

Supporting Information file

Divjak, D., Mackiewicz, J., & Milin, P (2026) Repeat after me? Mapping the Relation of Overimitation to Foreign-Language Learning Aptitude.

Overimitation scoring protocol

Character Scoring Protocol

Chinese characters are composed of individual strokes written in a specific sequence and direction, typically from top to bottom and left to right.

The characters are scored for 1/ Fidelity, 2/ Overall structure, 3/ over-imitation, 4/ number of corrections and the 5/ total time taken to produce the character.

Fidelity includes the following components: presence of the stroke, stroke sequence, accuracy, and stroke direction. Each of the eight strokes is evaluated against these 4 criteria with one point allocated:

- Presence: One point is awarded if the stroke is present.
- Sequence: One point is awarded for each stroke written in the correct serial order. There are 8 slots in total, and I assess which stroke falls into each slot. For example, if the stroke that should be written third is instead written second, no point is allocated.
- Accuracy: This is assessed by comparing the written stroke with the target model stroke.
- Direction: This is evaluated based on a video recording of the stroke's production. Specifically, I assess whether the writing movement follows the correct direction, typically from top to bottom and left to right.

The composite fidelity score is calculated as the average of the four components for each character, with a maximum possible score of 1.

The Overall Structure: One point is awarded when the entire character is positioned correctly within the designated space on the page. For instance, the left part of the character should be appropriately placed on the left side, the right part on the right side, and the character should be oriented horizontally rather than vertically. A single point is assigned for the overall structural accuracy of the character.

Over-Imitation: Characters were scored based on the manner of writing to assess over-imitation abilities. Each stroke was evaluated for two features: a flick of the hand and the speed of writing. These features are summarized in the stroke-by-stroke Table 1 below.

Character 1: Includes 3 strokes with a flick and 2 strokes with a "light end," where the hand lifts off the paper at the end of the stroke (5 special features in total).

Character 2: Includes 2 strokes with a flick and 3 strokes with a light end (5 special features in total).

I assigned 1 point each time a participant replicated these special hand gestures on the relevant strokes. However, if these special movements were applied to strokes that should be produced in a simpler manner, no points were awarded.

The flick and speed scores were averaged to calculate the over-imitation score.

Number of corrections. This refers to the number of times a participant made corrections to the characters while writing.

Total time. This is time taken to draw the character (expressed in seconds).

Table 1 Stroke by stroke flick and speed features

Character 1		Character 2	
Stroke	Characteristics	Stroke	Characteristics
1	short fast	1	slow with light end
2	short slow-slow-flick	2	slow
3	slow	3	short fast
4	slow with light end	4	slow
5	fast-slow-flick	5	fast with light end
6	slow-flick	6	slow with flick
7	fast with light end	7	fast with light end
8	short fast	8	slow with flick

Sentence repetition scoring protocol

We have two sentences:

1. Birthday: Total Characters: 8 (衷, 心, 祝, 你, 生, 日, 快, 乐)
2. University: Total Characters: 8 (欢, 迎, 来, 到, 这, 所, 大, 学)

There are three components for each Chinese sentence (Birthday and University):

1. Pronunciation accuracy
2. Tone accuracy
3. Chunking

Pronunciation Accuracy

- Scored on a character-by-character (syllable-by-syllable) basis.
- 1 point is awarded for each correctly repeated character/syllable (8 characters/syllables in total, so a maximum of 8 points).
- The final pronunciation accuracy score for the whole sentence is the average of all characters, resulting in a scale between 0 and 1.

Tone Accuracy

- Also scored on a character-by-character basis.
- 1 point is awarded if a character's tone is correctly reproduced.
- The final tone accuracy score for the whole sentence is the average of all characters, with a final scale between 0 and 1.

Chunking

- Each sentence can be divided into 4 meaningful units (chunks).
- Scoring system:
 - 0 points: No segmentation into chunks (i.e., no recognition of two-character words).
 - 1 point: One chunk correctly segmented.
 - 2 points: Two chunks correctly segmented.
 - 3 points: Three chunks correctly segmented.
 - 4 points: Four or more chunks correctly segmented.

Puzzle box scoring protocol

Each participant completed the box imitation task using the same box type in both sessions: either transparent or opaque. The task produced three main outcome measures: over-imitation, fidelity and fidelity specific.

The **over-imitation** score was calculated by dividing the number of unnecessary steps performed by the participant by the total number of unnecessary steps demonstrated (three). This value (ranging from 0 to 1) reflects the proportion of irrelevant or “useless” actions copied from the demonstrator—the higher the score, the greater the degree of over-imitation.

The **fidelity score** represented a weighted average across seven action clusters, corresponding to the seven main stages of the demonstrated sequence. Some stages could be completed in two ways—one accurate (weighted 1.0) and one approximate (weighted 0.5). Participants received full credit (1) for performing the exact demonstrated action, half credit (0.5) for a plausible alternative, and zero if neither was attempted. The weighted values were summed and divided by seven (the total number of clusters), yielding a score between 0 and 1, with higher values indicating greater fidelity to the model demonstration.

