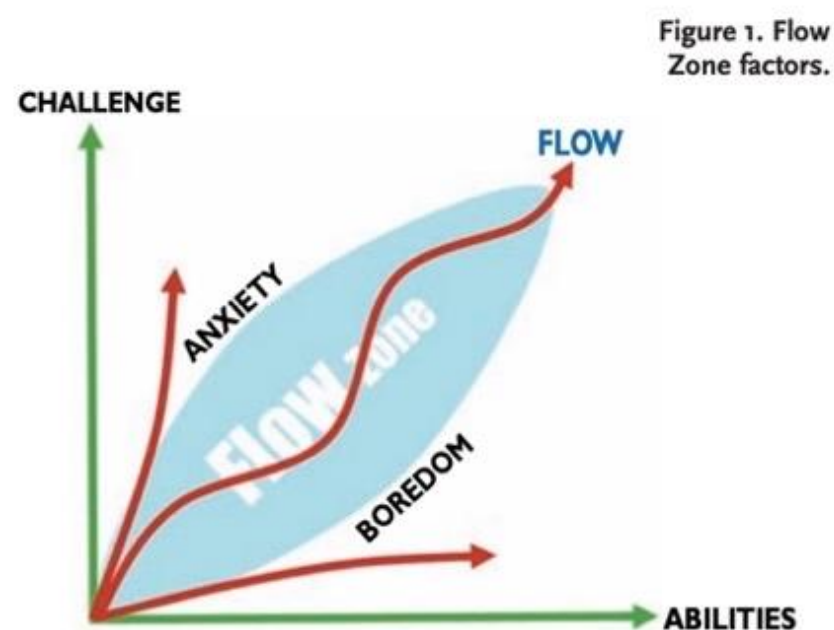
Related Works : Tongue- Training Game

| | Non-Contact | | | Contact | |
|-------------|--|--|--|--|--|
| | SITA | Tongue Drive System (TDS). | Squachu | Tongue-strengthening training Tablet Game | Intra-oral Joystick |
| Tech | Kinect +PC | WebCam + PC | WebCam + PC | IOPI (The Iowa Oral Performance Instrument) + Tablet | Intra-oral joystick + PC |
| Pros | Non-Contact Design | Non-Contact Design | Non-Contact Design | Support Intra-oral Posture High Accuracy High Portability | Support Intra-oral Posture |
| Cons | Design for Kids ,Not For Elder Less user friendly to elder Low Portability | Less user friendly to elder Low Portability | Less user friendly to elder Low Portability | Tool is Intra-oral Highest cost Needs to be accompanied by professional staff to operate | Tool is Intra-oral Less user friendly to elder Low Portability |
| Year | 2012 | 2014 | 2018 | 2020 | 2019 |



Older people play physical training games, it is easy to get tired, how to improve their interest?

- **Personalized experience:** Consider the interests and needs of each senior and adjust the content to their liking. A personalized experience is more engaging because it takes into account their uniqueness.
- **Set the challenge:** Challenges of varying difficulty are provided in the game, allowing older people to gradually increase the difficulty to maintain motivation. This can give them a sense of accomplishment and spark their interest.
- **Social Interaction:** Creating games allows older people the opportunity to interact with others, whether through multiplayer or online social features. Social interaction can increase the fun of the game and build connections.
- **Goal setting:** Help seniors set clear goals and track their progress. This can make them feel oriented and motivate them to stay engaged.
- **Diverse game content:** Various different types of games are available to avoid monotony. It can include different activities such as puzzle solving, movement, music, etc., so that the elderly have more choices.
- **Awards and Recognition:** Offer rewards or recognition, such as badges, virtual awards, or compliments, when specific milestones or achievements are achieved. This can motivate engagement and boost interest.
- **Integration into everyday life:** Consider integrating physical training games into the daily lives of older people, such as during daily exercise or leisure time. This makes the game more sustainable.
- **Educational elements:** Design games to be educational, such as providing health information or content related to life skills. This can stimulate interest in learning.
- **Regular Updates:** New game content, challenges or events are regularly introduced to keep the game fresh and engaging.
- **Listening and feedback:** Regularly ask for their opinions and feedback from older people and make improvements based on their suggestions. This allows them to feel engaged and involved in the development of the game.



Design Goals

Users



Primary : 45y ~ 75 people
Secondary : Their Family Members

Environment



Nursing home Resident 、
Aging at Home Elder

Appeal



Low-Cost
UX Friendly to Elder
Work with Existing Device

Demand Analysis:

Clearly understand the needs and goals of older adults. Interviews, questionnaires, and expert consultations may help identify areas they wish to improve, such as speech clarity, chewing ability, etc.

Game Concept :

Develop a fun and challenging game concept that enables the elderly to train their tongue muscles in entertainment. This can be something like blowing bubbles, catching food, or pronunciation.

Game Design:

Designed with a game interface that is simple, intuitive and easy to understand with the needs of older people in mind. Use large fonts and bright colors to ensure readability and visibility.

Motion Sensing Technology:

Integrate appropriate sensing technologies, such as touch screens, voice recognition, or motion sensors, to enable older adults to perform movement training of tongue muscles.

Training Mode :

Training modes of varying difficulty are available to accommodate different levels of ability and progress. Gradually increase the challenge to encourage older people to stay engaged.

Educational elements:

Include relevant health information in the game to raise awareness of oral health and muscle movement among older adults.

Privacy Protection:

Strictly comply with privacy laws and regulations and protect the personal information of the elderly.



Accessibility :

Consider adding accessibility features such as voice prompts, demonstration movies, or real-time feedback to help seniors play and train.

Testing and feedback:

It is repeatedly tested and evaluated during the development process and adjusted based on feedback from older people. Make sure game is effective & engaging to the target group.

Safety considerations:

Ensure that the game design does not pose a risk to the health of the elderly. Possible physical maladaptive symptoms, such as difficulty swallowing food, are taken into account in the design.

Cultural sensitivity:

Ensure that game content and design respect older people from different cultures and backgrounds and avoid elements that may cause discomfort or misunderstanding.

