

Development of a Cantonese Awake Craniotomy –Specific Language Assessment Protocol (CCLAP)

Pre-, Intra-, and Post-operative Neurolinguistic Assessment for
Cantonese-Speaking Patients

Yip Chui Yan Florence, Mo Kwan Nok Jacky, Cheung Yu Hin Adrian, Li Wing Yung Sara, Wong Kit, Ripley

Speech Therapy Department, Hong Kong Island Cluster

Preserving Language Function is the Central Goal of Awake Craniotomy

Awake craniotomy with Direct Electrical Stimulation (DES) is the gold standard for identifying and preserving eloquent language areas during tumour resection in language-dominant brain regions.

The Multidisciplinary Team

Neurosurgeons , Anesthetist, Specialty Nurses, Speech therapist, Clinical psychologist

88%

of patients resume work post-operatively following awake craniotomy (Jolley, 2022)

93.7%

of low-grade glioma patients return to work (Ng, 2024)

86%

of low-grade glioma patients show no cognitive decline after awake craniotomy with mapping (Lemaitre, 2022)

INTRAOPERATIVE FEEDBACK LOOP

1. STIMULATION
(Surgeon current)
applies

2. TASK PERFORMANCE
(ST/CP test patient)

3. EVALUATION
(Team analyzes
response)

4. SURGICAL DECISION
(Safe to resect vs.
Stop)



Cantonese Speakers Lack a Validated Intraoperative Language Mapping Protocol

No Cantonese or Chinese version currently exists for awake craniotomy language mapping.

Cantonese presents unique linguistic challenges that prevent simple translation of existing tools:

Phonology and Reading

Nine lexically contrastive
Special logographemes writing system

Syntax

Aspect marking systems and serial verb
constructions absent in English language.

Semantics

Culturally specific semantic and categorical
lexical organisation requiring local
adaptation.

This study aims to:

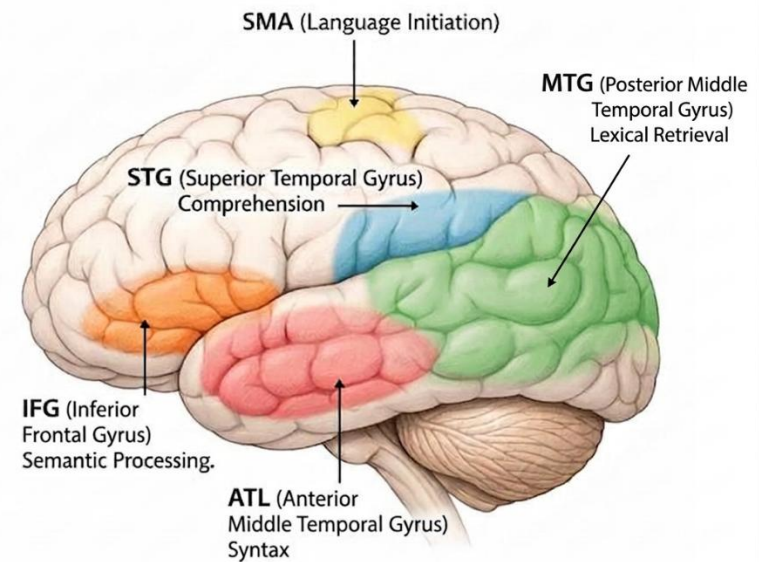
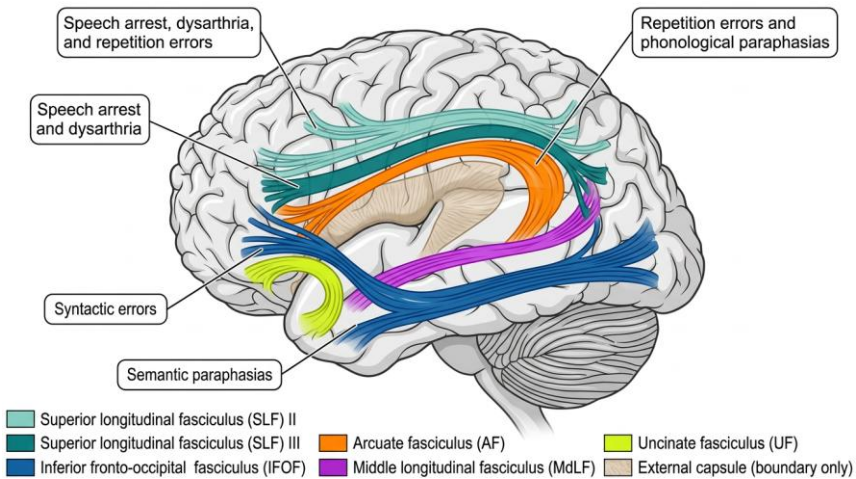
1. Develop and validate a Cantonese neurolinguistic test battery (CCLAP) for DES-based intraoperative language mapping.
2. Collect normative data from healthy controls and patients with unoperated brain tumours.

