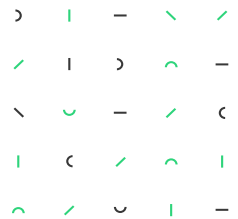


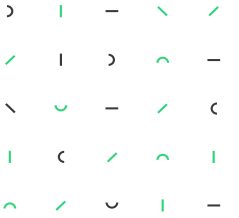
Effect Of Hearing Aids Usage On Cognitive Screening Performance Using Mini Mental State Examination and Montreal Cognitive Assessment In Elderly With Hearing Impairment



NHG DSRB Ref: 2020/01004
By: Teo Siok Chin (e0488960@u.nus.edu)
Supervised by: A/Prof Jenny Loo



CONTENT



1. Study Background

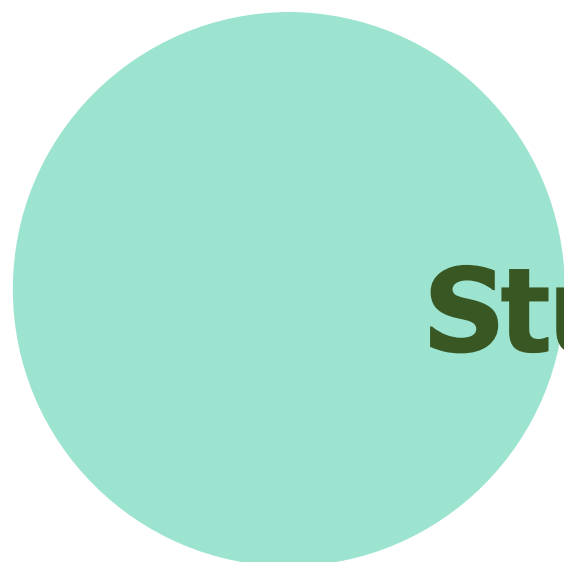
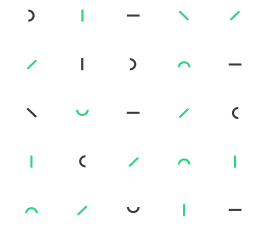
2. Methodology

3. Results and Discussion

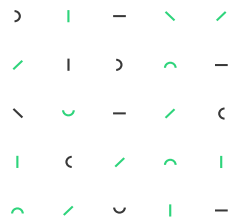
4. Conclusion

5. Credits





Study Background



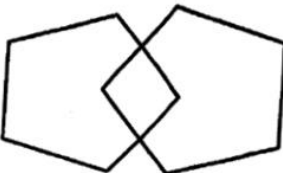
Cognitive Screening Tests

Mini Mental State Examination (MMSE)

Subject No. _____ Date _____

Domain	Question	Score
Orientation	Day of the week Today	(1)
	Today's date	(1)
	Month	(1)
	Year	(1)
	Place (Clinic / Hospital)	(1)
	Time (AM/PM/Nighttime)	(1)
	Name of the Place (NUH)	(1)
	Estate (Dover, Holland)	(1)
	Floor	(1)
	Country	(1)
Registration	3-Object Registration categories: Lemon, Key, Balloon	(3)
Attention and Calculation	Serial 7 (5 consecutive subtraction of 7 from 100)	(5)
Recall	3-Object Recall	(3)
Language	Name: Pencil, Watch	(2)
	Repeat: (English) "No ifs, ands, or buts" (Mandarin) "Forty-four Stone Lions" (Malay) "Marah Merah Murah"	(1)
	3-Stage Command: "Take this piece of paper, fold it into half, and put it on the table"	(1)
	Read and obey: "Raise your hands" (read if illiterate, instructed if illiterate)	(1)
Praxis	Write (or say, if illiterate) a sentence	(1)
	Copy Pentagons (All ten angles must be present and two must intersect to form a four sided figure)	(1)
TOTAL		(30)

Cognitex assessment sample version 1.1 dated 28 April 2015

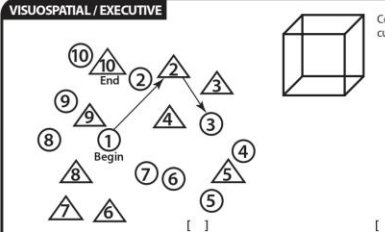
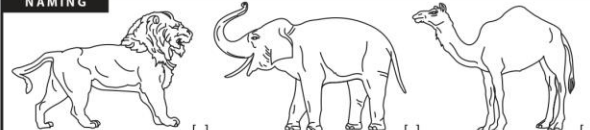


(Folstein et al., 1975)

Montreal Cognitive Assessment (MoCA)

Subject ID _____ Date _____

MONTREAL COGNITIVE ASSESSMENT (MOCA) - Singapore

VISUOSPATIAL / EXECUTIVE		Copy cube Draw CLOCK (Ten past eleven) (3 points)	POINTS
NAMING			
MEMORY	Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.	FACE SILK CHURCH ROSE RED	No points
ATTENTION	Read list of digits (1 digit/sec). Subject has to repeat them in the forward order [] 2 1 8 5 4 Subject has to repeat them in the backward order [] 7 4 2		/2
	Read list of numbers. The subject must tap with his hand at each number 1. No points if 2 errors [] 62137811976216174511191796112		/1
	Serial 7 subtraction starting at 100 [] 93 [] 86 [] 79 [] 72 [] 65		/3
LANGUAGE	Repeat: I only know that John will help me today. [] When dogs were in the room, the cat always hid under the bed. [] Fluency - Name as many animals as possible in one minute. [] _____ (N ≥ 11 words)		/2
ABSTRACTION	Similarity between e.g. banana - orange = fruit [] train - bicycle [] watch - ruler		/2
DELAYED RECALL	Has to recall words WITH NO CLUE [] FACE [] SILK [] CHURCH [] ROSE [] RED []	Points for UNCLUED recall only	/5
Optional	Category cue Multiple choice cue		
ORIENTATION	[] Date [] Month [] Year [] Day [] Place [] Country		/6
© Z.Nasreddine MD. Singapore Version (English) 30 September 2010. Modified by Dora Yehong and Christopher Chen. www.mocatest.org MoCA_English_Version_1_15_SEP_2020			TOTAL Add 1 point if ≤ 6 yr edu /30

(Nasreddine et al., 2005)

Cognitive Screening Tests



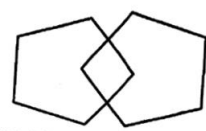
Administered verbally



Relies on hearing ability

MMSE

Domain	Question	Score
Orientation	Day of the week Today	11
	Today's date	11
	Month	11
	Year	11
	Place (State / Hospital)	11
	Time (AM/PM/Nighttime)	11
	Name of the Place (H/L)	11
	Estimate (Downer, H/L)	11
	Floor	11
	Country	11
Registration	3-Object Registration Categories: Lemon, Key, Balloon	11
Attention and Calculation	Serial 7 (5 consecutive subtraction of 7 from 100)	11
Recall	3-Object Recall	11
Language	Name: Pencil, Watch	11
	Repeat: (English) "No 10, and 6, or bus" (Mandarin) "Forty-four Stone Lions" (Malay) "Marsah Marsah Murat"	11
	3-Stage Command: "Take this piece of paper, fold it into half, and put it on the table" Read and obey: "Raise your hands" (read if illiterate, instructed if illiterate)	11
Praxis	Copy Pentagons (All ten angles must be present and two must intersect to form a four sided figure)	11
	TOTAL	30



Cognitive assessment sample version 1.1
dated 28 April 2015
MMSE English (with Mandarin and Malay language subtests), Version 1_16 SEP 2020

MoCA

MONTREAL COGNITIVE ASSESSMENT (MOCA) - Singapore

Subject ID: _____
Date: _____

Category	Task	Score
VISUOSPATIAL / EXECUTIVE	Copy cube	1
	Draw CLOCK (Ten past eleven) (3 points)	5
NAMING	Contour	1
	Numbers	1
	Hands	1
MEMORY	FACE	1
	SILK	1
ATTENTION	ROSE	1
	RED	1
LANGUAGE	Repeat: I only know that John will help me today.	1
	Fluency - Name as many animals as possible in one minute.	1
ABSTRACTION	Similarity between e.g. banana - orange - fruit	1
	train - bicycle	1
DELAYED RECALL	watch - ruler	1
	Has to recall words WITH NO CUE	1
Optional	Category Cue	1
	Match choice	1
ORIENTATION	Date	1
	Place	1
TOTAL		30

© E. Nasreddine MD
Singapore Version (English) 30 September 2003
Revised by Dora Venkoo and Christopher Chen
www.mocatest.org
MOCA_English_Version_1_16 SEP 2020

Literature Review

Review:

Individuals with hearing impairment were associated with lower cognitive scores for MoCA and MMSE

(Dupuis et al., 2015; Jorgensen et al., 2016)

Study on local elderly population:

MoCA and MMSE performance in a group of healthy elderly population with hearing impairment.

(Lim & Loo, 2018).



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RESEARCH ARTICLE

WILEY Geriatric Psychiatry

Screening an elderly hearing impaired population for mild cognitive impairment using Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA)

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²Department of Otolaryngology, Head and Neck Surgery, National University Hospital, Singapore

Correspondence

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Email: magdalene_lim@nuhs.edu.sg

Objectives: To determine if there is an association between hearing loss and poorer cognitive scores on Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) and to determine if poor hearing acuity affects scoring on the cognitive screening tests of MMSE and MoCA.

Methods: One hundred fourteen elderly patients (Singapore residents) aged between 55 and 86 years were sampled. Participants completed a brief history questionnaire, pure tone audiometry, and 2 cognitive screening tests—the MMSE and MoCA. Average hearing thresholds of the better ear in the frequencies of 0.5, 1, 2, and 4 kHz were used for data analysis.

Results: Hearing loss was significantly associated with poorer cognitive scores in Poisson regression models adjusted for age. Mini-Mental State Examination scores were shown to decrease by 2.8% ($P = .029$), and MoCA scores by 3.5% ($P = .013$) for every 10 dB of hearing loss. Analysis of hearing-sensitive components of "Registration" and "Recall" in MMSE and MoCA using chi-square tests showed significantly poorer performance in the hearing loss group as compared to the normal hearing group. Phonetic analysis of target words with high error rates shows that the poor performance was likely contributed by decreased hearing acuity, on top of a possible true deficit in cognition in the hearing impaired.

Conclusions: Hearing loss is associated with poorer cognitive scores on MMSE and MoCA, and cognitive scoring is likely confounded by poor hearing ability. This highlights an important, often overlooked aspect of sensory impairment during cognitive screening. Provisions should be made when testing for cognition in the hearing-impaired population to avoid over-referral and subsequent misdiagnoses of cognitive impairment.

KEYWORDS

cognitive impairment, cognitive screening, hearing impairment, hearing loss, MMSE, MoCA

1 | INTRODUCTION

Hearing impairment and cognitive decline are both common conditions that occur with aging, and are thought to have high comorbidity in the elderly. Hearing loss (HL) is estimated to affect approximately one-third of older persons aged 65 and above,¹ and several recent studies have suggested an association between poor hearing acuity and cognitive decline, including with conditions such as mild cognitive impairment (MCI) and dementia.²⁻⁷

The authors confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

A commonly overlooked fact, however, is that detection and diagnoses of cognitive impairment are frequently dependent upon results from cognitive screening tests, which are administered verbally, and thus contain components that need to be heard. Administration of such tests on individuals with undetected hearing problems might lead to false representation of cognitive impairment, as cognitive scores might be confounded by their inability to hear test items. Currently, the more commonly used cognitive screening tests are the Mini-Mental State Examination (MMSE)⁸ and the Montreal Cognitive Assessment (MoCA).⁹ Mini-Mental State Examination is considered as a standard cognitive assessment tool and is commonly used in the diagnosis of dementia,^{10,11} while MoCA is widely used for detection

Screening an elderly hearing impaired population for mild cognitive impairment using Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA)

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Conclusions: Hearing loss is associated with poorer cognitive scores on MMSE and MoCA, and cognitive scoring is likely confounded by poor hearing ability. This highlights an important, often overlooked aspect of sensory impairment during cognitive screening. Provisions should be made when testing for cognition in the hearing-impaired population to avoid over-referral and subsequent misdiagnoses of cognitive impairment.