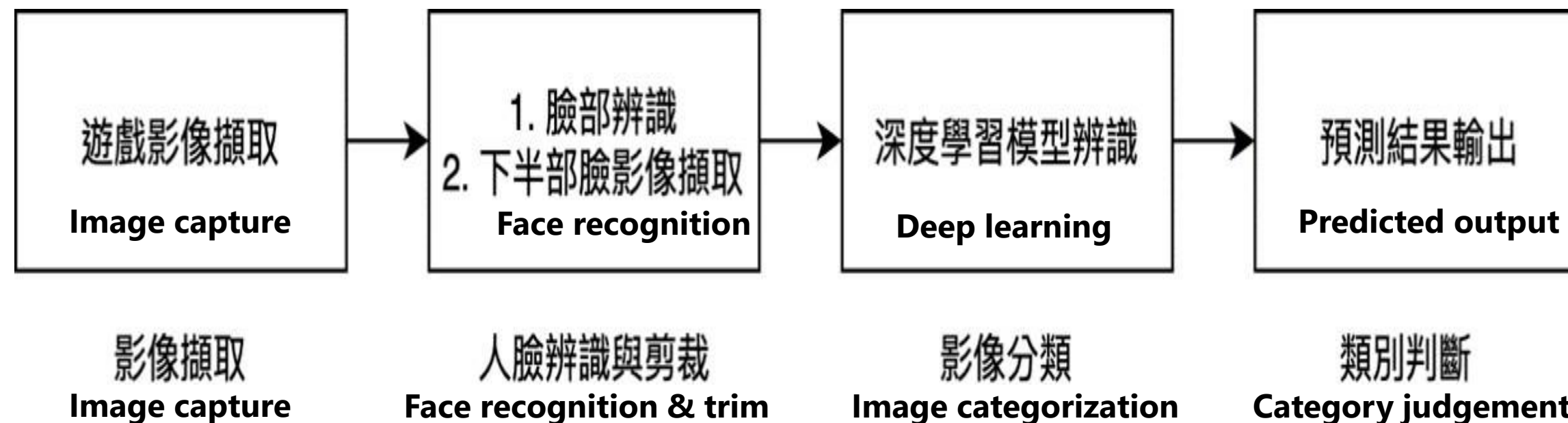
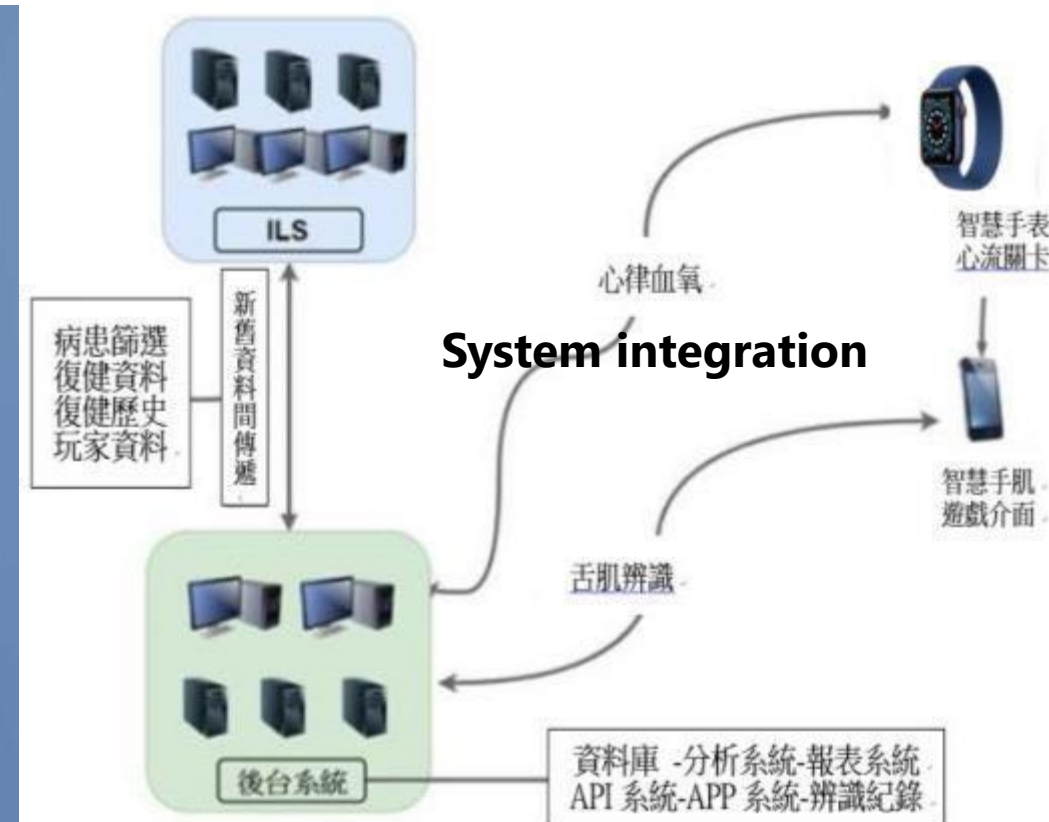
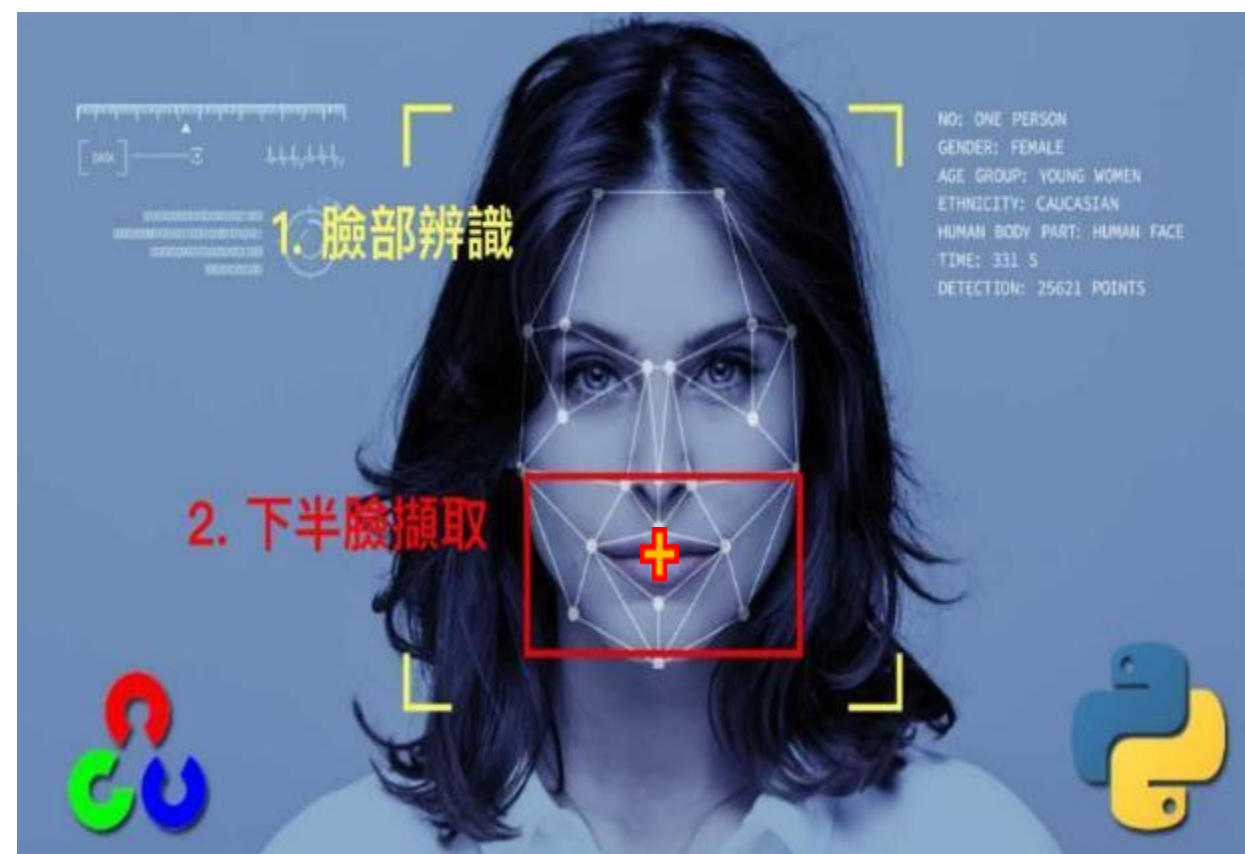
Easy to use and maintain:

