Capitalizing on Strengths while Improving Weaknesses

Intelligent Dyslexic Interface Design (I-DID): Web and Mobile App-based Parallel Assessment and Intervention Systems for Dyslexia

Speech, Language, and Reading Lab

(https://slrlab.edu.hku.hk/)

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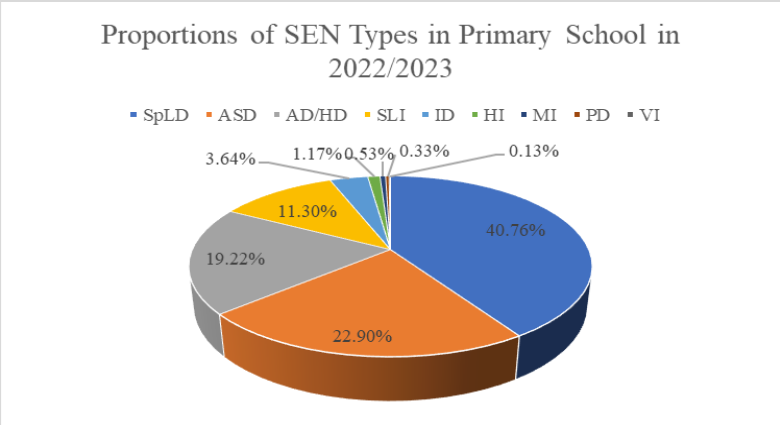
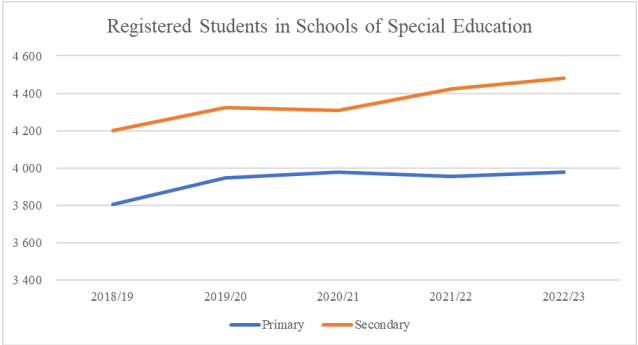
Developmental Dyslexia (DD)

- A neurodevelopmental disorder manifested by persistent difficulties in learning despite adequate intelligence, instruction and social-cultural opportunities (Shaywitz et al., 1992).
- Dyslexia is the most common type of specific learning difficulties (SpLD), affecting 9.7%-12.6% of school-age children in Hong Kong (Chan et al., 2007; Lam et al., 2018).

➢ **2022/2023:** 35% of students with special educational needs (SEN) are dyslexics.



➢ **Hong Kong:** 5.62% increase in 5 years



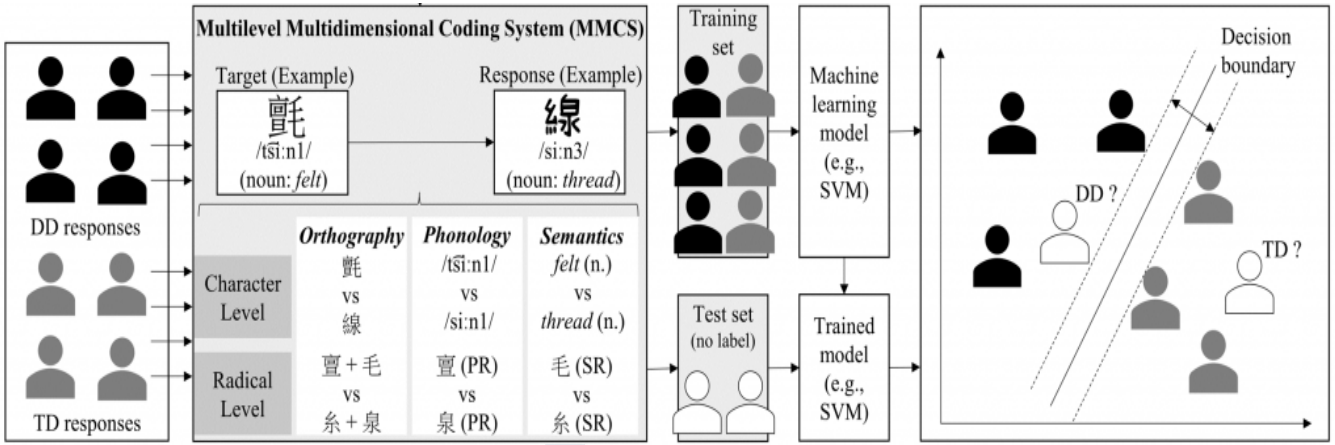
The Diagnostic Tool for Dyslexia in Hong Kong