Hearing aid users **performed better on the MMSE**, despite having poorer hearing.
(Qian et al., 2016)

Experienced hearing aid users had **better MoCA performance** compared to non-hearing aid users
(Castiglione et al., 2016)

Significant improvement in MMSE scores after 3 months of hearing aids usage
(Acar et al., 2011)

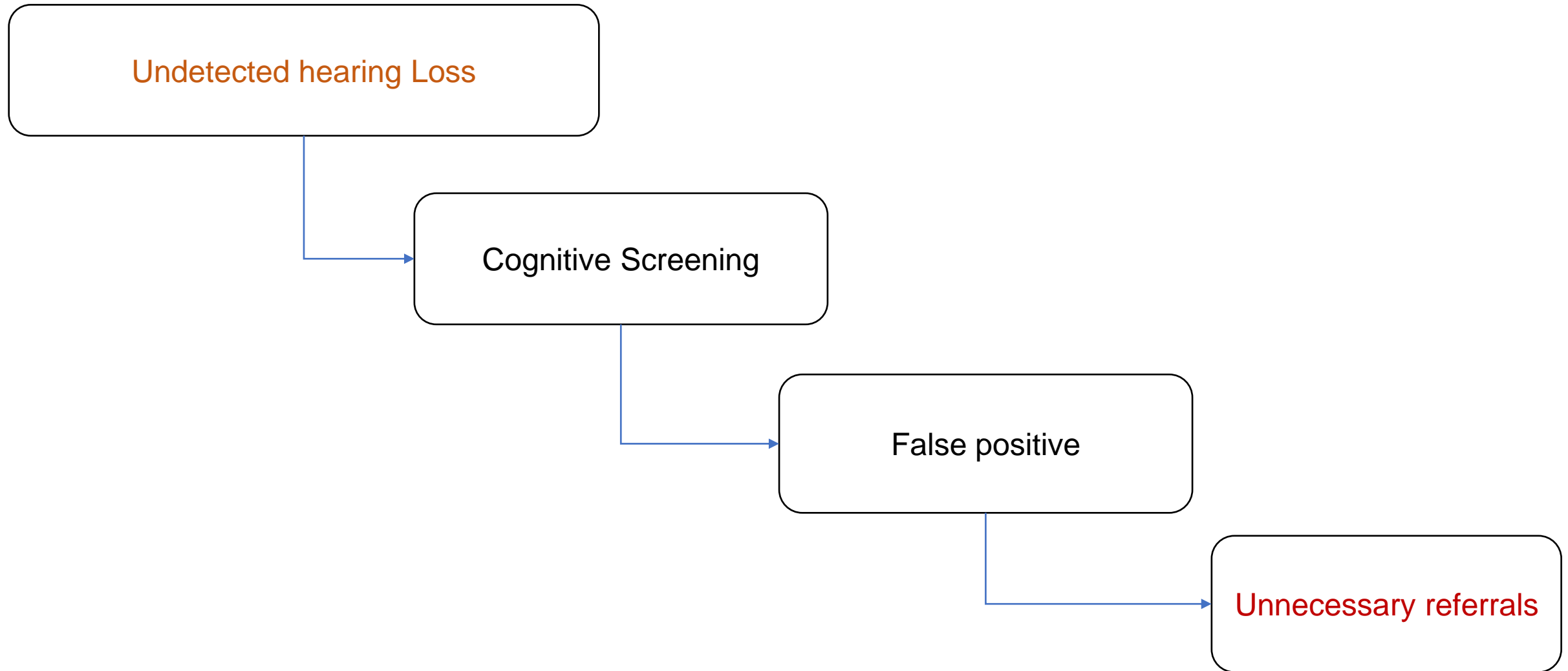
No significant change in MoCA performance with and without hearing augmentation
(Saunders et al., 2018)

Singapore ?

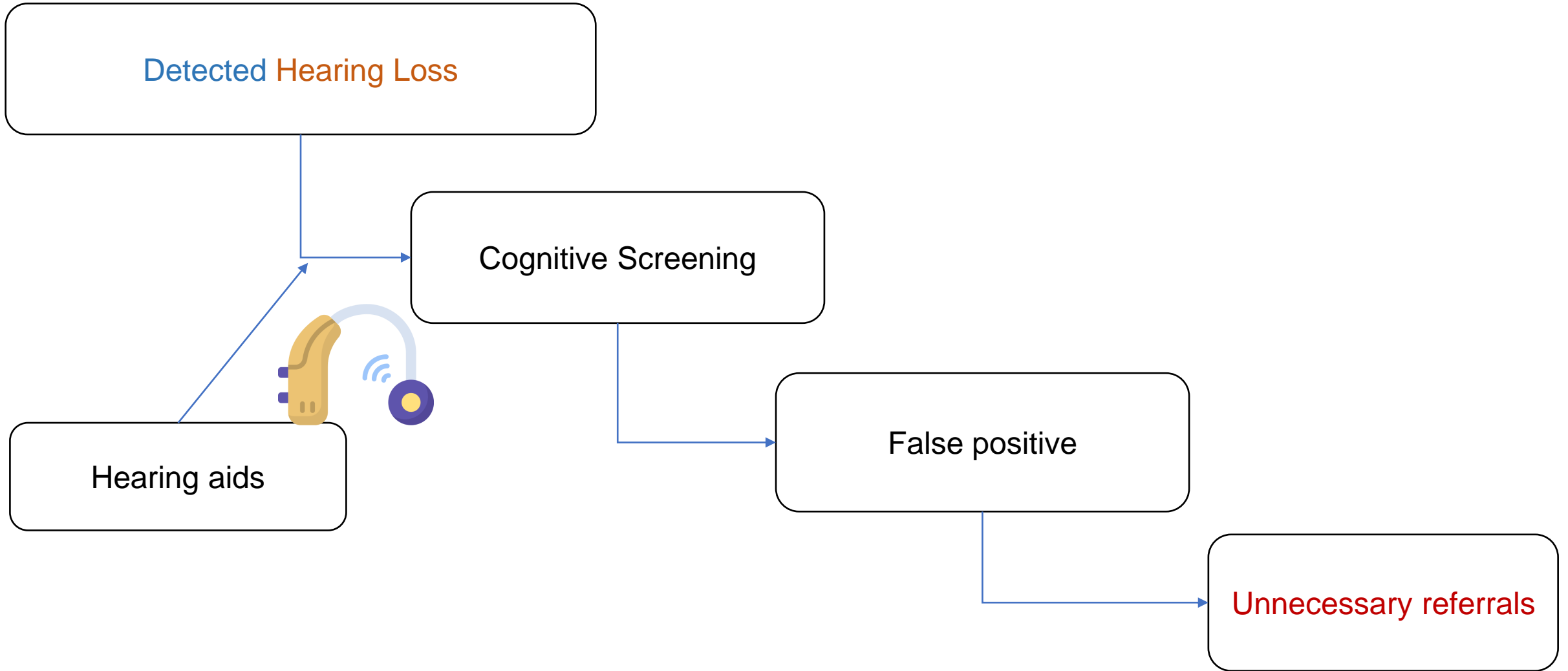
Clinical Significance

1. Multilingual society
 - Local versions of MMSE and MoCA (English, Mandarin and Malay)
2. Hearing screening and intervention not mandatory before cognitive screening test.