Make sure the game is easy to install, upgrade, and maintain, and provide the necessary support and guidance.

User Feedback

Developing such a game requires a deep understanding of the target audience and incorporating their needs and characteristics into the design and development process. At the same time, users are constantly listening to feedback to continuously improve the game and ensure that it provides tangible benefits to the elderly.

Face recognition



01 | Expert Interview

| No | Professionals |
|----|-----------------------------------|
| E1 | Paramedic |
| E2 | Paramedics/academics |
| E3 | Speech therapist |
| E4 | Medical assistive device designer |
| E5 | Image Recognition Engineer |

*1 : E1~E3 have more than 10 years of medical professional experience, E4 have more than 5 years of medical design research experience, and E5 have more than 2 years of hands-on experience in image recognition.

Training takes time to work and patients tend to feel frustrated

Expert E3 indicated that the current training is led by a nurse practitioner on the ward, and caregiver E2 indicated that it takes about 8 weeks to feel significant improvement and that patients are easily frustrated by the loss of control over their bodies during the training.

Lack of supervision makes it easy to give up training

Experts E3 believe that if patients are discharged from the hospital without physician supervision and without family supervision, it is easy for patients to give up exercise and stop rehabilitation after leaving the hospital or after treatment, resulting in a lack of continuous improvement.



Existing training relies primarily on post-admission manual instruction



Nurse Practitioner E2 indicated that the current training method is a one-to-many oral rehabilitation exercises taught to patients by a nurse practitioner on the floor of the room. Speech therapist E3 indicated that patients usually learn after being admitted to the hospital for more serious illnesses such as stroke and brain injury.


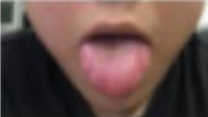
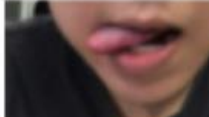


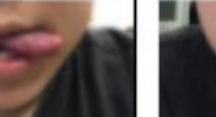
Explore Game Themes From elder life experiences

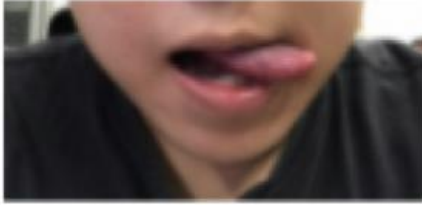
E4, an expert in medical and assistive device design, believes that the theme and style of the game can be based on the life experience or interests of the elderly, which can easily form a resonance.


02 | Training Protocol

| | | |
|----|---|--|
| A1 | B1 Turn Down | B2 , Retract tongue |
| |  |  |

| | | |
|----|---|--|
| A4 | B6 Use of the tongue to top the upper incisors , Hold on for ten seconds | B2 , Retract tongue |
| |  |  |

| | | | | | | |
|----|---|---|--|---|---|---|
| A3 | B4 open mouth | Turn the tongue clockwise | | | | B2 , Retract tongue |
| |  |  |  |  |  |  |

| | |
|------|---|
| A2-1 | B3-1 Turn Right |
| |  |

| | |
|------|--|
| A2-2 | B3-2 Turn Left |
| |  |



進食、吞嚥困難照護及指導方案 指引手冊

教練：胡月娟
 種子教師：
 郭炯村 江青桂 陳瑋
 陳蕙玲 林武佐 張琪
 何玉雲 陳玉葉 劉晚菁
 呂哲維 陳秋珍 林至德



Training Protocol Based On 《Dysphagia Care Manual》 Published By Taiwan Ministry of Health and Welfare (2018)

03 | User Interview 45y ~ 75 y



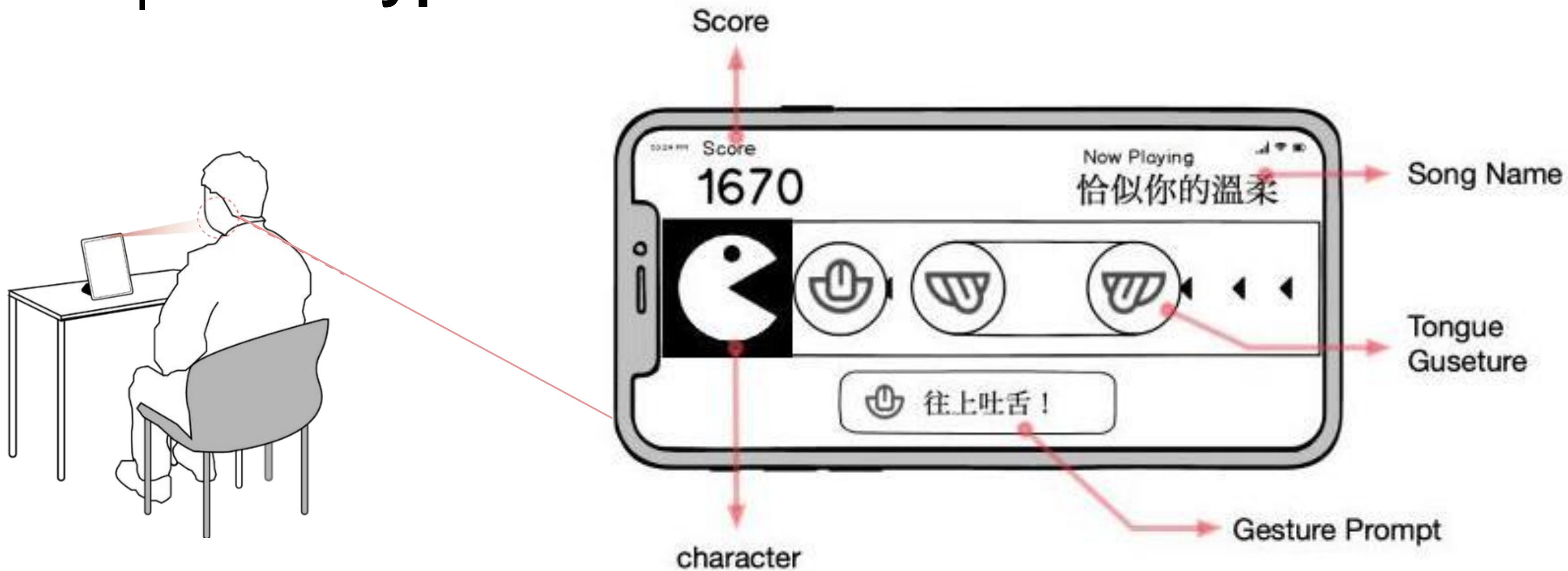
1. Music appreciation is the most common interest