CCLAP Integrates Two Task Tiers to Cover the Full Surgical Timeline

The CCLAP battery comprises **10 tasks** across two functionally distinct tiers, designed to address the strict temporal and procedural constraints of awake neurosurgery.

Task Tier	Purpose	Response Window	Tasks Included
Type A	Intraoperative DES Mapping	≤ 4 seconds	Object Naming, PPTT, Read Aloud, Action Naming, Repetition, Verb Generation, Verbal Comprehension, Syntax Production
Type B	Pre- & Post-operative Assessment	Unrestricted	Passage Reading, Passage Comprehension, Verbal Fluency

Visual stimuli are presented as black-and-white line drawings on an iPad screen, with slides auto-advancing every 4 seconds.

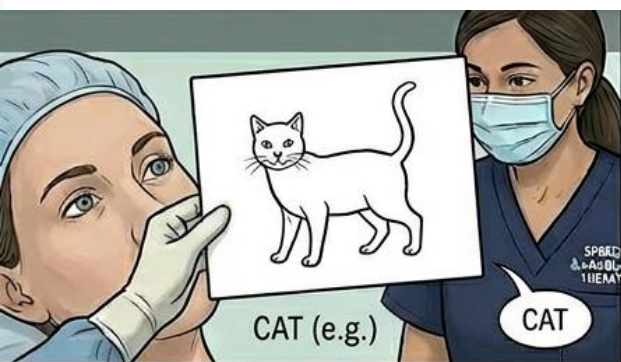


Each Task Targets Distinct Cortical and Subcortical Language Pathways

The battery systematically covers phonological, semantic, syntactic, and articulatory language domains.

Object	Lexical retrieval, semantic & phonological encoding	Verb Generation	Semantic association & syntactic competence
Pyramid & Tree Test	Non-verbal semantic processing	Verbal Comprehension	Auditory semantic
Read Aloud	Grapho-phonological & semantic routes	Syntax Production	Grammatical encoding, aspect markers
Action Naming	Verb retrieval, frontal-temporal networks	Passage Reading & Comprehension	Discourse-level language
Repetition	Phonological encoding, dorsal dorsal pathway	Verbal Fluency	Semantic retrieval, executive function

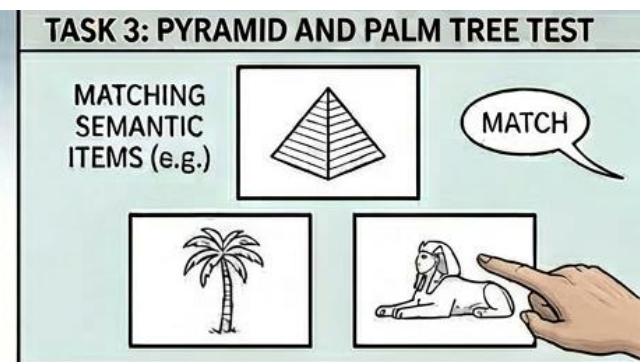
Language mapping Tasks adopted in the past