The **fidelity-specific** value represents imitation accuracy for the necessary (goal-relevant) actions only. Each of the three necessary steps was awarded one point if performed, and the final score was calculated as the total number of these steps completed divided by three (yielding a value between 0 and 1). Higher scores indicated greater fidelity-specific accuracy.

Table 2 Necessary and unnecessary steps in the box imitation task

Step	Description	Status	Can be done differently?
1	Unbuckle the paper strip	Unnecessary	No
2	Take out the hook	Unnecessary	No
3	Use hook to pull the box from the left side	Unnecessary	Yes – without hook
4	Untie the black belt and remove	Necessary	Yes – leave belt tied
5	Untie the blue ribbon	Necessary	No
6	Use hook to pull the box from the right side	Necessary	Yes – without hook
7	Use hook to retrieve the golden item	Necessary	Yes – without hook

Grammatical Judgement task stimuli

STIMULI	Alternative sentence	Correct	Focus	Source
PRACTICE				
Two paintings are on the wall.	N/A	YES	—	—
There is two paintings on the wall.	There are two paintings on the wall.	NO	—	—
The little boy fell down, didn't he?	N/A	YES	—	—
He came my house at noon.	He came to my house at noon.	NO	—	—
She went up the strairs in a hurry.	N/A	YES	—	—
The paper was full mistakes.	The paper was full of mistakes.	NO	—	—
I was away on holiday last week.	N/A	YES	—	—
I have a friend who she does all the platters.	I have a friend who does all the platters.	NO	—	—
EXPERIMENT				
Sandy filled a jar with cookies last night.	N/A	YES	Past tense	De Keyser
Last night the books fell off the shelves.	N/A	YES	Past tense	De Keyser
Yesterday the teacher sent Allison to the principal.	N/A	YES	Past tense	De Keyser
Many houses were destroyed by the flood last week	N/A	YES	Plural	De Keyser
Two mice ran into the house this morning.	N/A	YES	Plural	De Keyser

Our neighbour bought new furniture last week.	N/A	YES	Plural	De Keyser
Mrs Sampson cleans her house every Wednesday.	N/A	YES	Third-Person Singular	De Keyser
Mary will go to Europe next year.	N/A	YES	Third-Person Singular	De Keyser
The Johnsons may be moving to Chicago this fall.	N/A	YES	Third-Person Singular	De Keyser
Janet is wearing the dress I gave her.	N/A	YES	Present Progressive	De Keyser
The children are playing in the garden till dark these days.	N/A	YES	Present Progressive	De Keyser
Mrs. Johnson went to the library yesterday.	N/A	YES	Determiners	De Keyser
After a life like that he will go straight to hell.	N/A	YES	Determiners	De Keyser
Mary looked at the flowers but didn't buy them.	N/A	YES	Pronominalization	De Keyser
Peter did not have any money on him.	N/A	YES	Pronominalization	De Keyser
The drunk slept off his hangover in the guest room.	N/A	YES	Particle Movement	De Keyser
The man looked the new cars over yesterday.	N/A	YES	Particle Movement	De Keyser
The little boys laughed at the clown.	N/A	YES	Subcategorization	De Keyser
I hope you will go to the store now.	N/A	YES	Subcategorization	De Keyser
Has the King been served his dinner?	N/A	YES	Yes-No Questions	De Keyser
Can the little girl ride a bicycle?	N/A	YES	Yes-No Questions	De Keyser
Does John know the answer to that question?	N/A	YES	Yes-No Questions	De Keyser
Where did Arnie hunt last year?	N/A	YES	Yes-No Questions	De Keyser
Where is Ted working this summer?	N/A	YES	Wh-Questions	De Keyser
What do they sell at the corner store?	N/A	YES	Wh-Questions	De Keyser
The boy caught the ball.	N/A	YES	Word Order	De Keyser
The boy feeds the rabbits carrots.	N/A	YES	Word Order	De Keyser
The dog bites.	N/A	YES	Word Order	De Keyser
The children play with the dog.	N/A	YES	Word Order	De Keyser