Using interest questionnaires and interviews to understand the leisure interests of middle-aged to older adults, it was found that music and video appreciation and hiking were the most common interests, especially music appreciation, which is a habit of listening to music or singing regardless of whether or not the patient has had swallowing difficulties.

2. Feedback and exercise tracking encourage users to continue training

About half of the respondents used the smart bracelet watch to track their steps and activities. They said that their daily progress encouraged them to set harder and longer-term exercise goals. Respondent T1, who had swallowing difficulties, said that in the past, he preferred reading the newspaper aloud to training exercises because the process of reading the newspaper "was better, but doing training exercises quietly did not know whether he had gotten better".

04 | Prototype 01 : Wireframe



| | | | | | |
|--------|------|--------|------|------|--------|
| Gender | male | female | male | male | Female |
| Age | 64 | 62 | 55 | 61 | 55 |

Scale of Tongue Monitor

Small

Big



Preference ranking | P1>P2>P3>P4

The P1 prototype was found to be the most positively rated, with an average preference order of P1>P2>P3>P4. All six respondents, with the exception of respondent aT3, were almost unanimous in their negative attitude toward the P4 interface, which has the largest proportion of tongue pane, and the larger the proportion of face image pane, the less users liked it.

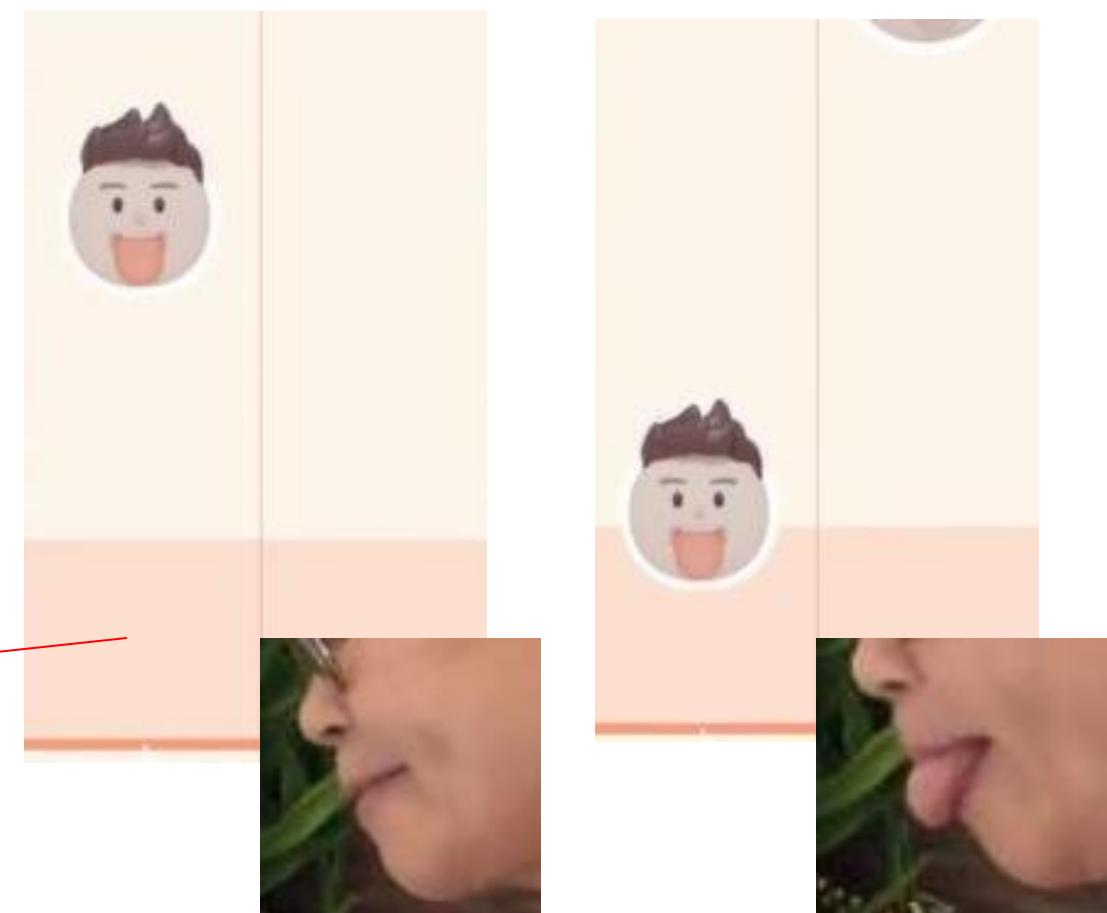
Respondents expect to use a colorful, fun and easy-to-use interface

Regarding the style of the interface, aT4 expressed her wish to express it with cartoon characters: aT2 said she liked the colorful style, and liked the colorful and bright colors of P1, P2, and the middle background. aT1, a respondent, was confused about the direction of the screen: "Just logging in, the screen was straight, and now it's horizontal, so I'm not used to it."