TASK 1: BOSTON NAMING TEST



TASK 2: COUNTING ALOUD



TASK 3: PYRAMID AND PALM TREE TEST

Rigorous Task Design & Stimulus Selection Criteria



Object Naming

>85% Naming Accuracy | >90% Naming Agreement

Snodgrass & Vanderwart (1980) stimuli adapted via Law & Yip (2007) Cantonese norms.



Pyramid and Palm Tree Test

>75% Accuracy

Triads selected via Law et al. (2007) to ensure cultural and conceptual transparency.



Read Aloud

100% Baseline Accuracy

HKCCPN adaptation with balanced frequency and regularity effects. 29 low frequency words, 43 high frequency words



Action Naming

4.7/5 Naming Agreement | <4 visual Complexity

Lau (2024) set selection to limit perceptual processing load.



Repetition

High Imageability

Real words via Chan & Tse (2024); non-words designed for co-articulation detection.



Verbal Fluency

Cantonese norm well established

4 categories with Cantonese norms already published

AGE OF ACQUISITION (AOA)

WORD FREQUENCY

VISUAL COMPLEXITY

PHONETIC CONTROL



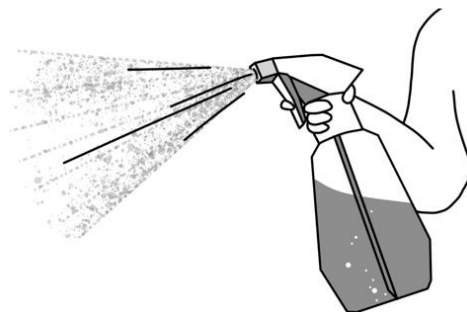
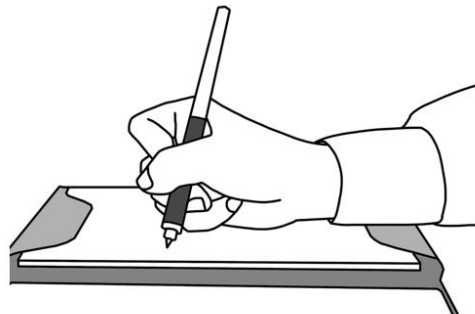
香港島醫院聯網
Hong Kong Island Cluster

請讀出

朵

Read Aloud

Action Naming



香港島醫院聯網
Hong Kong Island Cluster

Original Task Design: Tailored for Cantonese Neurolinguistics

Verb Generation

- **Lexical Constraint:** Target responses limited to 1-5 choices
- **Stimuli:** 52 newly developed line drawings of highly imageable nouns.

Verbal Comprehension

- **Memory Control:** Stimuli limited to 5-9 syllables
- **Format:** 30 Yes/No questions , 2 contrastive element

Syntax Production

- **Cantonese Specificity:** Focuses on obligatory **aspect markers**
- **Stimuli:** 59 action pictures

Passage Reading & Comprehension.

- **Discourse Level:** 441-word narrative passage for higher-order language assessment.
- **Evaluation:** 10 questions (8 literal, 2 inferencing)

Syntax production

佢而家...



佢啱啱...



我諗起...



我諗起...



Verb Generation



香港島醫院聯網
Hong Kong Island Cluster

Study Design: Two-Phase Validation

PHASE 1

Stimulus Adjustment

- ✓ Initial screening of 10 subtests
- ✓ Item deletion based on **Healthy Control** and **expert ST** performance
- ✓ Refining linguistic and cultural relevance
- ✓ Ensuring 100% accuracy for baseline tasks

PHASE 2

Normative Data

- ✓ Establishing **Cut-off Scores**
- ✓ Percentile 2 (Clinical Impairment)
- ✓ Percentile 7 (Pathological Impairment)
- ✓ Validation of the final 10-task battery

Exclusion Criteria: History of neurological/psychiatric disease, developmental language disorders, neuroleptic drug use.