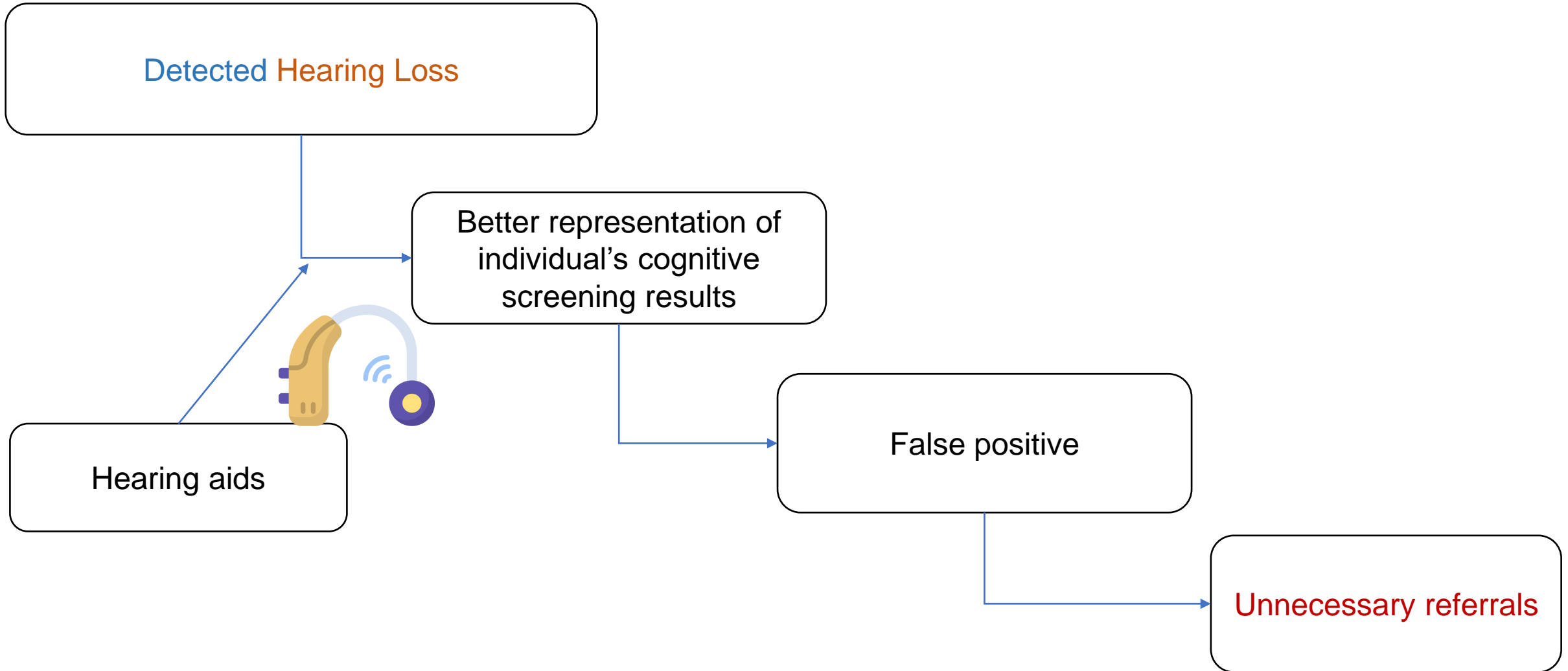
Clinical Significance



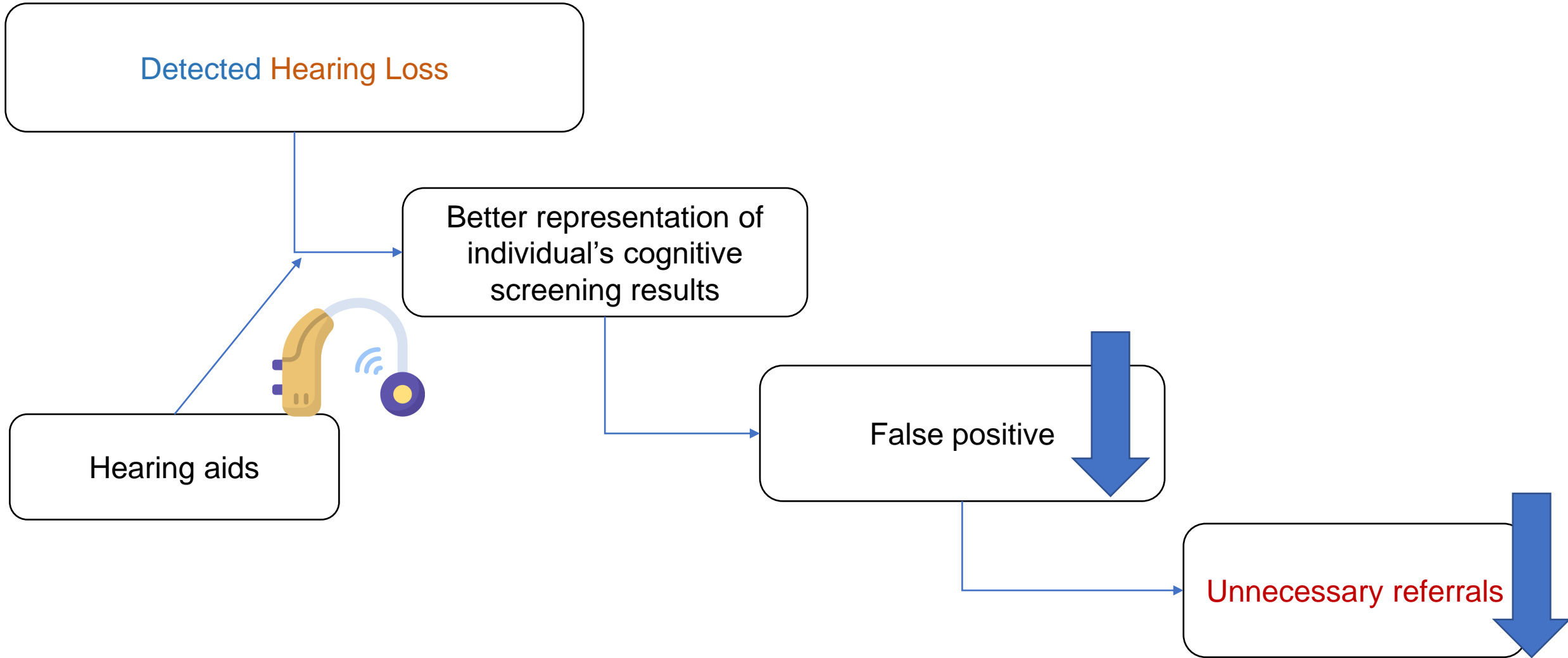
Clinical Significance



Clinical Significance



Clinical Significance



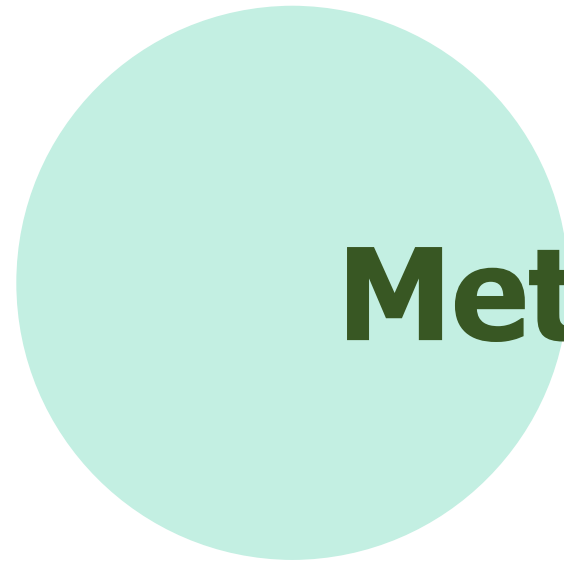
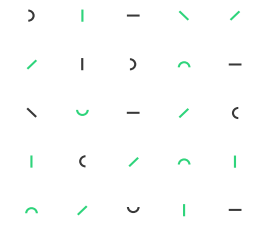
Study Aim

The effect of **hearing aids usage** on **cognitive screening performance** (MMSE and MoCA) in elderly with **hearing impairment**.

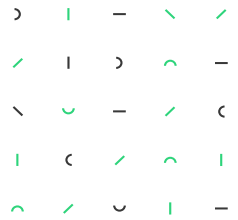
Does hearing aids usage **better represent** the performance of healthy hearing-impaired elderly during cognitive screening tests.

Hypothesis

There is a **significant improvement** in MMSE and MoCA cognitive screening test scores of elderly with hearing impairment **after hearing aid usage** compared to before hearing aid usage.



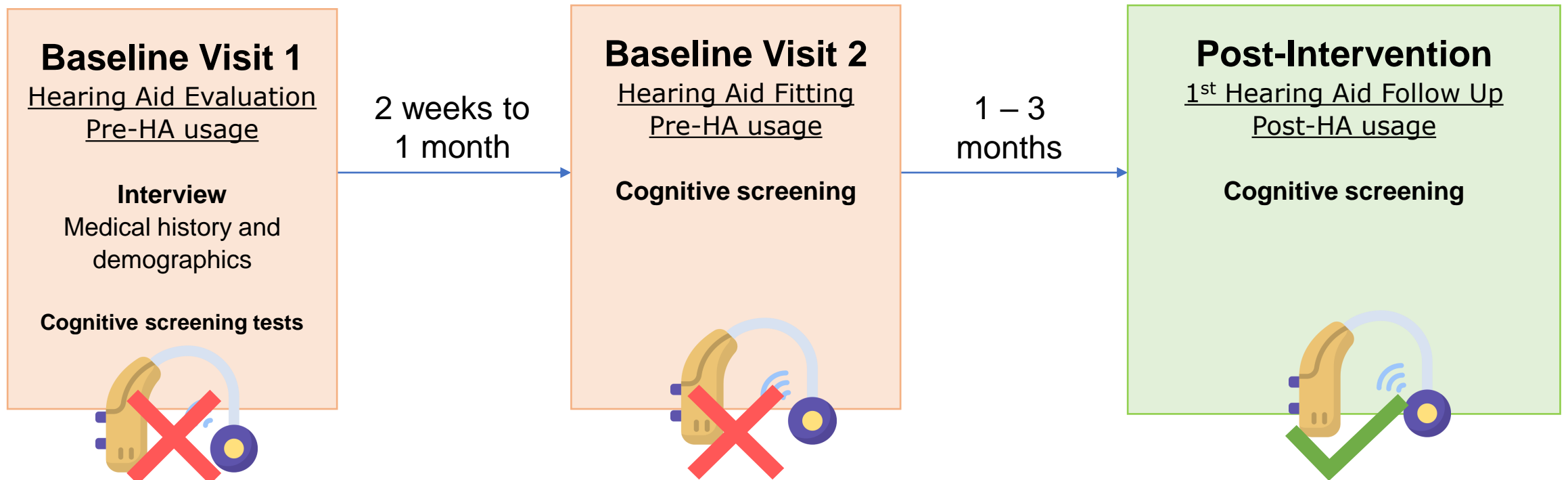
Methodology



Study Design and Procedure

Location: National University Hospital Singapore

Single-subject study (Each participant acts as his or her own control)



Two Baseline visits.

(To account for any procedural effect and act as control)

Test Materials

- Local versions of MMSE and MoCA cognitive screening test (English and Mandarin)
- Scoring ranges from 0 (Worst performance) → 30 (Best Performance)
- Normal limits cut off value.
 - MMSE > 25*
 - MoCA > 22*

*Department of Psychological Medicine, of National University Hospital

*(Lim & Loo, 2018).

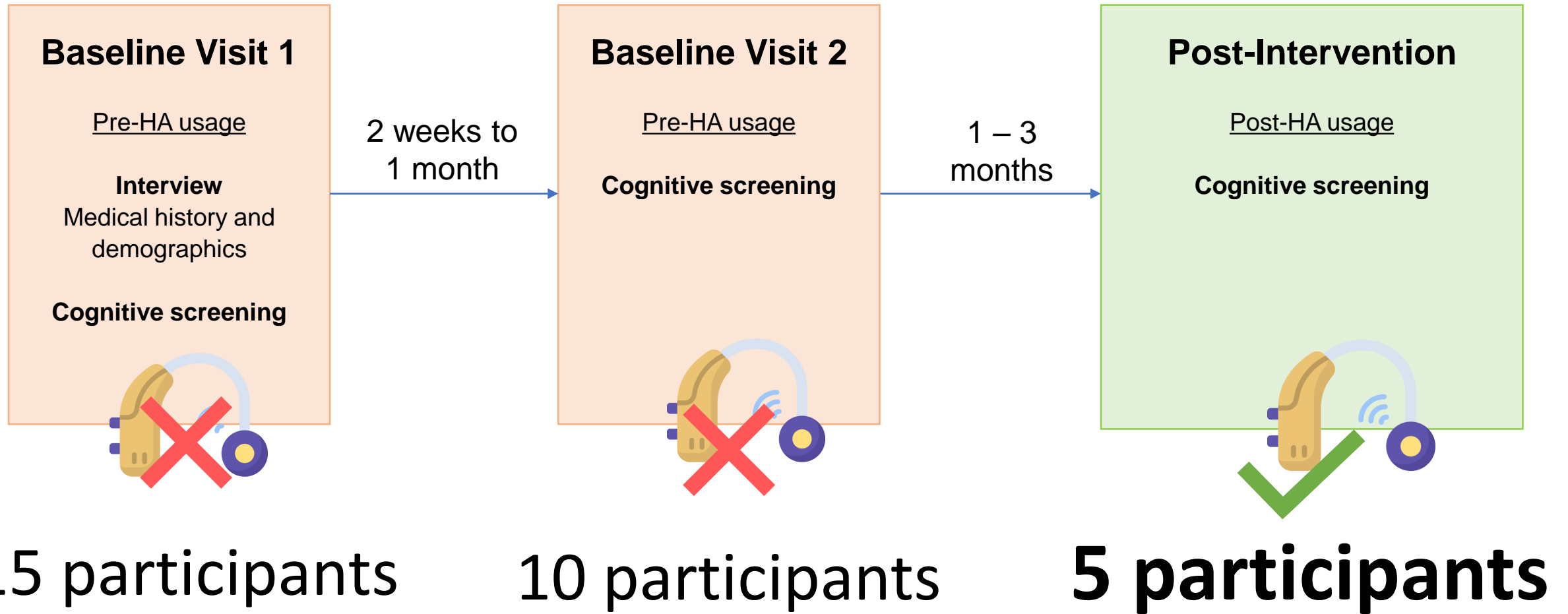
Inclusion Criteria

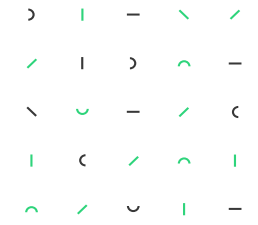
- ≥ 60 years old
- Moderate to severe sensorineural hearing loss
- Have not used hearing aids within the past 5 years and keen to purchase
- No diagnosis of cognitive impairment or dementia
- Can follow verbal instructions.
- Patient who speaks and legible in English or Mandarin.

Exclusion Criteria

- Unilateral hearing loss

Sample Size

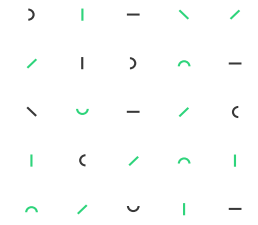




Results and Discussion

1. Changes in Overall Cognitive Scores
2. Registration and Recall Performance
 - Hearing sensitive component



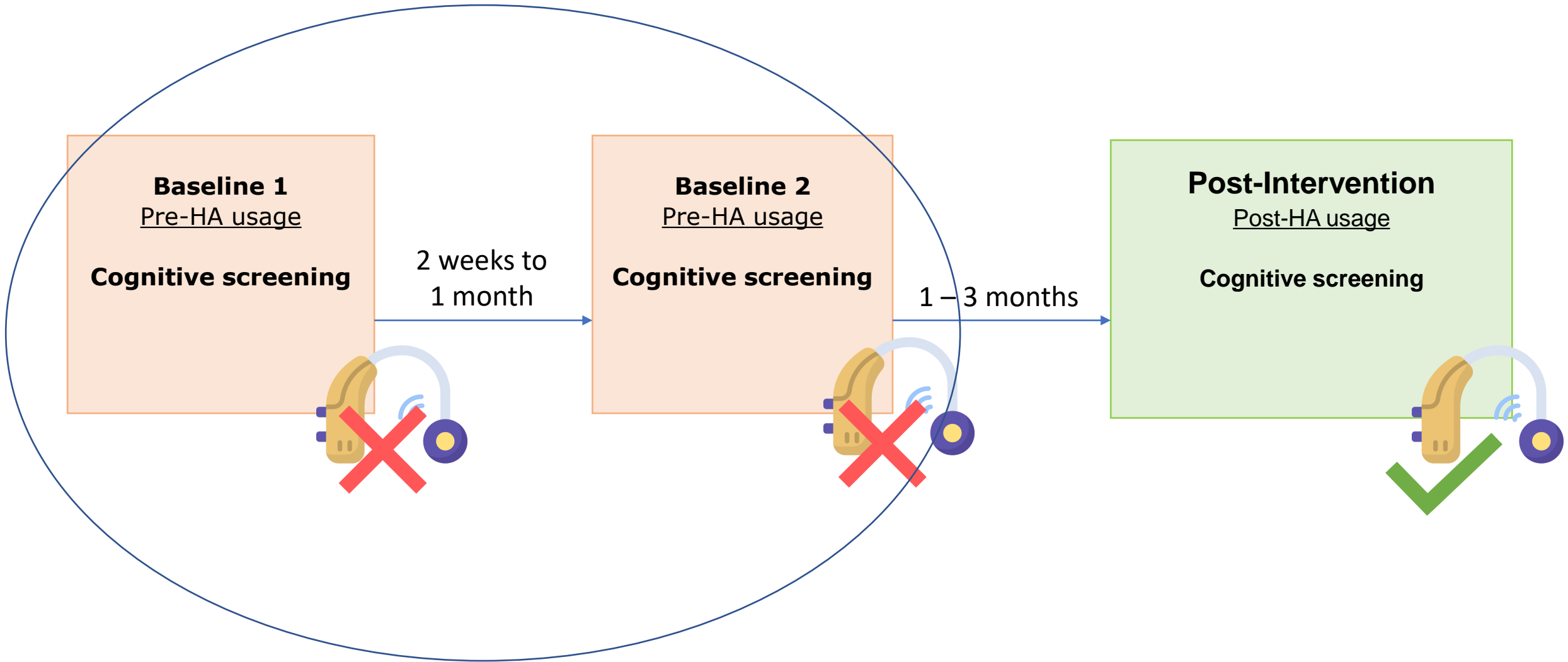


Results and Discussion

1. Changes in Overall Cognitive Scores
2. Registration and Recall Performance
 - Hearing sensitive component



Analysis: Baseline Cognitive Scores



Analysis: Baseline Cognitive Scores

Non-parametric test was conducted to **compare both baseline scores** (Wilcoxon Sign Rank Test – jamovi 1.6.16).