- The Hong Kong Test of Specific Learning Difficulties in Reading and Writing for Primary School Students (HKT-P(III); Ho et al., 2015)
  - Children are formally diagnosed with dyslexia when they have an IQ score of 80 or above but score one standard deviation below average in both the literacy composite score and at least one of the cognitive composite scores
    - Literacy composite score: Chinese character recognition, one-minute word reading, and word dictation
    - Cognitive composite score: Rapid digit naming, phonological awareness, phonological memory and orthographic knowledge

However, our large-scale studies using machine learning models to predict dyslexia indicate the inefficiency and limitations of existing assessment tools.

Classification and Prediction of Chinese Dyslexia Combining Reading Theory and Machine Learning

- 1,015 Hong Kong Chinese children, 7-12 years old, Grades 1-6
- 454 were formally diagnosed or identified as at-risk of dyslexia (DD)



- ***Supervised machine learning models***:
  TD vs. DD
- ***Features***: Two levels of three domains
- ***Algorithms***: NB, SVM, KNN, Decision Tree (DT), Artificial Neural Network (ANN), and Logistic Regression (LR)
- ***Prediction accuracy***: **80%**

Multilevel and Multidimensional Assessment and Intervention

Pennington's (2006) multifactorial model

- The necessity of developing a much more comprehensive assessment for identifying the critical indicators of Chinese dyslexia.

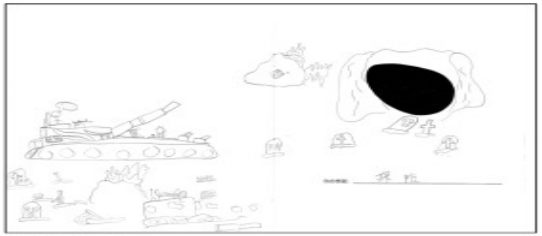
Lee, Liu, & Tong (2022**).** Identifying Chinese children with dyslexia using machine learning with character dictation. *Scientific Study of Reading*. https://doi.org/10.1080/10888438.2022.2088373

The Strengths of Dyslexic Children

- Children with dyslexia exhibited higher nonverbal creativity strengths than their neurotypical peers, regardless of age and grade (Lam & Tong, 2021).

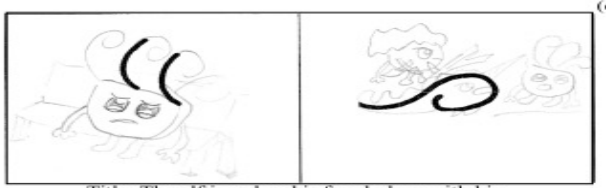
➢ **Dyslexic drawing**

(a)



Title: Adventure

(c)



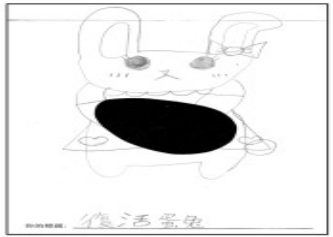
Title: The elf is sad so his frend plays with him.

(e)

Title: Mickey jumps over the wall and goes through the tunnel to escape from bird.

➢ **Neurotypical drawing**

(b)



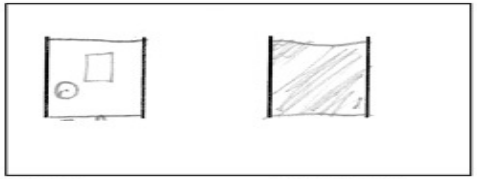
Title: Easter Egg Bunny

(d)

Title: Moon

Title: Wave

(f)



Title: Door

Title: Window

Lam, J. H. & Tong, X. (2021**).** Drawing a new picture: Children with developmental dyslexia exhibit superior nonverbal creativity. *Research in Developmental Disabilities*, 116, 104036. 10.1016/j.ridd.2021.104036

However, the strengths of children with dyslexia have not been taken into consideration in both the diagnosis and intervention.

More importantly,

Existing tools have focused solely on:

- One language without considering the multi-literate educational policy in multi-lingual societies (e.g., Hong Kong Chinese children simultaneously acquire Chinese as an L1 and English as an L2);
- Children while overlooking the parent-child connection;
- Linguistic and cognitive skill deficits while neglecting underutilized assets and untapped potential, such as music, social-emotional skills, and creativity;
- Costly in-person service delivery models, which limit the capacity to simultaneously assess a large number of children at risk for dyslexia;
- Primary school-age populations and thus may miss the optimal time for prevention and intervention.