05 | Prototype V2



Sense Area





SUS score 68

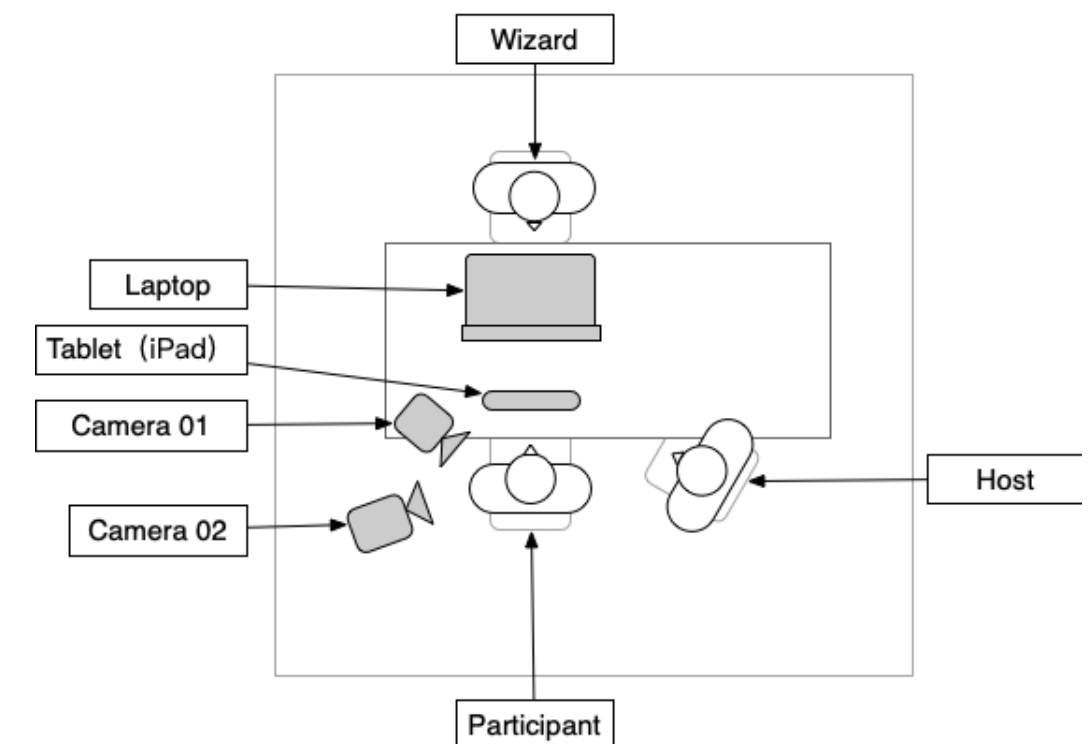
SUS scored 68 on ease of use, with most participants being able to operate the game correctly and having fun with the music-themed gameplay. t2, t3, and t4 indicated that they liked the concept of using music for training.

Reminds the test subjects of nostalgic games

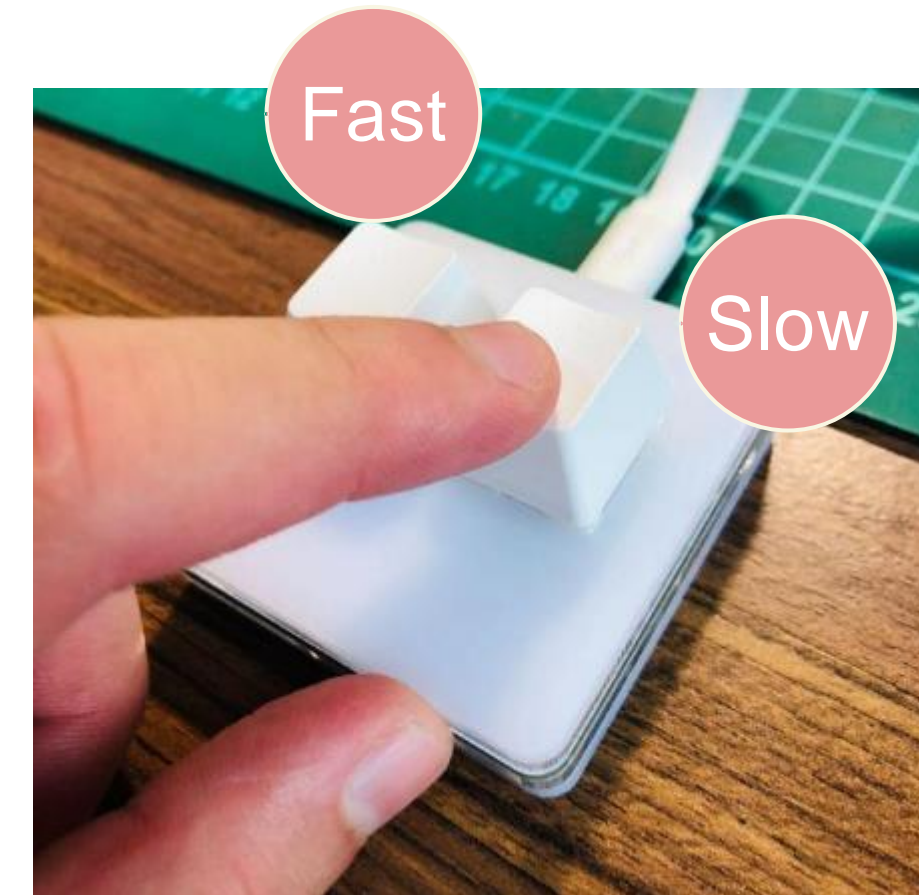
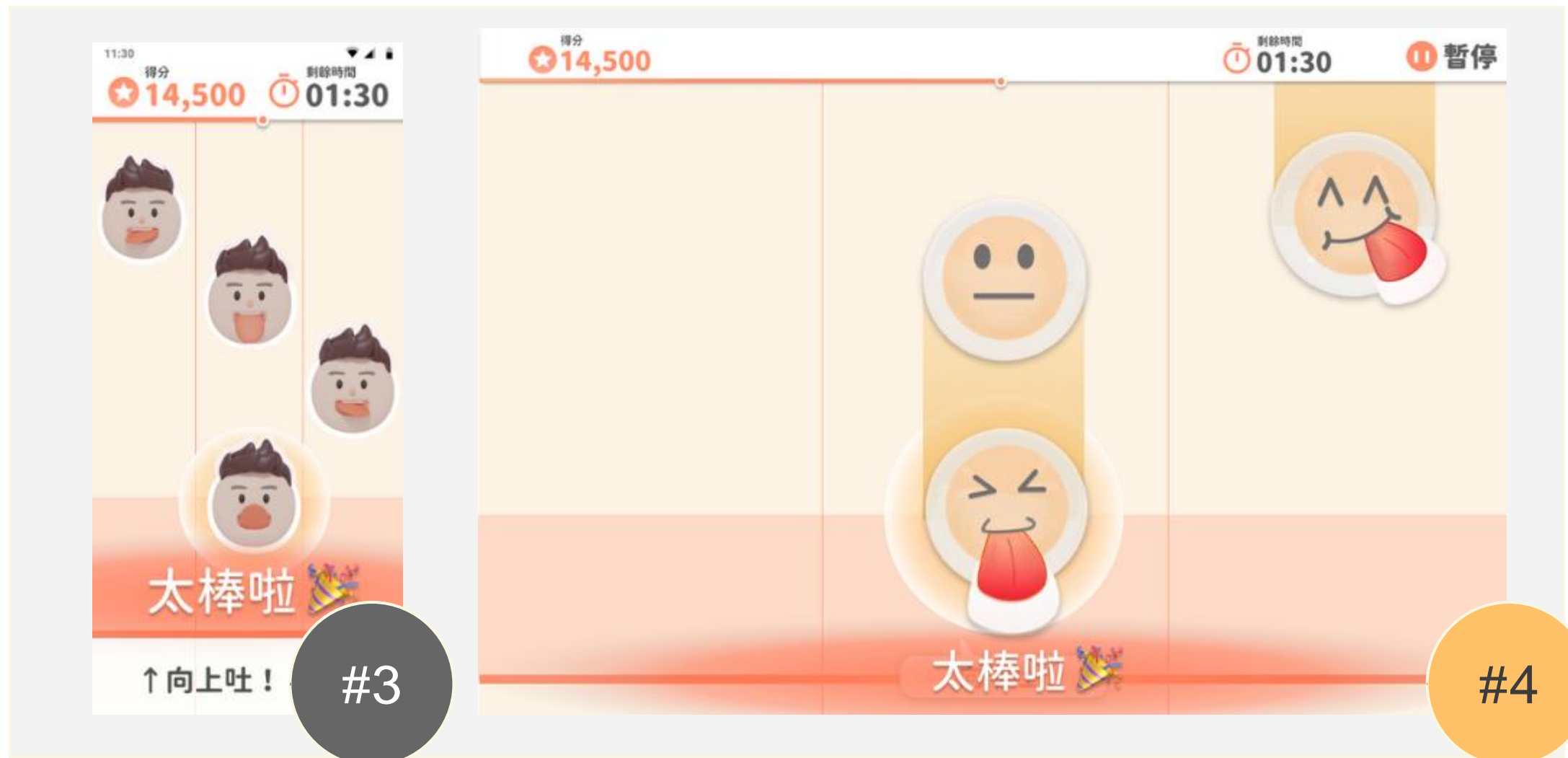
Three participants mentioned that the game reminded them of games they had played when they were young. For example, "... It's like I used to play that dancing machine, dancing mat, right" (T3)