Summary of MMSE and MoCA tests scores at Baseline (n = 5)

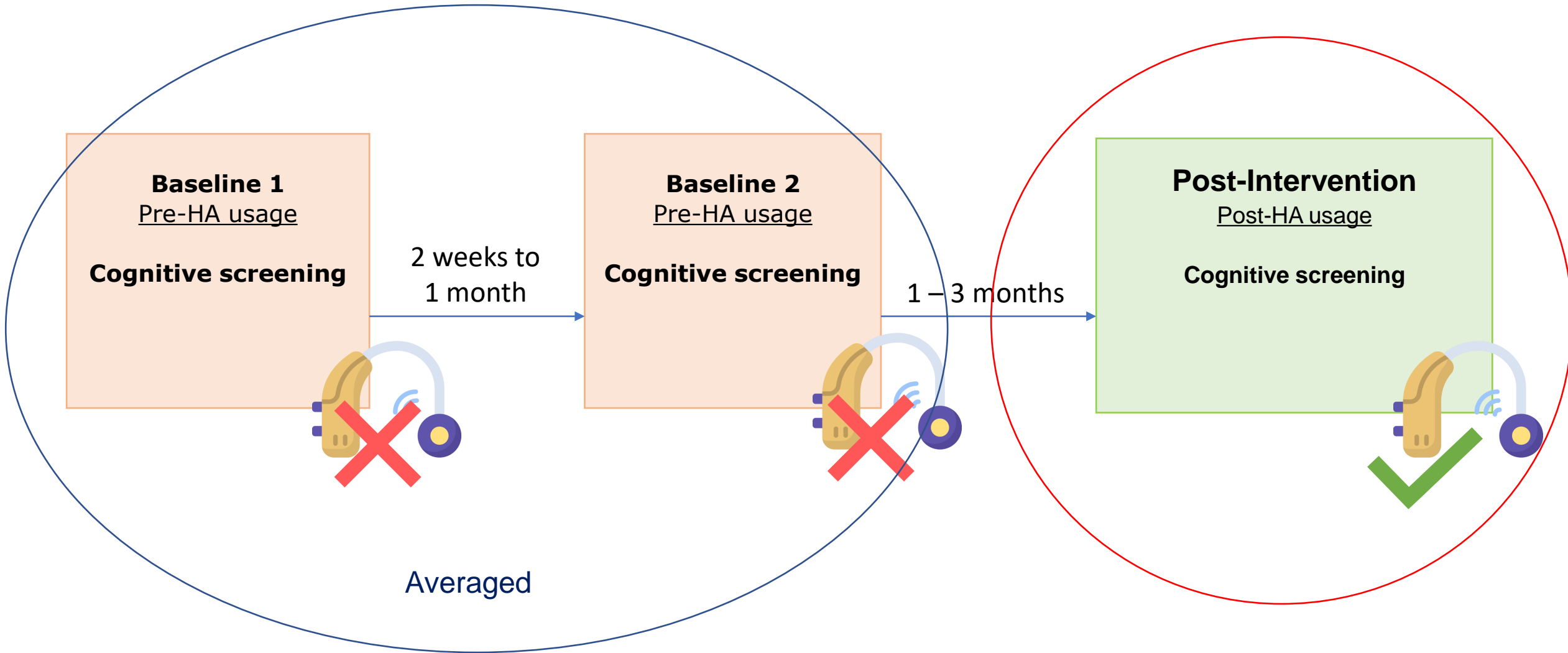
Cognitive Screening Tests	Score (n = 5)		p (n = 5)
	Baseline 1	Baseline 2	Baseline 1/ Baseline 2
MMSE			
Mean	24.6	23.6	0.345
Median	24.0	24.0	
SD	2.8	3.1	
MoCA			
Mean	20.4	21.2	0.713
Median	19.0	21.0	
SD	2.0	3.4	

Both baseline scores were not significantly different.

Scores obtained from both baseline were averaged before comparing to post-intervention scores

p value ≤ 0.05 indicates significance

Analysis: Post Intervention Cognitive Scores



Analysis: Post Intervention Cognitive Scores

- Non-parametric test was conducted to compare both averaged baseline and post intervention scores (Wilcoxon Sign Rank Test -jamovi 1.6.16).

Summary of MMSE and MoCA tests scores at Baseline and at post HA usage.

Cognitive Screening Tests	Score (n = 5)		p (n = 5)
	Baseline average	Post Intervention	Baseline Average/ Post Intervention
MMSE			
Mean	24.1	25.8	0.269
Median	23.0	27.0	
SD	2.8	3.0	
MoCA			
Mean	20.8	24.6	0.058
Median	21.5	24.0	
SD	2.4	2.1	

* p value ≤ 0.05 indicates significance

Both MoCA and MMSE scores at post-HA usage did not show significant difference.

Limitation: Small sample size

Analysis: Post Intervention Cognitive Scores

Summary of MMSE and MoCA tests scores at Baseline and at post HA usage.

Cognitive Screening Tests	Score ($n = 5$)		p ($n = 5$)
	Baseline average	Post Intervention	Baseline Average/ Post Intervention
MMSE			
Mean	24.1	25.8	0.269
Median	23.0	27.0	
SD	2.8	3.0	
MoCA			
Mean	20.8	24.6	0.058
Median	21.5	24.0	
SD	2.4	2.1	

* p value ≤ 0.05 indicates significance

1. Scores for MoCA managed to show a tendency towards significance ($p = 0.058$).

Analysis: Post Intervention Cognitive Scores

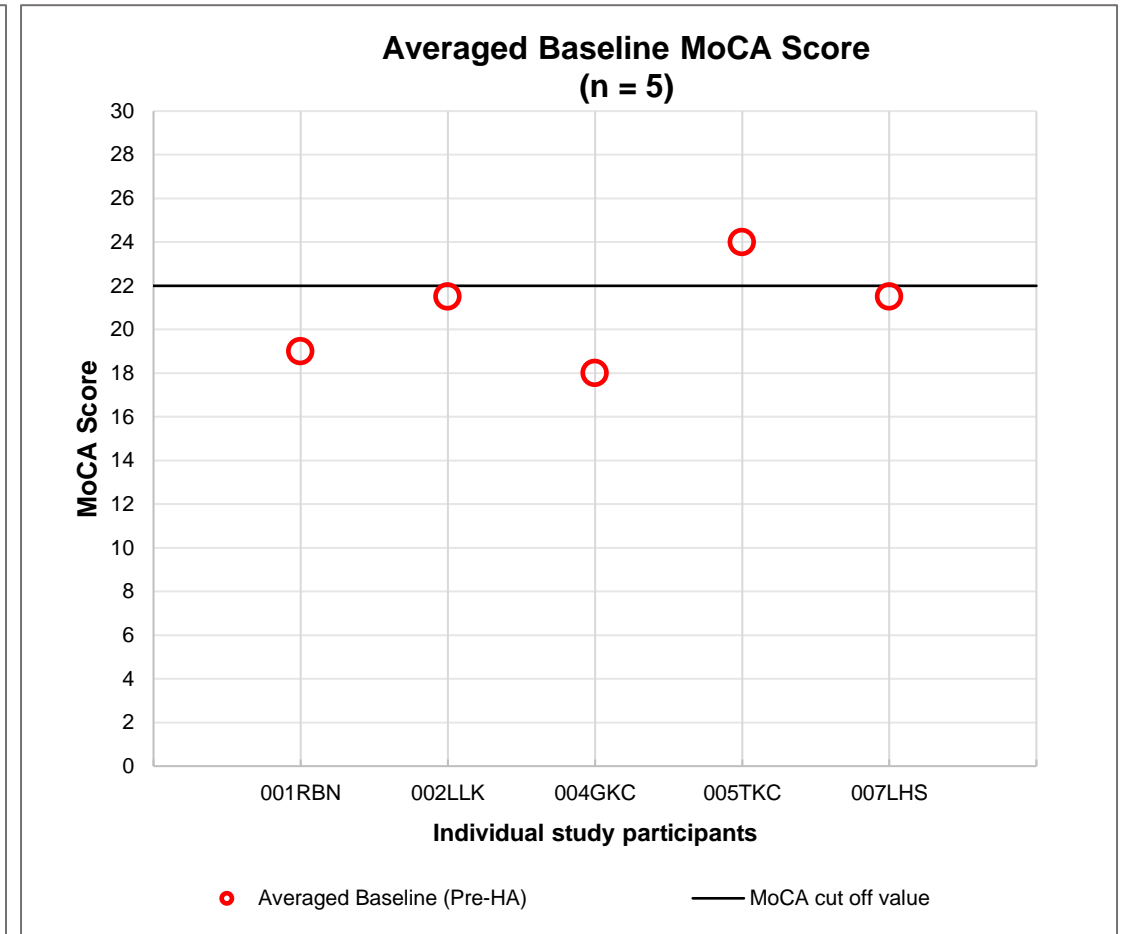
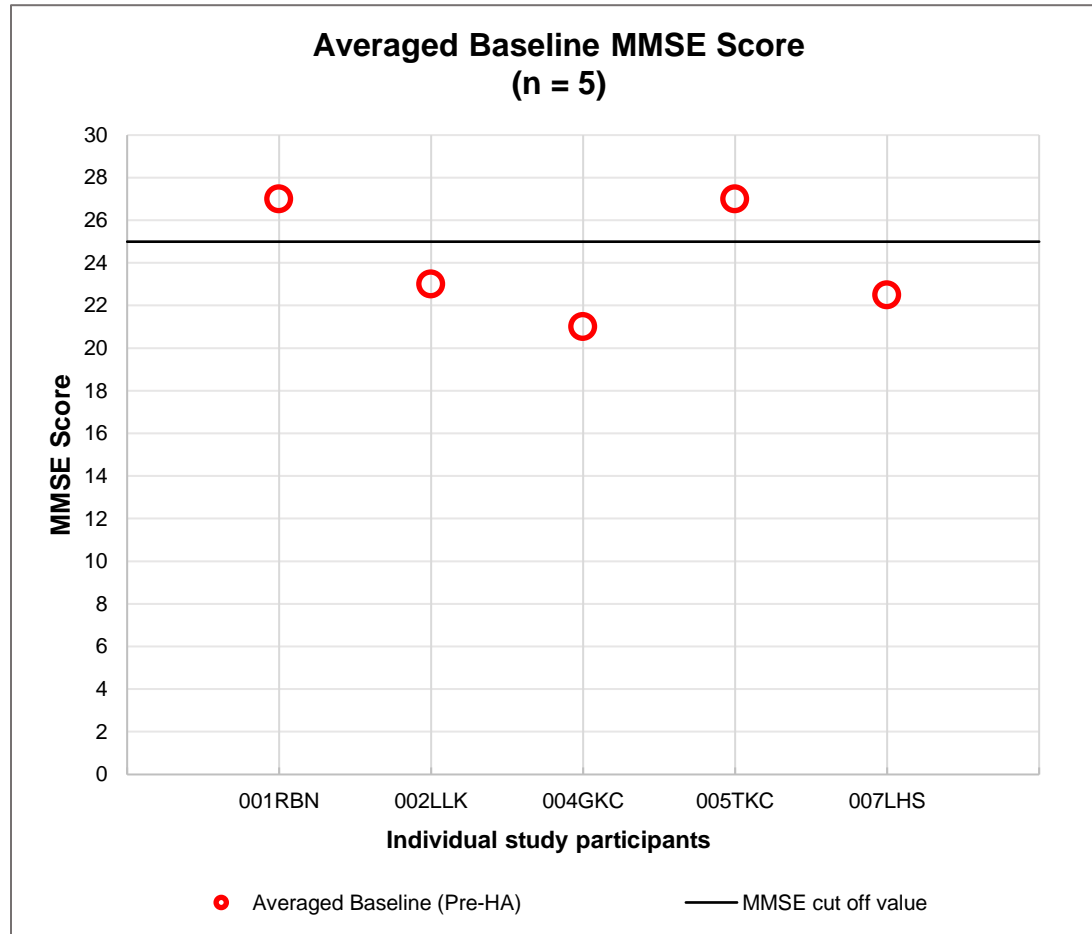
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Cognitive Screening Tests	Score (n = 5)		p (n = 5)
	Baseline average	Post Intervention	
MMSE			
Mean	24.1	25.8	0.269
Median	23.0	27.0	
SD	2.8	3.0	
MoCA			
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SD	2.4	2.1	