Intelligent Dyslexic Interface Design (I-DID): A Synergy of AI, Cognitive Neuroscience, and Learning Science

- A multifaceted assessment and intervention of Chinese, English, and Chinese-English bilingual dyslexia in 4- to 12-year-old children and their parents
- Utilizing parallel dual-language and strength-weakness-based approaches to assess and classify patterns of strengths and weaknesses in five domains

A New Conceptual Framework: I-DID Synchronizes and Optimizes Five Essential Human Elements

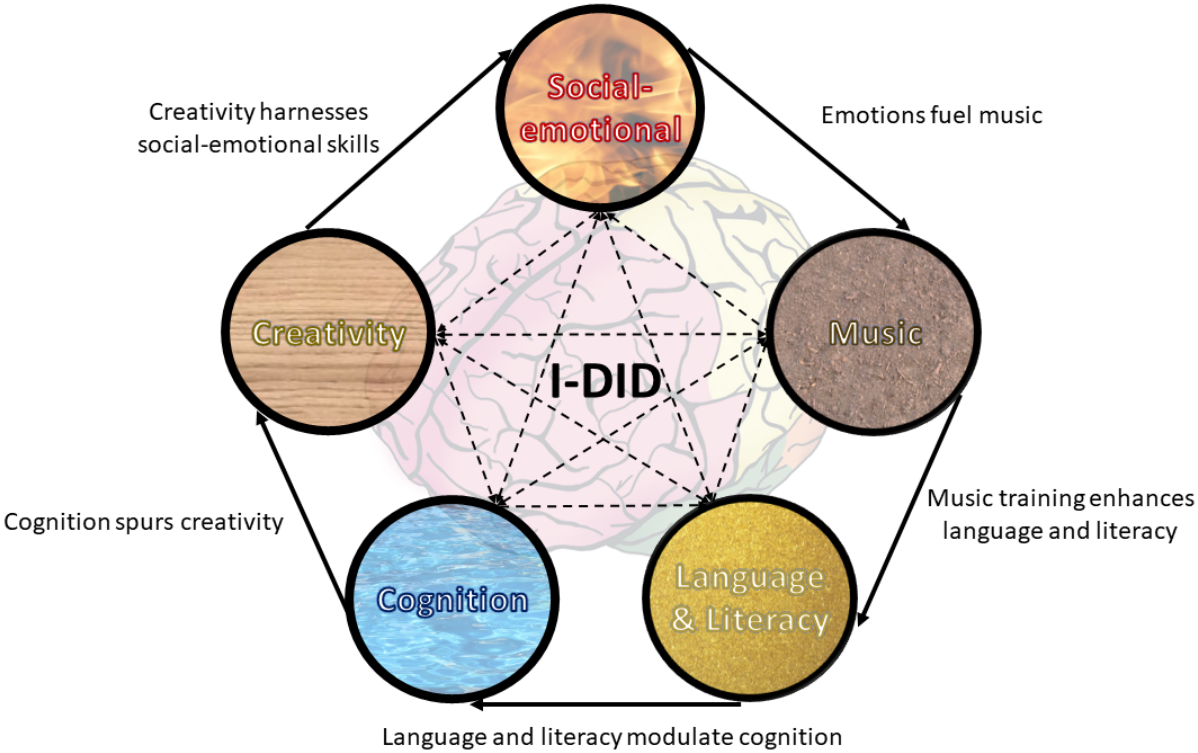


Figure 1. A 2C-SEM-2L Brain-Based Learning and Training Model (Tong, 2020)

Parallel Parent-Child Assessment: Some Constructs (Over 90 games/tasks for children and adults)

Cognition
- Statistical Learning
- Working Memory
- Executive Functioning

Creativity
- Drawing
- Acting
- Playing
- Speaking

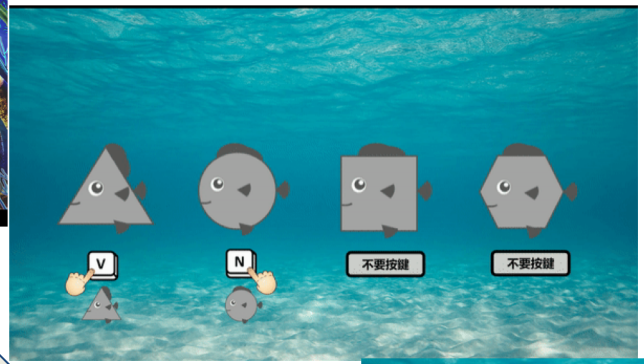
Social-Emotional Skills
- Personal competence
- Psychological well-being
- Resilience