Game speed is too fast

T1 and T3 participants with relatively low SUS scores said that the game prototype was too fast, for example, "I think that this is very fast, running... I think that the head is still too small, so I might end up reading your words below..." (T5)



06 | Prototype 3 | Implementing techniques



Redesigned icons

Icons were changed from cartoon-like, three-dimensional style to 2D illustration style, and the color contrast and vividness were improved, and the proportion of oral icons was increased.

Software Implementation

The game has been able to detect the subject's oral training movements, including A1 down, A2-1 left, A2-2 right, A3 open wide, A4 up

Speed Control

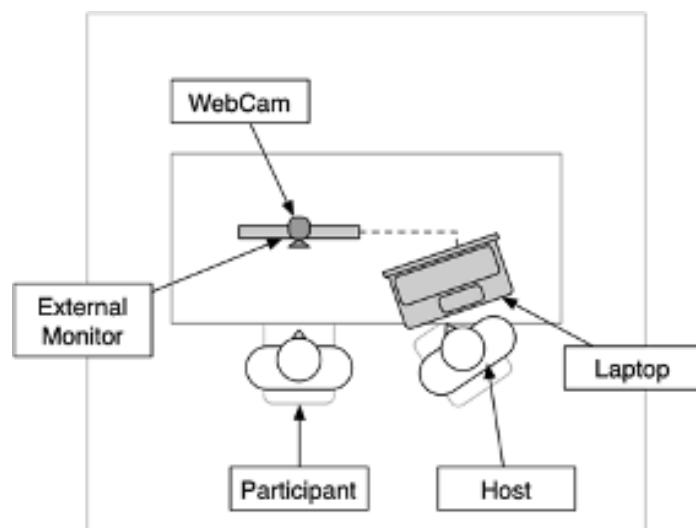
Players can use the button to adjust the speed by themselves.

Prototype 3 Test and Heart Flow Experiment Planning

| Mode | M1 Bored | M2 Balance | M3 Anxiety |
|---------------|--|------------|------------|
| Start Speed | 50 | 250 | 550 |
| Speed Control | No | Yes | No |
| Action Type | A1(down) 、 A2(left) 、 A3-1(right) 、 A3-2(open wide) 、 A4(up) | | |
| Drop Rate | 49% | | |

After each test, players were required to fill out the heart flow and cognitive load questionnaires (FSS-2, Flow Dis-tance, NASA-TLX), complete the ease of use questionnaires (SUS, UEQ-S, NPS) and undergo a semi-structured interview after playing all levels of difficulty, and at the end of which they were guided to remove the rhythm chest strap device.

Prototype 3 test | N=36 | Age 45y ~ 75y



| Usability Scale | | | | |
|-----------------|-----|-------------|-----------------|-------------------|
| Score | SUS | | UEQ-S | |
| | | | Hedonic quality | Pragmatic quality |
| | | | | Average Score |
| v2.0 | 69 | | | |
| v3.0 | 79 | 1.763888889 | 2.0625 | 1.91 |

| Flow and Cognitive load | | | | |
|-------------------------|----------|------------------------|-----|----------|
| Average | FSS-2 | Flow Distance | NPS | NASA-TLX |
| | 40.34/45 | 0.19 Balance - Easy | 19 | 548.817 |

Player Performance

Game Difficulty and Player Performance Statistics

| Difficulty | | Performance | | |
|------------|----------------|---------------|----------|-------------|
| Mode | Starting speed | Speed Control | Accuracy | Final Speed |
| M1 | 50 | No | 72.52% | NA |
| M2 | 250 | Yes | 58.41% | 198.64* |
| M3 | 550 | No | 38.15% | NA |