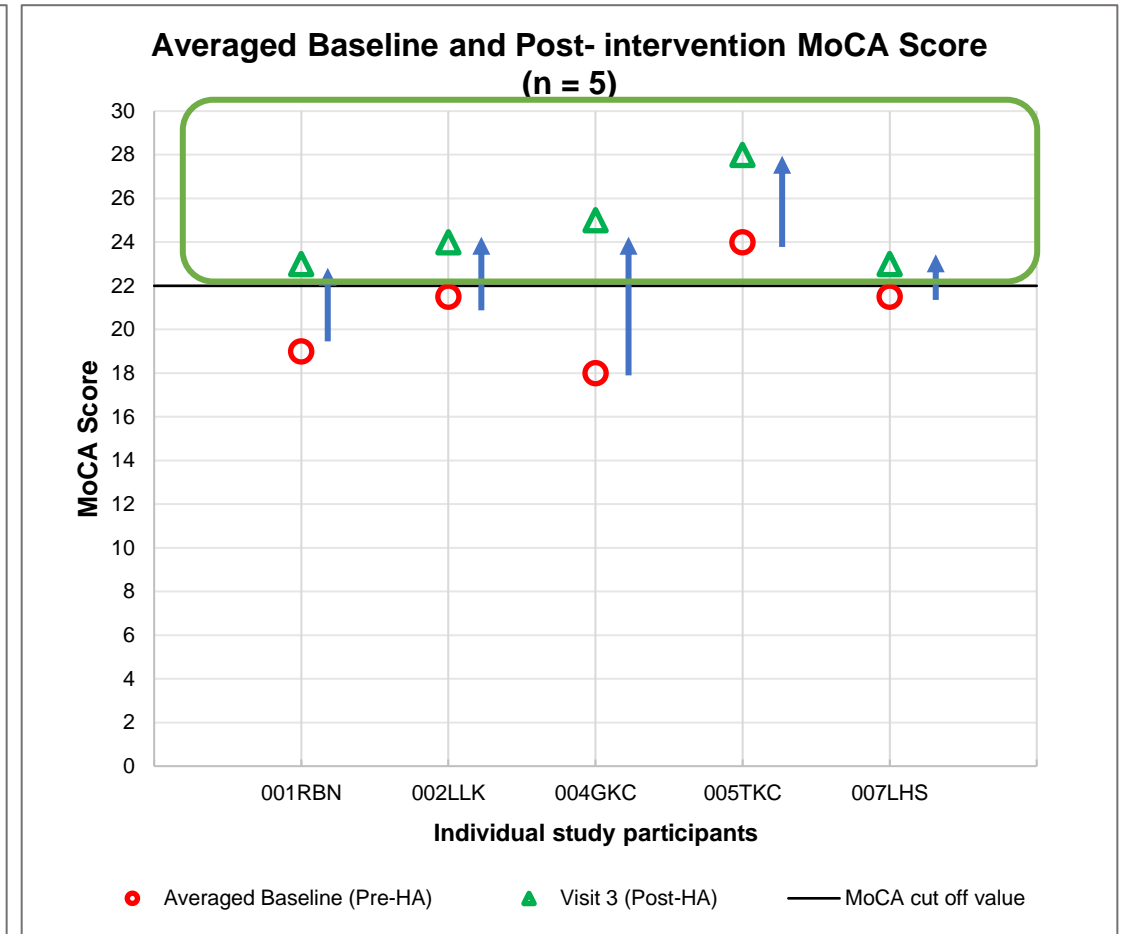
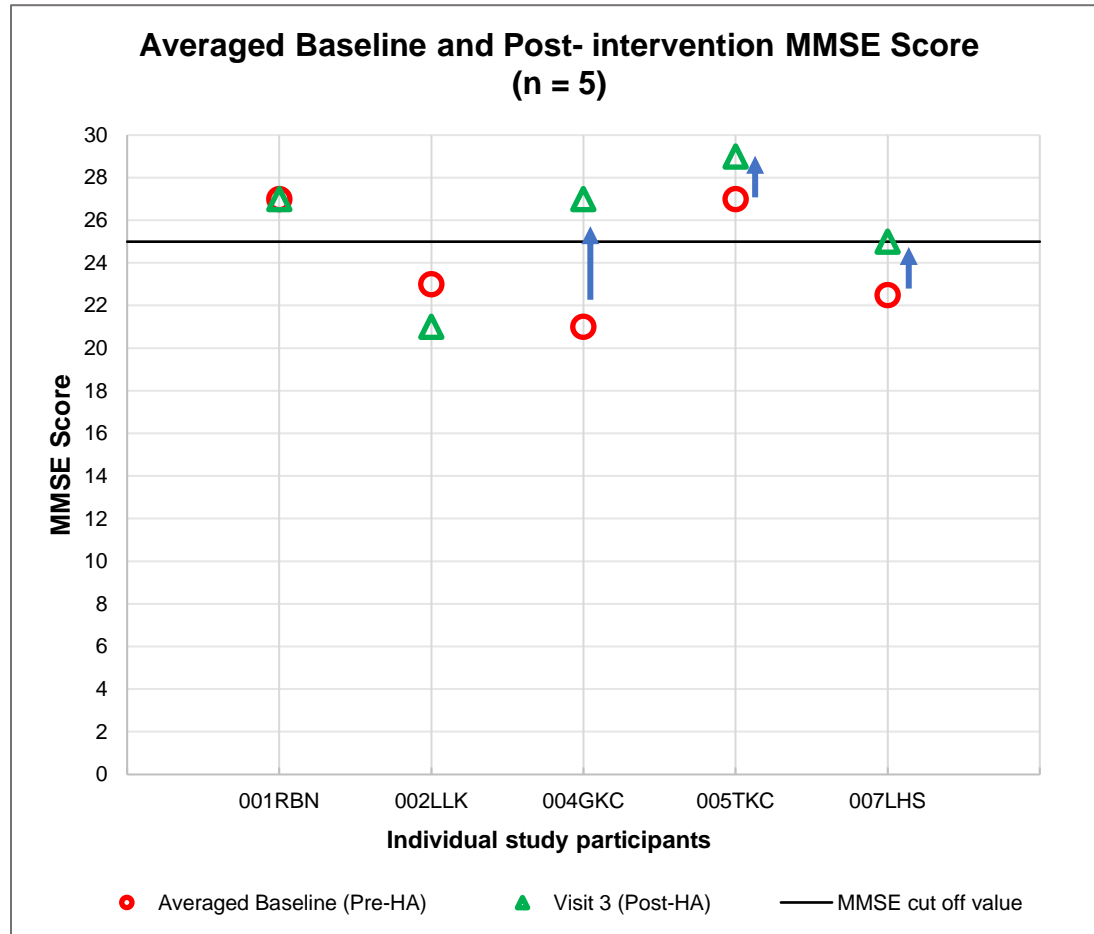
* p value ≤ 0.05 indicates significance

1. Scores for MoCA managed to show a tendency towards significance ($p = 0.058$).
2. Through observing median scores for both test
 - A positive change observed from both tests at baseline and after HA usage.
 - MMSE (> 25): Increased from 23.0 \rightarrow 27.0
 - MoCA (> 22) : Increased 21.5 \rightarrow 24.0

Visual Representation



Visual Representation



Discussion

Improvements in
MoCA performance

>
More evident

Improvements in
MMSE performance

Discussion

Effect of hearing impairment on
(Dupuis et al., 2015).

Improvements in
MoCA performance

>
More evident

Improvements in
MMSE performance

MoCA

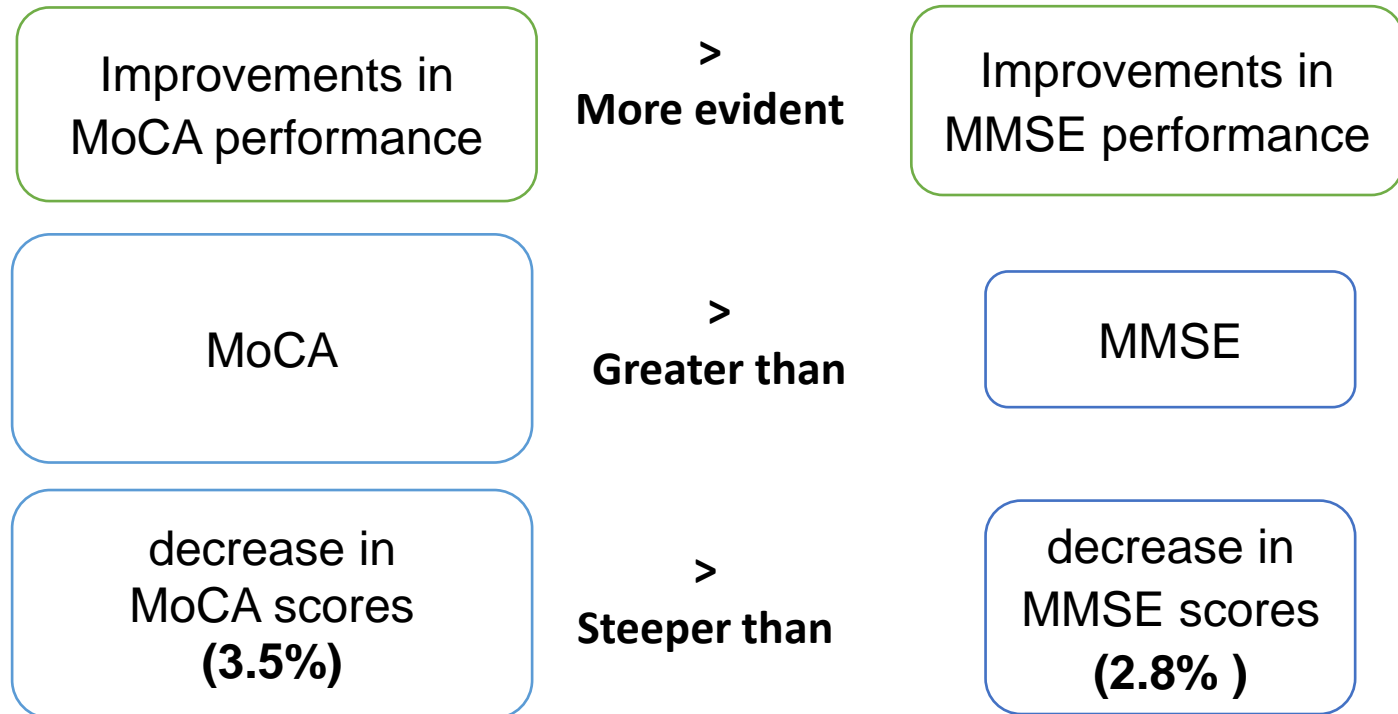
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Greater than

MMSE

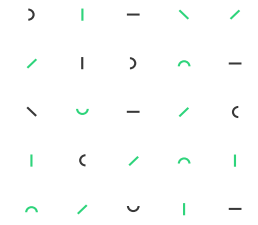
Discussion

Effect of hearing impairment on
(Dupuis et al., 2015).

For every 10dB HL of
hearing impairment,
(Lim and Loo, 2018)

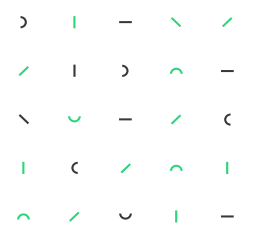


- MoCA were known to be more affected by hearing ability
- Obvious improvement in performance can be observed through MoCA after hearing aid usage.
- Poorer MoCA performance at baseline may have been compensated with the use of hearing aids.