SAMPLE SIZE
N = 51 Healthy Controls



MEAN AGE
31.82 Years (SD 9.15)



GENDER
13 Male / 38 Female



EDUCATION
Mean 19.65 Years
HK-MOCA Mean
28.73(1.56)



Right Handed 38 /Left Handed 13



香港島醫院聯網
Hong Kong Island Cluster

Phase 1 Eliminated Culturally Outdated and Ambiguous Stimuli

Task	Original Items	Final Items	Deletion Rate	Key Reason for Deletion
Object Naming	199	150	22.1%	Outdated pictures not matching current Cantonese usage
Action Naming	70	67	4.3%	Pictures not easily comprehended
Repetition (Total)	357	293	18.0%	Phonotactic complexity; non-word difficulty
Verb Generation	68	52	23.5%	Newly drawn stimuli not easily comprehended
Syntax Production	66	59	10.6%	Failed to elicit target Cantonese aspect markers
PPTT, Verbal Comp., Passage	—	Unchanged	0%	Met all criteria without adjustment

The highest deletion rate was in **Verb Generation (23.5%)**, reflecting the challenge of newly designed line drawings.

Healthy Controls Demonstrated High Accuracy, Establishing Robust Clinical Baselines

Subtest	Max Score	Mean (SD)	Accuracy
Object Naming	150	146.04 (3.18)	97.36%
PPTT	35	33.39 (1.99)	95.41%
Read Aloud	72	71.82 (0.43)	99.75%
Action Naming	67	65.25 (1.65)	97.40%
Verb Generation	52	50.35 (1.68)	96.83%
Verbal Comprehension	30	29.90 (0.30)	99.67%
Syntax Production	59	56.63 (2.77)	95.98%
Passage Comprehension	14	12.76 (1.56)	91.18%
Verbal Fluency	—	21.15 (2.79)	—

No significant sex differences were found across any subtest (Mann-Whitney U, all $p > .05$).

Evidence-Based Cut-off Scores & Normative Performance

	Mean	Range	Cut-off (P2)	Cut-off (P7)
Object Naming	146.04	137-150	137.01	140.64
PPTT	33.39	27-35	27.00	29.64
Read Aloud	71.82	70-72	70.04	71.00
Action Naming	65.25	60-67	60.04	62.00
Repetition (Disyllabic Nonword)	65.96	60-67	60.12	63.00
Repetition (Trisyllabic Nonword)	65.30	58-67	58.00	61.64
Verb Generation	50.35	45-52	45.04	47.00
Verbal Comprehension	29.90	29-30	29.00	29.00
Syntax Production	56.63	42-59	42.40	53.60
Passage Comprehension	12.76	7-14	7.00	10.60

Verbal Fluency Norms (N=52)

25.4(SD4.3)
ANIMALS

29.4(SD 5.6)
FOOD

13.7 (SD3.5)
FURNITURE

16.1(SD 3.2)
TRANSPORT

Passage Reading Speed

233.4

Words Per
Minute
(WPM)

Expanding the Normative Database and Clinical Validation Are the Critical Next Steps

Current Limitations

- **Sample size:** A sample of 51 is insufficient
- **Demographic skew:** The current sample is skewed toward younger, highly educated and predominantly female participants.
- **Clinical data:** There is currently limited clinical data from patients with brain tumors

Conclusion: Impact & Future Directions

Clinical Impact

Standardized Assessment

Evidence-Based Precision

Multidisciplinary Synergy

Future Roadmap

-  Clinical Validation
-  Longitudinal Tracking
-  Standard of Care

“

"Maximizing resection while safeguarding the unique linguistic identity of Cantonese-speaking patients."