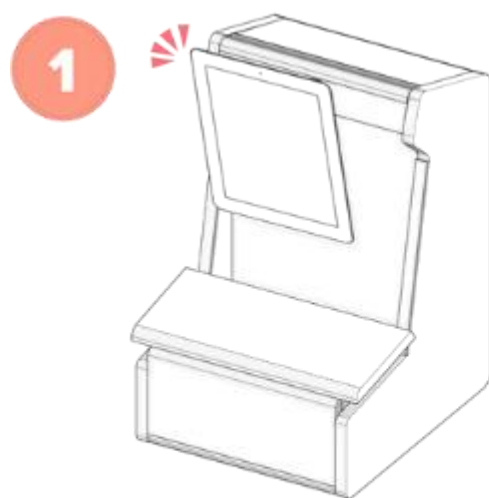
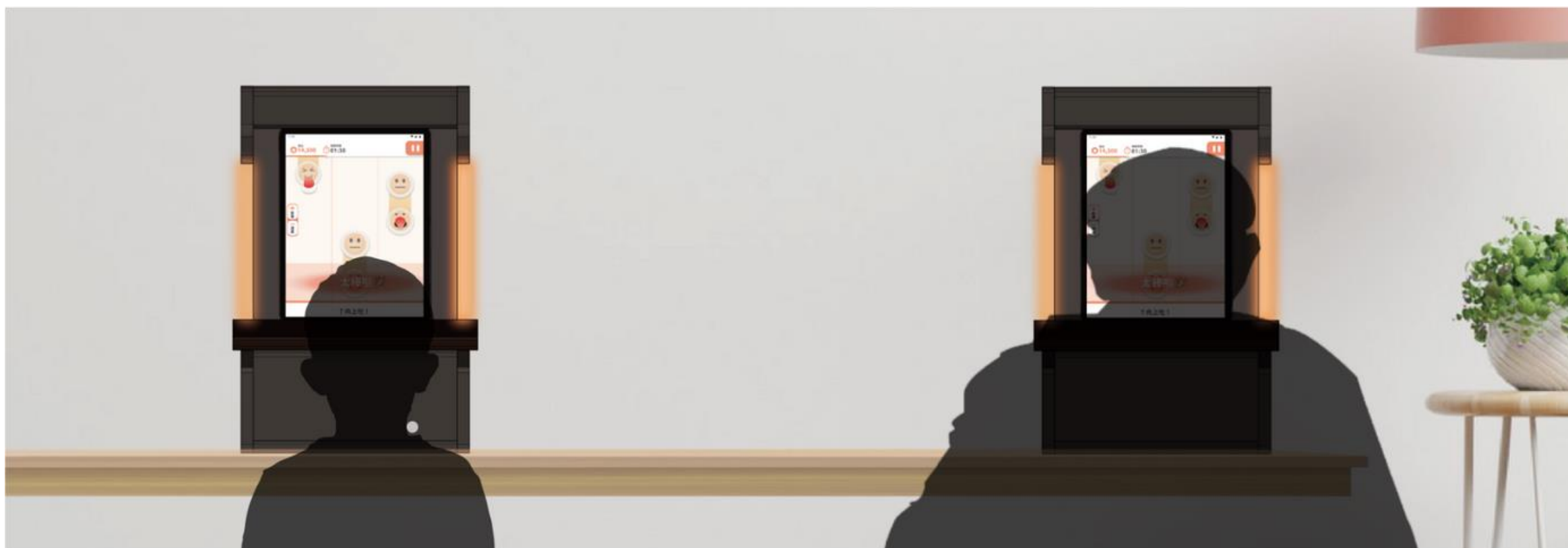
Results of the third prototype test and Flow experiment

| | Challenge | Skill | Flow distance | Anxiety (FD>0) | Flow/ Balance (FD = 0) | Boredom (FD < 0) |
|----|-----------|-------|---------------|------------------|--------------------------|--------------------|
| M1 | 4.4 | 3.06 | 0.3325 | 3.3% | 36.6% | 60% |
| M2 | 4.2 | 3.23 | 0.25 | 5.5% | 41.6% | 47.2% |
| M3 | 4.03 | 3.96 | 0.0165 | 30% | 30% | 36.6% |

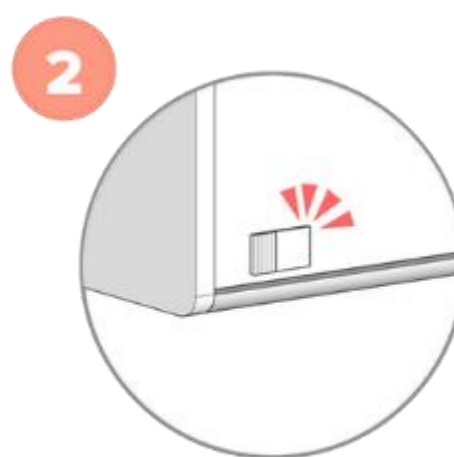
Physiological signals and cardiac-flow co-relationships in the M1 ~ M3 states

| FSS-2 Scale | | | |
|-------------------|-------|-------|-------|
| Bio-Signal | M1 | M2 | M3 |
| HR | -.134 | -.354 | -.054 |
| rMSSD | .273 | .054 | .306 |
| HRV Total Power | .262 | .147 | .028 |
| HF-HRV | .218 | .118 | .619 |
| LF-HRV | .281 | .137 | .656 |
| LF/HF | -.039 | .085 | 0.918 |
| Position Accuracy | 0.330 | 0.344 | 0.312 |

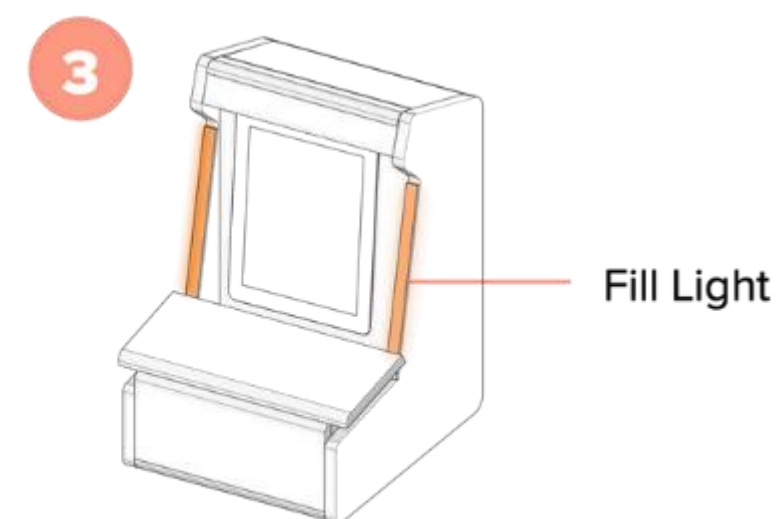
07 | Prototype V4 | Tongue-Training Arcade