Results and Discussion

1. Changes in Cognitive Scores
2. Registration and Recall
 - Hearing sensitive component



MMSE

Registration	3-Object Registration categories: Lemon, Key, Balloon (3)
Attention and Calculation	Serial 7 (5 consecutive subtraction of 7 from 100) (5)
Recall	3-Object Recall (3)

1. Word Registration/ Memory

Required to hear and repeat the words presented correctly.

MMSE – 5 trials

MoCA – 2 trials

MoCA

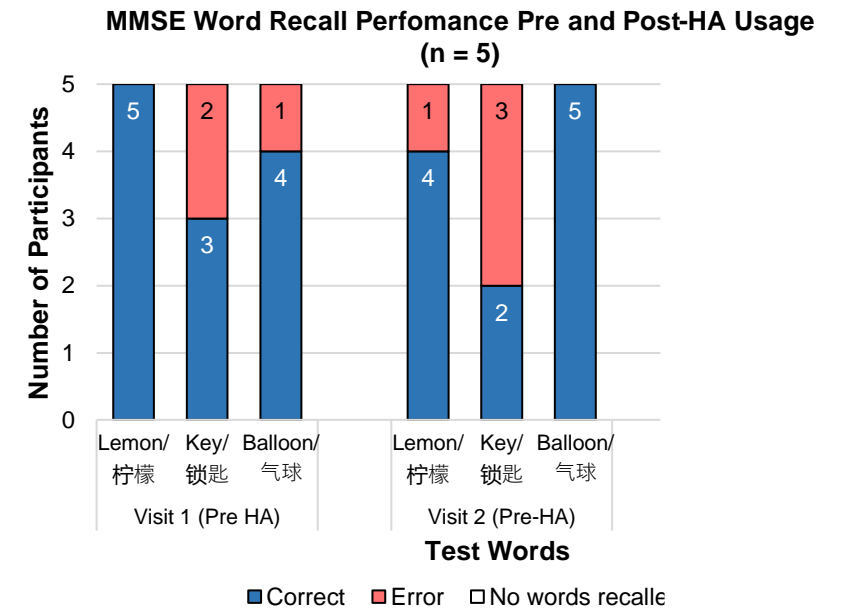
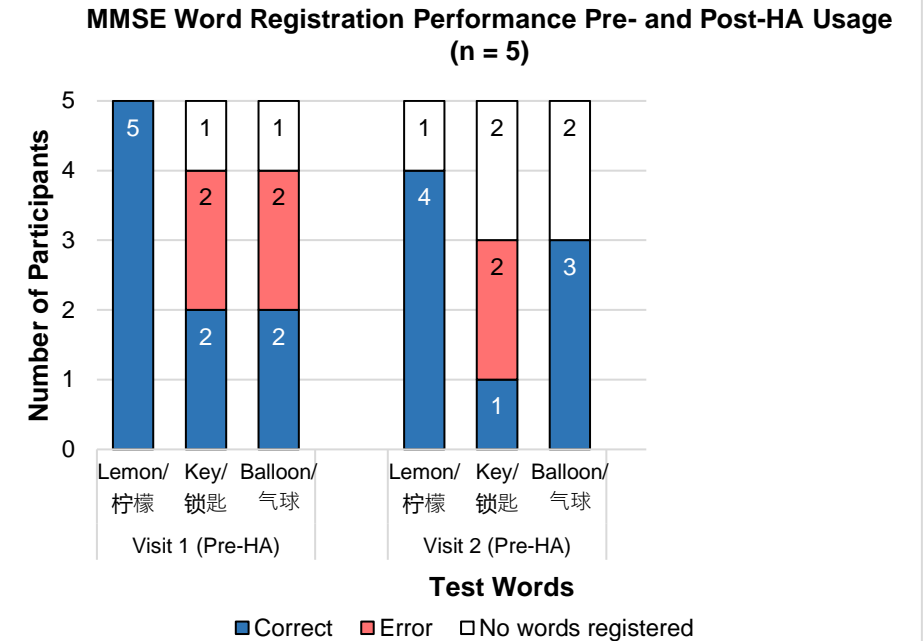
MEMORY	Read list of words, subject must repeat them. Do 2 trials, even if 1st trial is successful. Do a recall after 5 minutes.	FACE	SILK	CHURCH	ROSE	RED	No points
		1st trial					
		2nd trial					
ATTENTION	Read list of digits (1 digit/ sec.). Subject has to repeat them in the forward order [] 2 1 8 5 4 Subject has to repeat them in the backward order [] 7 4 2						___/2
	Read list of numbers. The subject must tap with his hand at each number 1. No points if ≥ 2 errors [] 6 2 1 3 7 8 1 1 9 7 6 2 1 6 1 7 4 5 1 1 1 9 1 7 9 6 1 1 2						___/1
	Serial 7 subtraction starting at 100 [] 93 [] 86 [] 79 [] 72 [] 65 4 or 5 correct subtractions: 3 pts , 2 or 3 correct: 2 pts , 1 correct: 1 pt , 0 correct: 0 pt						___/3
LANGUAGE	Repeat: I only know that John will help me today. [] When dogs were in the room, the cat always hid under the bed. []						___/2
	Fluency – Name as many animals as possible in one minute. [] ____ (N ≥ 11 words)						___/1
ABSTRACTION	Similarity between e.g. banana - orange - fruit [] train - bicycle [] watch - ruler						___/2
DELAYED RECALL	Has to recall words WITH NO CUE	FACE	SILK	CHURCH	ROSE	RED	Points for UNCUE recall only
	Category cue	[]	[]	[]	[]	[]	
Optional	Multiple choice cue						
ORIENTATION	[] Date [] Month [] Year [] Day [] Place [] Country						___/6



2. Word Recall (MMSE)/ Delayed Recall (MoCA)

Required to remember and recall the correct words.

MMSE (Baseline) Registration and Recall Performance

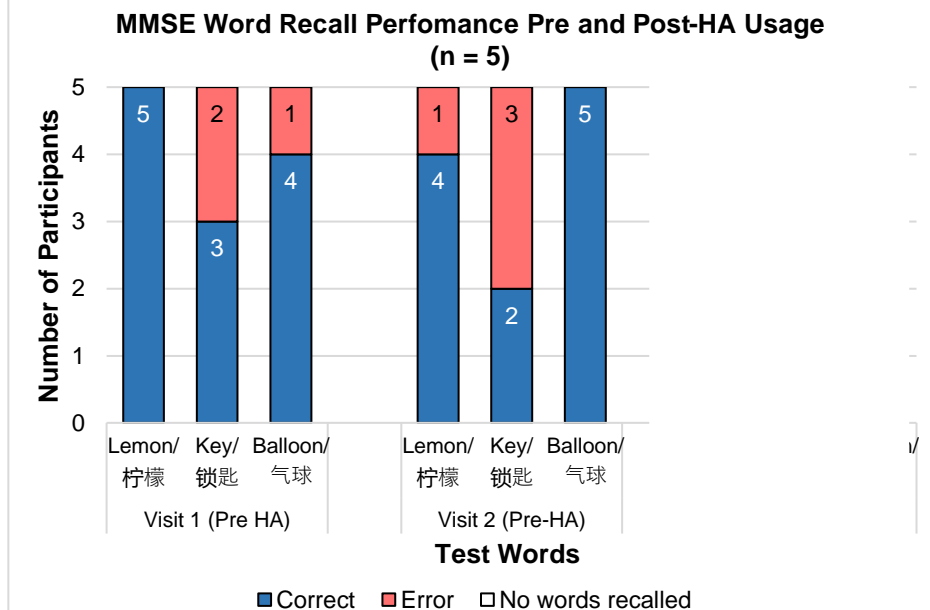
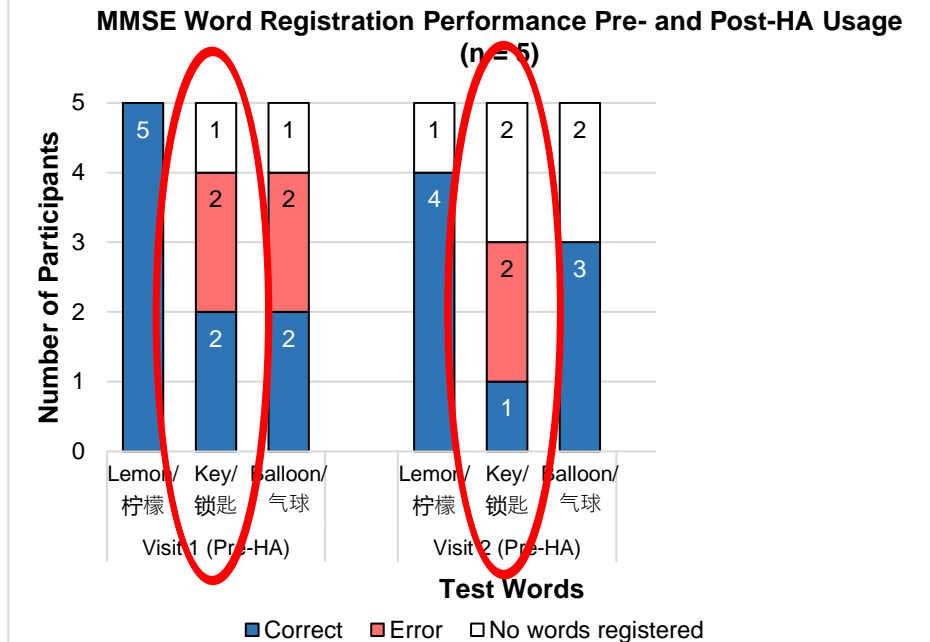


MMSE (Baseline) Registration and Recall Performance

- Poorest registration performance before hearing aids usage - “KEY” and “锁匙/suo’shi”

Common Error – Substitution

Language	Test Word	Word substitution error
English	KEY	TEA
Mandarin	锁匙/suo'shi' (Key)	果实/guǒ shí (Fruits)



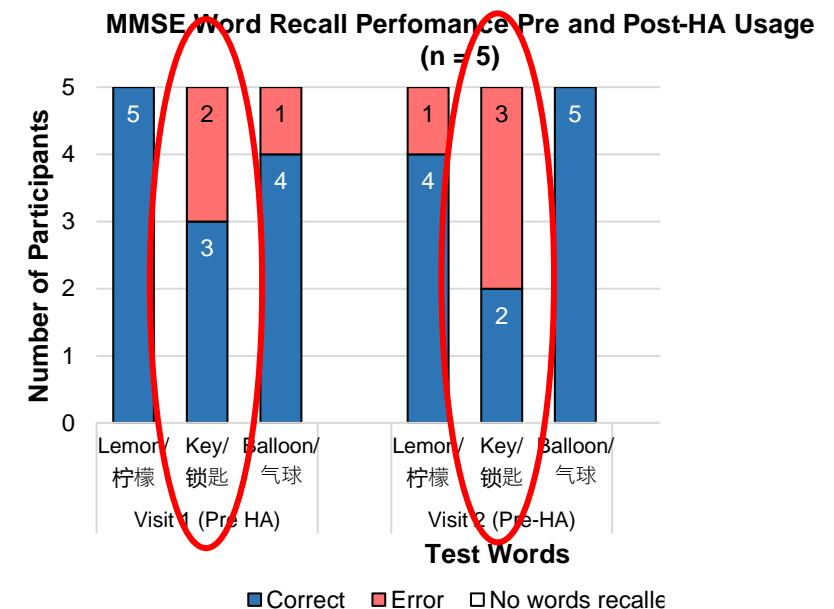
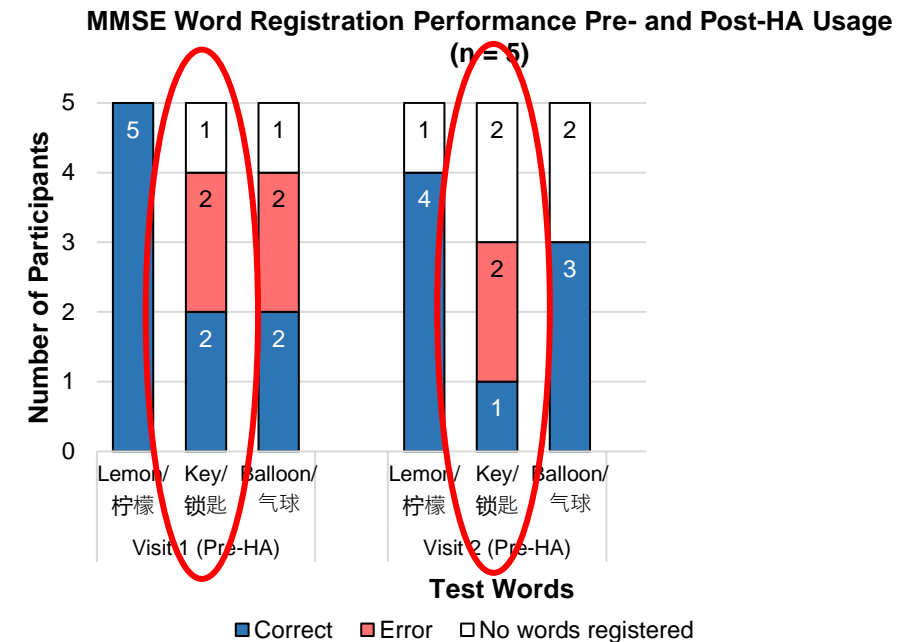
MMSE (Baseline) Registration and Recall Performance