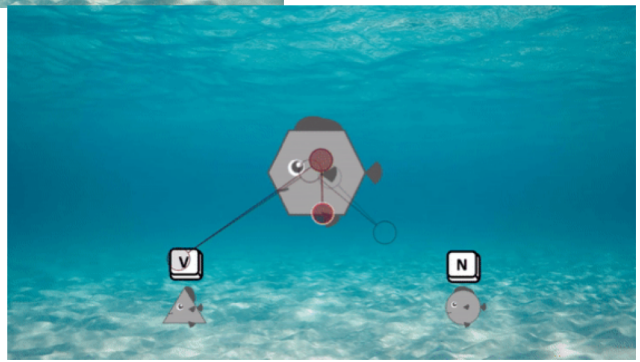
Chinese-English Language and Literacy
- Vocabulary knowledge
- Oral language competence
- Phonological awareness
- Morphological awareness
- Syntactic awareness
- Orthographic awareness
- Print awareness
- Word reading
- Word dictation

Music Aptitude
- Pitch perception
- Melody perception
- Rhythm perception
- Tempo perception

Cognitive Test Interface: An Example

- **Statistical Learning**





Creativity Test Game Interface: An Example

- Non-verbal creativity

Music Aptitude Test Interface: An Example

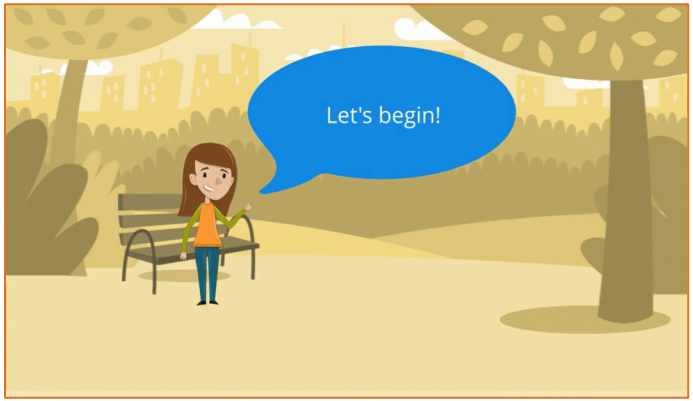
- **Pitch Perception**

Language and Literacy Test Interface: An Example

Chinese (L1)

An Example of the Chinese Language Test interface

English (L2)



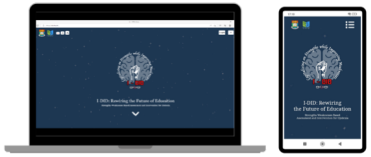
An Example of the English Language Test Game Interface

Social-Emotional Skills Test Interface

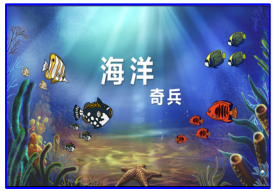
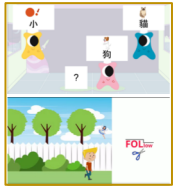
Examples of instruction videos helping children learn and recognise their emotions and well-being

I-DID Design

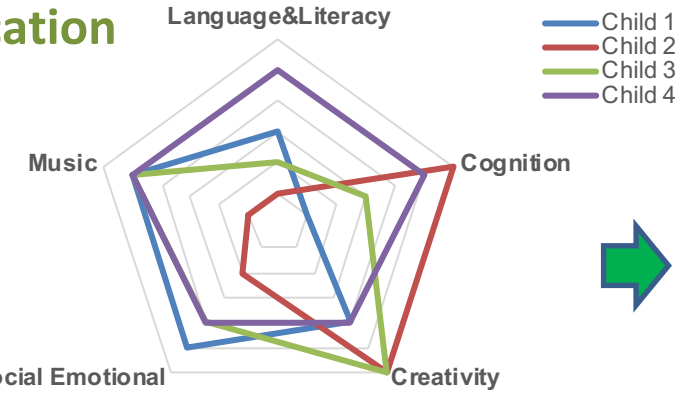
Assessment (https://idid.hku.hk)



Self-Designed Games by Our In-House Programmers for Assessing Five Elements

8 tests	10 tests	3 tests	4 tests	44 tests
				
Creativity	Cognition	Social-Emotional Skills	Music Aptitude	Language and Literacy