Install The Tablet

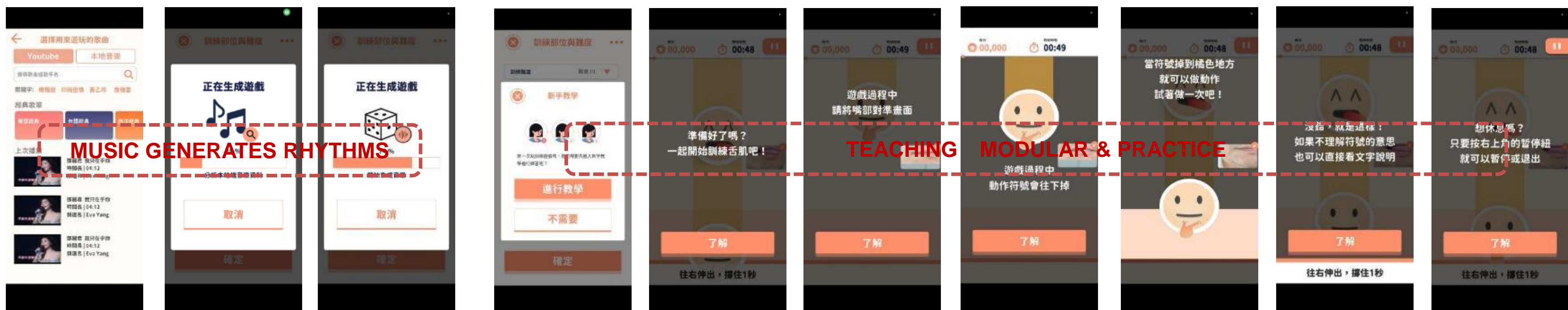
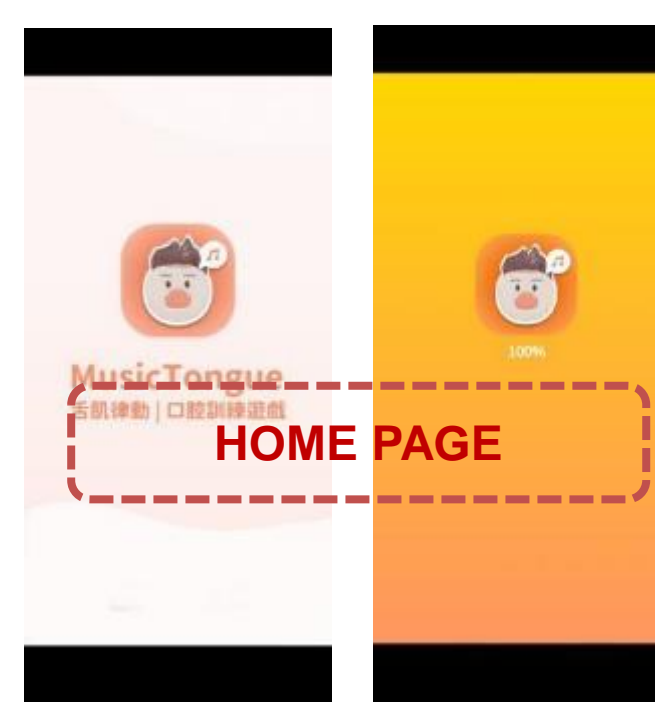


Turn On The Fill Light



Ready To Play !

MUSIC TONGUE Functions



UI Walkthrough

Discussion (1) - Enhancement of community/home environmental quality to improve the daily-life functions for the elderly

- The elderly have lost or **reduced physical functions**, resulting in use disorders and stress to re-acclimatize. Under the concept of **Productive Aging, Aging at Place and Life-long Housing**, To reshape our community and surrounding environments suitable for the elderly to maintain their **daily life functions**, and enhance **health conditions** are important issues.
- Facing of **complex needs of of the elderly**, and **corresponding level of environmental conditions** (including urban public space, transportation, and housing), to developing and planning of age-friendly cities requires much detailed information to ensure rationality and fairness actions to help the elderly.
- Taiwan's **rapidly aging** population has **increased the cost of social care**. however, under balancing of demand and supply in economics, it lies in how to maximize the effectiveness of limited resources
- **Inclusive Design** demonstrates the concepts of **union set of clients** and **intersection set of needs** to define possible services to everyone.
- Applying of **Digital (tools) Applications** based on inclusive design to submit **alternative way** and flexible means to resolve the **problems of changing needs reflected in a fixed and limited urban megastructure** and establishments.
- To explore the substitution between hardware construction and software development in order to meet the varied indicators of Taiwan's age-friendly city, **Music-tongue** was develop as **a case study of exergame** for aging at place, and for Taiwan's medical and long-term care service.

Discussion (2) – Sport games (exergame) for medical rehabilitation to enhance the motivation of continuous training

- The NDC estimates that between **2018 and 2060**, the proportion of the elderly population will increase from **14.6% to 41.6%**.
- Among the diseases that older people are prone to, **dysphagia** is a common disease that affects **self-care**. Difficulties with nutritional intake and social conversation also increase the likelihood of aspiration pneumonia.
- **Regular oral exercise** in advance according to the concept of preventive medicine can greatly reduce the symptoms of dysphagia for the elderly, effectively **reduce the probability of future disease** and the corresponding social cost of care.
- **Tractional** oral training method mainly relies on the efforts of medical treatments after the illness, and the mainstream oral exercise. While lacks of feedback, and the **process is boring**, and generally results to a lack of motivation to encourage the elderly to practice and parallel oral movement before the disease.
- **A tongue muscle exercise game APP** was designed to allow patients to move when their tongue muscles through **mobile devices**, combined with **gamification** and **flow experience design**.

Discussion (3) –Game-flow, human-computer interaction, and AI to develop an ubiquitous game may lead new business model for aging at place

- **Flow theory** is an important theory in game development, hoping to keep players stuck with the game.
- **Smart healthcare** and **body-senor games** combined with **mobile devices** offer a new opportunity to develop **flow-oriented sports games** and review related business models.
 - Nintendo Japan used the Wii-Fit to develop motion games (w/ physical facilities) for lower extremity rehabilitation programs for the elderly.
- Mobile games (exergame) can be played from anywhere in the home and community, **across physical boundary**, integrated with recalling (old songs) **memory**, and form **mixed-reality communications** for everyone in a society.
- **Somatosensory games**, interactive interfaces and flow factors integrated a **mechanism** can collect the psychological and physiological data of sports gamers, and provide big data analysis which integrating the mind-body dimension help the elderly in **preventive medicine - smart medicine** of fundamental medical research.
- The **physical fitness standards** and **psychological counseling procedures** required for different level of **training difficulties** can be used as reference.
- Music Tongue may suggest an opportunity for **platforming social network service** among community and changing the **service business model** for aging at place.



Global Health Forum in Taiwan

Ubiquitous exergame for the elderly- A tongue-training case study

Thank You For Your Listening