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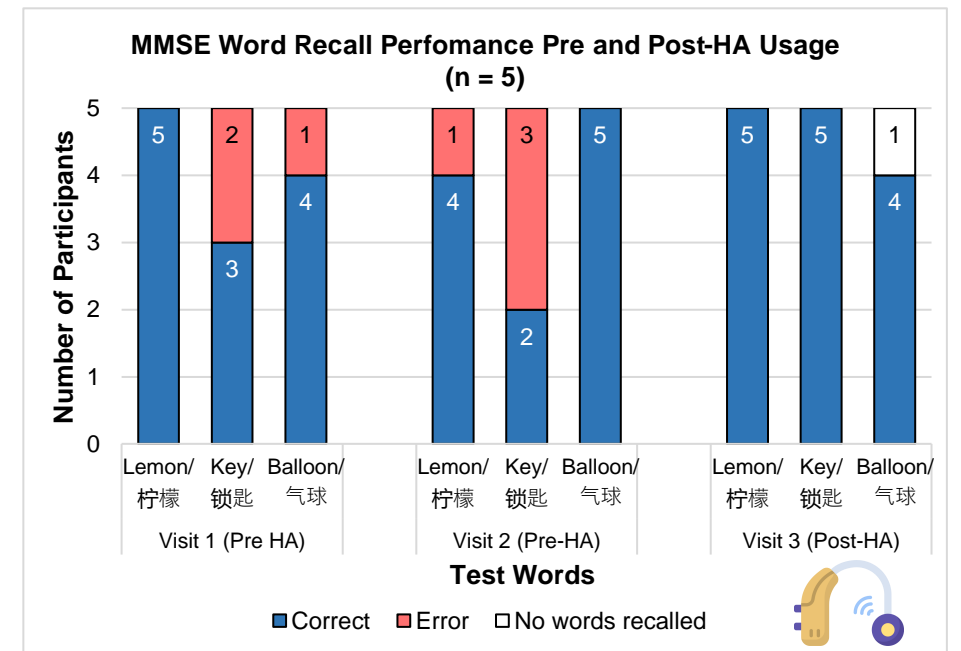
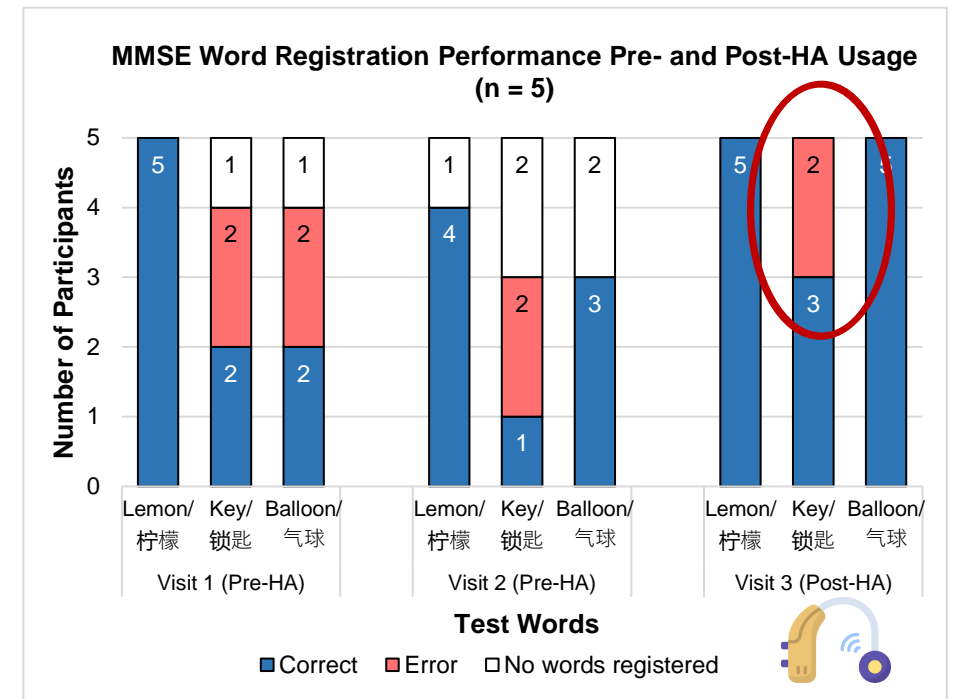
Language	Test Word	Word substitution error
English	KEY	TEA
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- Even with five trials of repetition in Registration section, word error were still evident, and was found to surface at the recall section



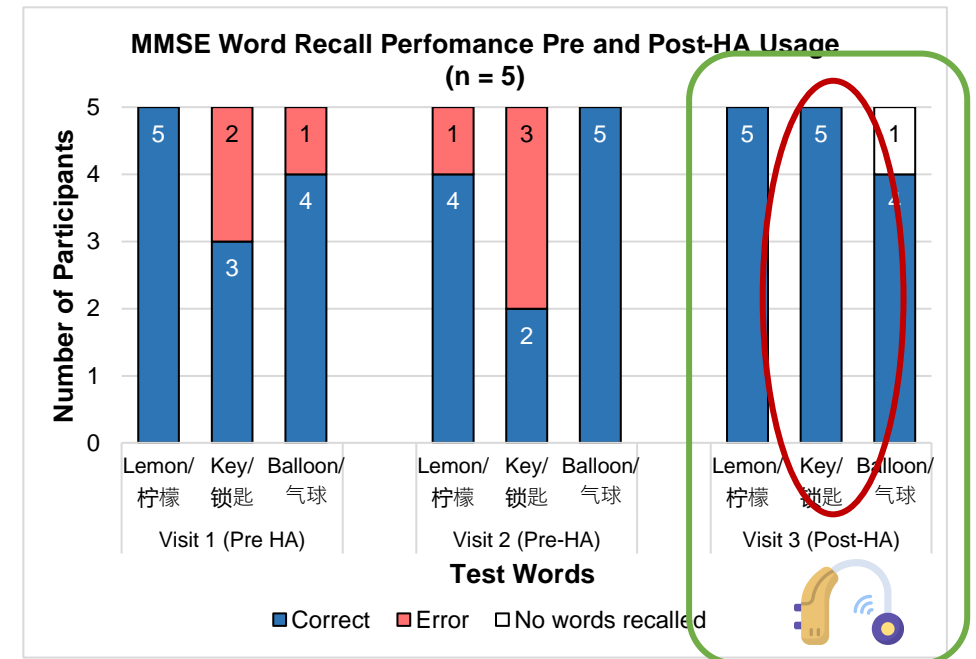
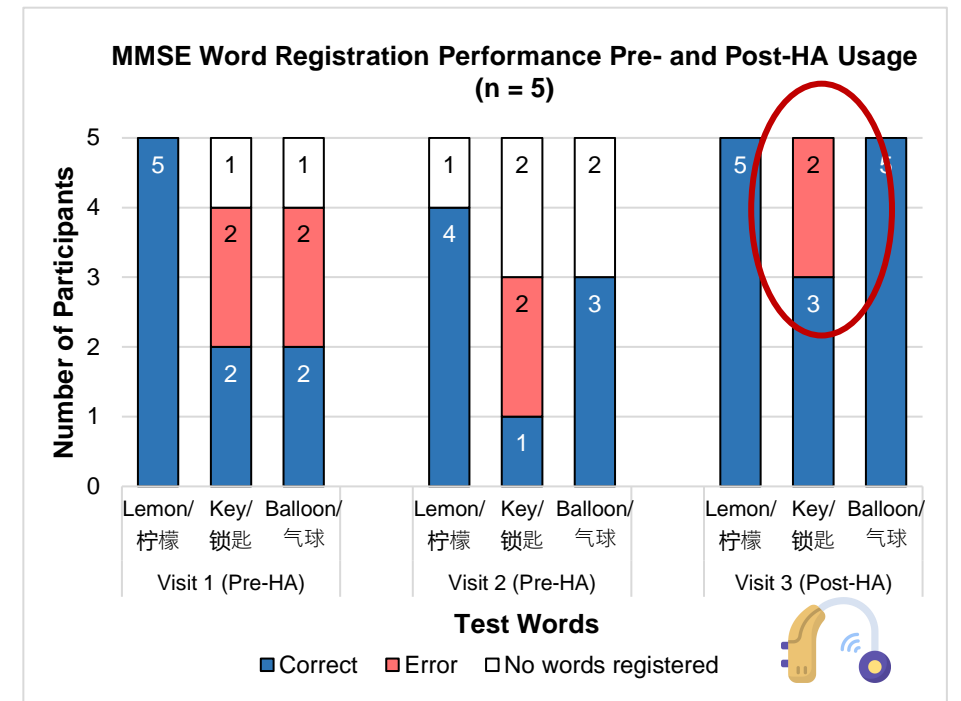
MMSE (Post-Intervention) Registration and Recall Performance

1. Error in Registration persist.



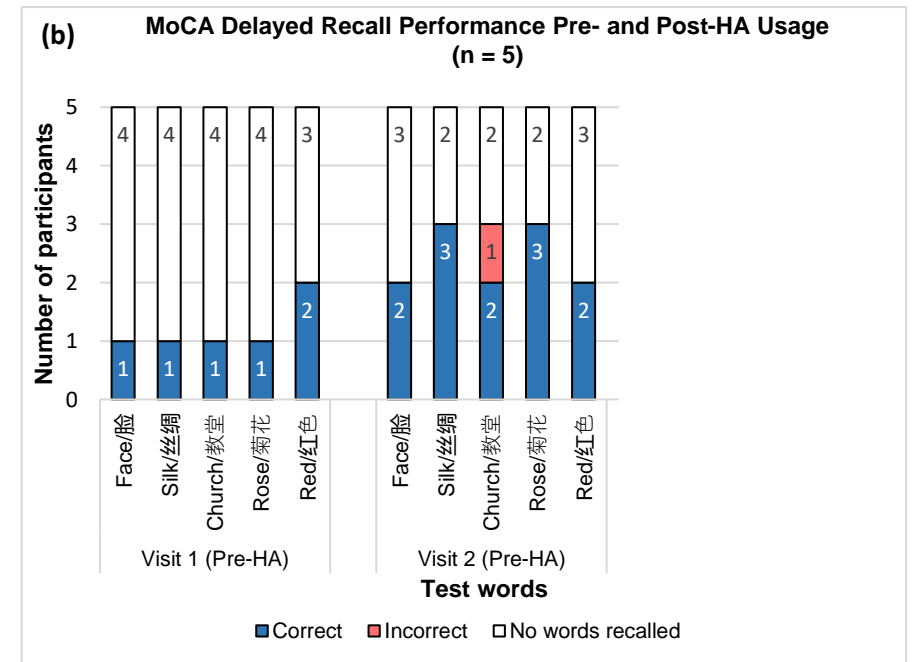
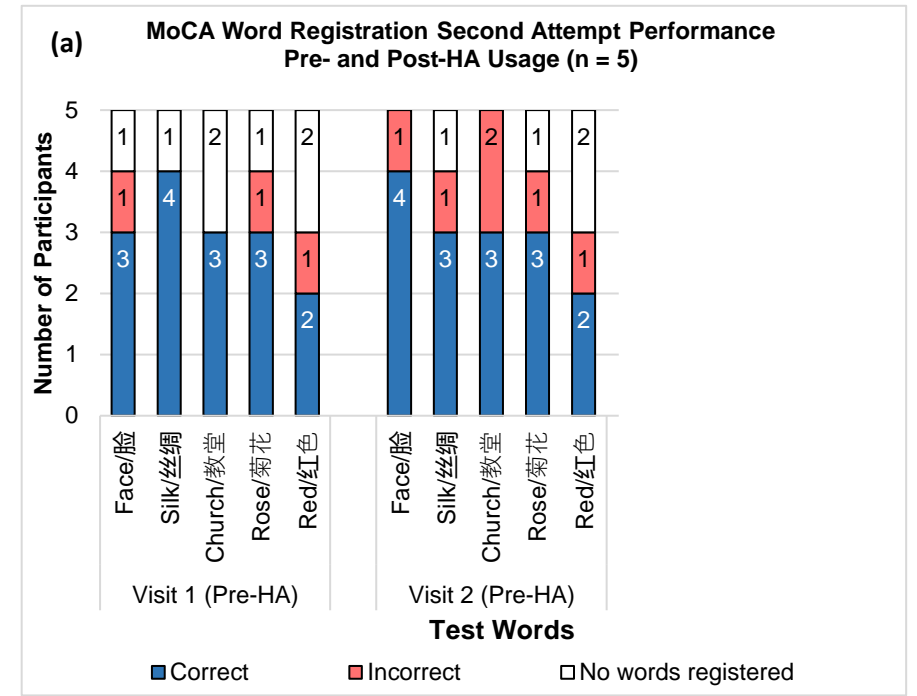
MMSE (Post-Intervention) Registration and Recall Performance