The student eats his meals quickly.	N/A	YES	Word Order	De Keyser
Alec sighed heavily, as if this scene were depressing him.	N/A	YES	Past tense	oominds
Water also contains varying amounts of rust, grit and silt.	N/A	YES	Third person agreement	oominds
But it has been lying dead for twelve years.	N/A	YES	Present Perfect Progressive	oominds
So far, three thousand jobs have been created under the scheme.	N/A	YES	Present Perfect Passive	oominds
Thank you for this morning, we will see you this afternoon.	N/A	YES	Future tense	oominds
Three men drove onto the icy surface of a frozen lake.	N/A	YES	Determiners	oominds
Austria will be the first country to make COVID-19 vaccines obligatory.	N/A	YES	Determiners	oominds
A Dutch company is building a yacht for Jeff Bezos.	N/A	YES	Determiners	oominds
The government passed a law, and the Austrian president signed it.	N/A	YES	Determiners	oominds
Sir David Attenborough said that the carbon dioxide around the earth was too high.	N/A	YES	Determiners	oominds
Janie slept with her teddy bear last night.	Janie slept with her teddy bear last night	NO	Past tense	De Keyser
A bat flew into our attic last night.	A bat flew into our attic last night	NO	Past tense	De Keyser
Three boy played on the swings in the park.	Three boys played on the swings in the park	NO	Plural	De Keyser
A shoe salesman sees many foots throughout the day.	A shoe salesman sees many feet throughout the day.	NO	Plural	De Keyser
I need to get some informations about the train schedule.	I need to get some information about the train schedule	NO	Plural	De Keyser
John's dog always wait for him at the corner.	John's dog always waits for him at the corner	NO	Third-Person Singular	De Keyser
John can plays the piano very well.	John can play the piano very well	NO	Third-Person Singular	De Keyser
Our new neighbor should turns his radio down a bit.	Our new neighbor should turn his radio down a bit.	NO	Third-Person Singular	De Keyser

The boy has been lie to his father.	The boy has been lying to his father.	NO	Present Progressive	De Keyser
Tom working in his office right now.	Tom is working in his office right now.	NO	Present Progressive	De Keyser
Tom is reading book in the bathtub.	Tom is reading a book in the bathtub	NO	Determiner	De Keyser
The beauty is something that lasts forever.	Beauty is something that lasts forever	NO	Determiner	De Keyser
Peter made out the check but didn't sign.	Peter made out the check but didn't sign it	NO	Pronominalization	De Keyser
The girl cut himself on a piece of glass.	The girl cut herself on a piece of glass	NO	Pronominalization	De Keyser
The man climbed the ladder up carefully.	The man climbed up the ladder carefully	NO	Particle Movement	De Keyser
Kevin called Nancy for a date up.	Kevin called Nancy up for a date	NO	Particle Movement	De Keyser
George says much too softly.	George says his prayers much too softly	NO	Subcategorization	De Keyser
The girls enjoy to watch TV.	The girls enjoy watching TV.	NO	Subcategorization	De Keyser
Will be Harry blamed for the accident?	Will Harry be blamed for the accident?	NO	Yes-No Questions	De Keyser
Will wear Harry his new shirt to the party?	Will Harry wear his new shirt to the party?	NO	Yes-No Questions	De Keyser
Swam Janet in the race yesterday?	Did Janet swim in the race yesterday?	NO	Yes-No Questions	De Keyser
Did Bobbie stayed at home last night?	Did Bobbie stay at home last night?	NO	Yes-No Questions	De Keyser
What Martha is bringing to the party?	What is Martha bringing to the party?	NO	Wh-Questions	De Keyser
Who you meet at the park every day?	Who do you meet at the park every day?	NO	Wh-Questions	De Keyser
The dinner the man burned.	The man burned the dinner.	NO	Word Order	De Keyser
The woman the policeman asked a question.	The woman asked the policeman a question.	NO	Word Order	De Keyser
Drinks the man.	The man drinks	NO	Word Order	De Keyser
The students to the movies went.	The students went to the movies.	NO	Word Order	De Keyser
Kevin rides usually his bicycle to work.	Kevin usually rides his bicycle to work.	NO	Word Order	De Keyser
The girl the movie likes	The girl likes the movie.	NO	Word Order	DeKeyser
Hopefully we met him next season.	Hopefully we will meet him in the Premier League next season.	NO	Future Tense	oominds
It was obvious she has never been before.	It was obvious she had never been before.	NO	Past Perfect Tense	oominds
Dementia is the cognitive disease.	Dementia is a cognitive disease.	NO	Determiners	oominds

The country was the British colony in the past.	The country was a British colony in the past.	NO	Determiners	oominds
They lived in an ordinary villa, with coloured glass in a front door.	They lived in an ordinary villa, with coloured glass in the front door.	NO	Determiners	oominds
That is the best fish and chips I am ever having.	That is the best fish and chips I have ever had.	NO	Present Perfect	oominds
And finally he announces that the referendum would be held in January.	He announced that another referendum would be held in January.	NO	Past tense	oominds
Sarah was the student at the University of Nottingham.	Sarah Buckle was a student at the University of Nottingham.	NO	Determiner	oominds
She currently worked on a new book for the trust.	She is currently working on a new book for the trust.	NO	Present Progressive	oominds
I was waiting for the train at Willesden Junction, and a platform was crowded.	I was waiting for the train at Willesden Junction, and the platform was crowded.	NO	Determiners	oominds