- **Profile Classification**



Identify strengths and weaknesses

- **Adaptive Remediation: I-DID 嘉年華 (I-DID app)**

https://apps.apple.com/fr/app/i-did-%E5%98%89%E5%B9%B4%E8%8F%AF/id1643640330

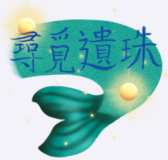
I-DID Intervention

In-House Self-Designed Theme-Based Intervention Games

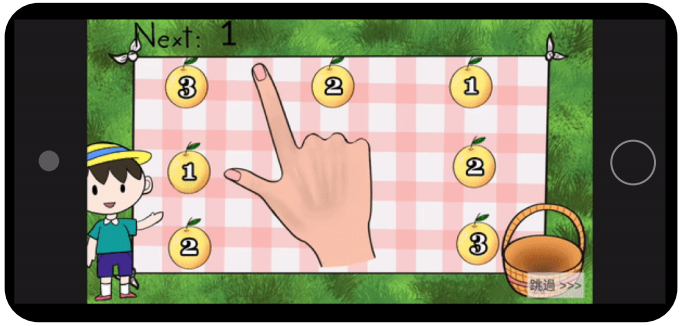
GET IT ON Google Play

I-DID

Download on the App Store

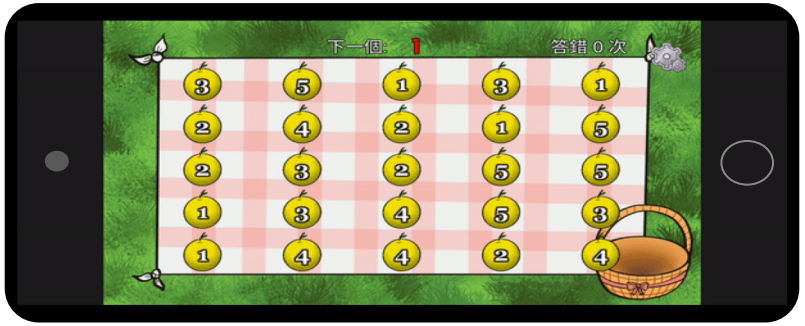


Intervention: Gamification and Multimedia



Storyline: Sequence Learning

Training and Testing



- Images
- Audio
- Video
- Animation
- Text

Educational Entertainment: Fun and Stimulating Testing and Training

Freely Accessible and Captivating Treatment

- Badges
- Prizes
- Challenges
- Levels
- Feedback
- Reward

Levels

Rewards

Maximizing cognitive and emotional engagement

Key Highlights of I-DID

Assessment

- **Bilingual**
- **Child-Parent Parallel**

Intelligent and Integrated

Intervention

- **Freely accessible**
- **Captivating**

- **Gamification and multimedia**
- **Multi-dimensional**
- **Individual strength and weakness**

Translational Science: Designed by an interdisciplinary team comprising scientists, computer engineers, linguists, artists, and educational specialists.

I-DID: Reimagining the Future of SEN Education

I-DID: Reimagining Dyslexia

教育提案：伴你開創閃閃發光的未來：讀寫障礙童也具備無限潛能

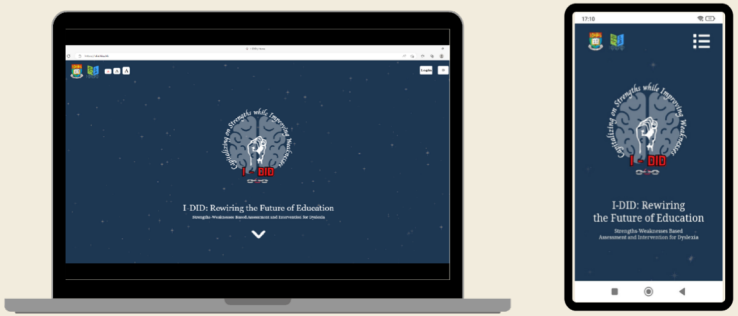
2022年7月12日

Link to the news article

Translate evidence into policy and clinical practice

An Intelligent Dyslexic Interface Design (I-DID)

Assessment Interface



https://idid.hku.hk/

Intervention Interface

GET IT ON Google Play

https://play.google.com/store/apps/details?id=com.SLRlab.interventionGame

Download on the App Store

https://apps.apple.com/app/i-did-%E5%98%89%E5%B9%B4%E8%8F%AF/id1643640330

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  (https://awards.ugc.edu.hk/awardees/shelley-xiuli-tong-2020)

- **All RFS research team members including in-house researchers, programmers, graphic designers, software engineers, illustrators, assessment administrators, and many research volunteers**

- **I-DID Patent NO.: HK30088724**

- **I-DID Logo: Trademark protected**

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