1. Error in Registration persist.
2. Cascading effect in Word Registration and Recall at baseline diminished.
 - All participants registered correctly within 5 trials
 - All managed to recall the correct word.
3. Almost all participants managed to recall all words correctly



MoCA (Baseline)

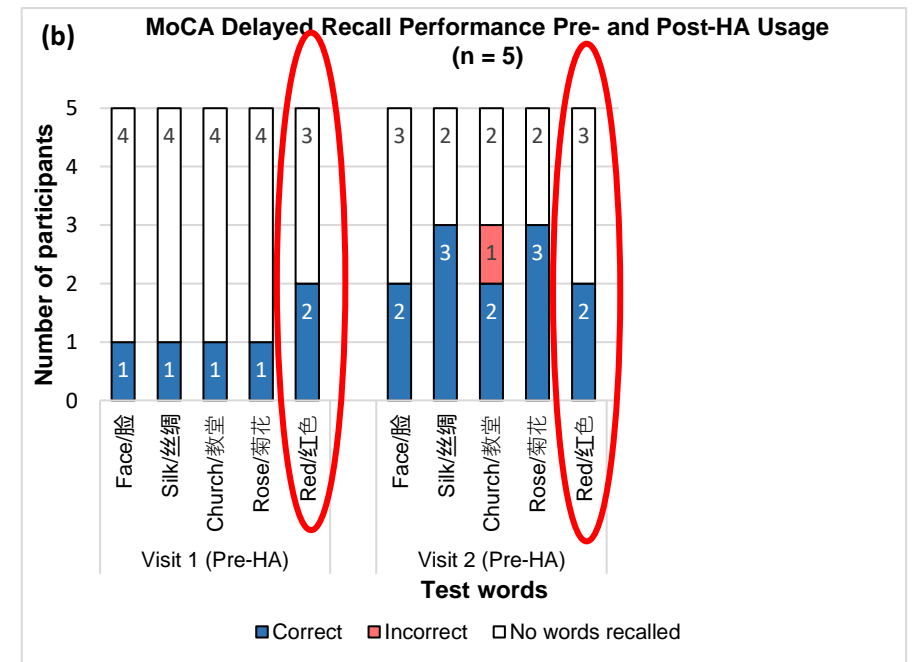
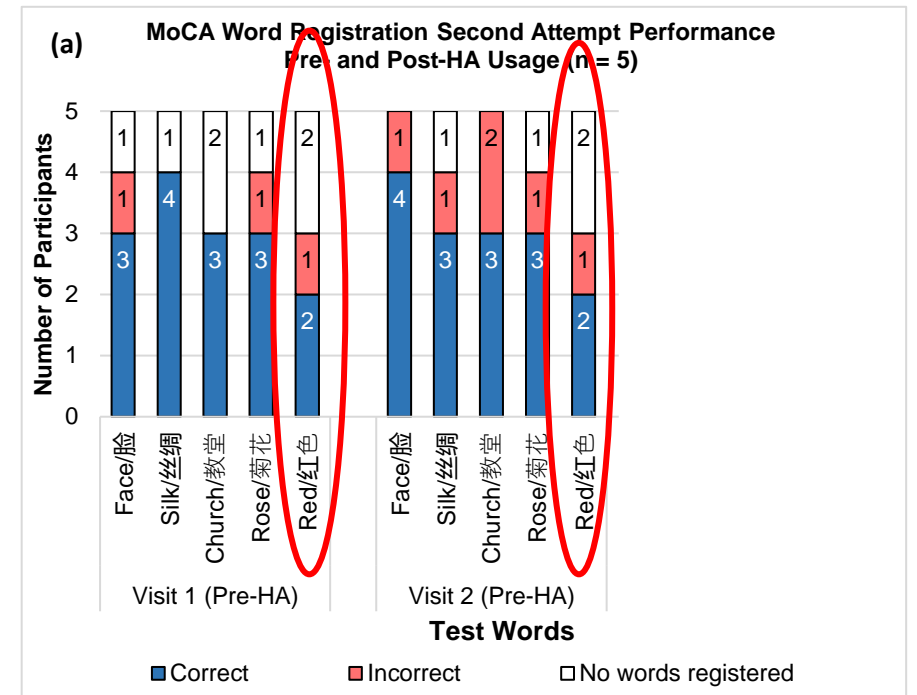
Registration and Delayed Recall Performance



MoCA (Baseline)

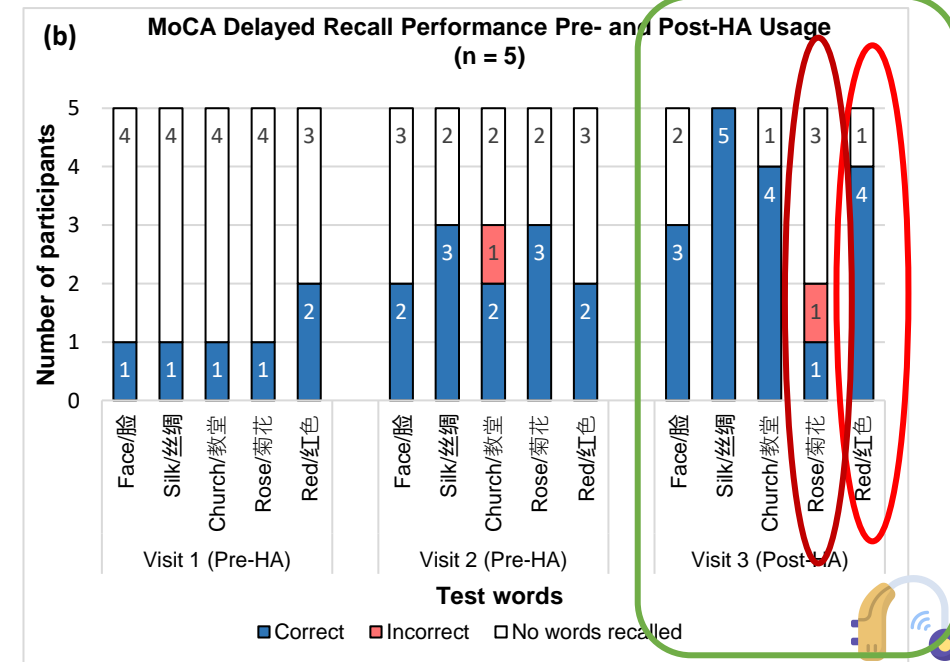
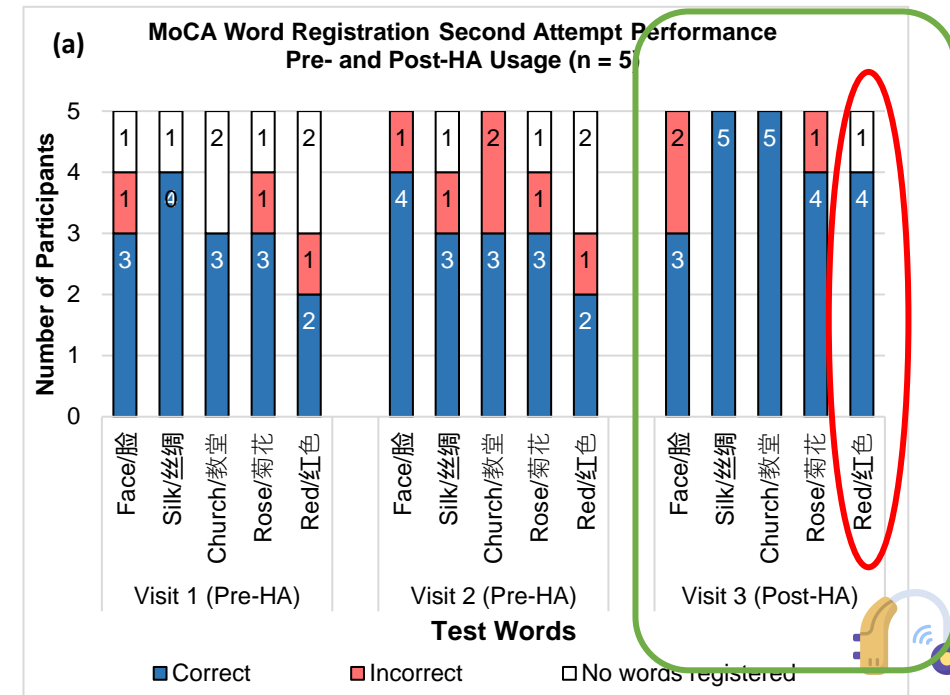
Registration and Delayed Recall Performance

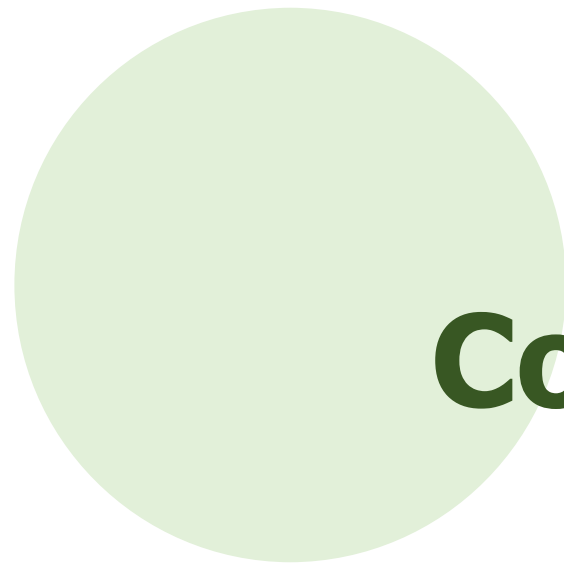
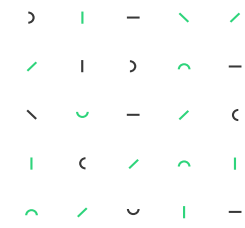
- “Red” or “红色/hóng sè”
 - Poorest registration performance at baseline
 - Recall component



MoCA (Post-Intervention) Registration and Delayed Recall Performance

1. “Red” or “红色/hóng sè” at Registration and Recall sections improved.
2. Overall, improvement were visually observed where there were More correct word registration and recall
3. Performance for “Rose or 菊花/jú huā (Chrysanthemum)” were not as expected.
→ Related factors beyond participants hearing ability.





Conclusion



Conclusion

1. **Upward trend** in cognitive screening scores observed.
 - Insights on the positive effect of hearing aids usage on cognitive screening performance.
 - Importance of hearing screening and intervention prior to cognitive screening test
2. Current study could not confidently indicate significant improvement in cognitive screening performance after hearing aid usage
3. Future Research Recommendation
 - Larger sample size
 - Longer hearing aids usage period
 - Correlation between degree of hearing impairment to changes in scores after hearing aid usage.

Credits

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Mr. Perumal Balakuthalingam

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Ms. Joanna Tang

Triage Coordinators:

Ms. Tricia Fong

Ms. Tan Sin Yee

THANK YOU!

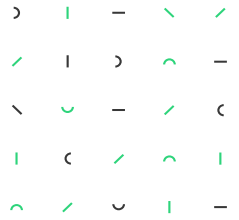
All Lecturers and Instructors

Faculty Staff

Classmates



References



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