Assessing Naming Ability in Elders without Stroke and Non-aphasic Stroke Patients with Confrontational and Category Naming to Detect Anomia

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Abstract

Introduction: Aphasia is a disorder of language most commonly due to ischemic stroke. Anomia is possible in all types of aphasia and is conveniently used to screen for aphasia. Bedside confrontational naming or conventional naming tests may fail to detect mild language abnormalities in clinical practice. In this study, we additionally performed confrontational naming and category naming in elderly patients and non-aphasic stroke patients in hopes of improving the sensitivity of anomia detection. The relationship of age, sex, education level, stroke location, and vessel type with naming ability was also examined.

Material and Methods: An analytical cross-sectional study was performed on 40 patients in two groups of elderly outpatients with no known brain pathology and inpatients being treated for ischemic stroke without aphasia. The 15-item Thai Boston Naming test (T-BNT) was used to test confrontational naming and category naming test of fruits was performed.

Results: Non-aphasic stroke patients tended to be slower in naming latency than control patients in both univariate ($p=0.019$) and multivariate analysis ($p=0.063$), but did not differ significantly in naming accuracy and category naming. Age, sex, education, stroke location, and vessel types did not impact naming ability. High frequency words were relatively spared compared to low frequency words for both groups.

Conclusion: Even in the absence of clinically detectable aphasia, stroke patients were potentially slower on naming tasks. The T-BNT and category

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naming may be feasible bedside tools to improve sensitivity of detection of language dysfunction in stroke patients beyond standard assessments.

Keywords: Aphasia, Stroke, Boston Naming Test, Anomia, Confrontational naming, Category naming

Introduction

Aphasia is a disorder of language and communication most commonly due to ischemic stroke, but may also be subsequent to other pathologies e.g. tumor, autoimmune encephalitis, or neurodegenerative disease.

For both right and left handed people, language centers are usually situated in the dominant (left) hemisphere. However, both hemispheres may contain language centers in a minority of left-handed individuals. Therefore, language disorders generally arise from left hemispheric lesions, with only about 2% of right hemispheric lesions being the culprit[1].

According to the Wernicke-Geschwind model, anomia is possible in all types of aphasia. Although anomia may suggest a lesion in the dominant inferior temporal lobe or the dominant angular gyrus (if seen in conjunction with Gerstmann syndrome), but in reality language processing is modulated by numerous bihemispheric cortical, subcortical, and cerebellar neural circuits[2]. Consequently, the localization of a language disorder in patients may not be so simplistic.

Naming difficulty is a physical and psychological disability that impedes social interaction. In clinical examination of stroke patients, bedside confrontational naming and/or standard naming assessments (e.g. NIHSS) may fail to detect mild language abnormalities and may not adequately reflect language competency in real world scenarios. Full assessments that require speech-language specialists are time consuming to perform and may be overwhelming for patients. Abridged versions such as the 15-item CERAD-Boston Naming Test or the 15-item Thai Boston Naming test have been used as an alternative in clinical research, with comparable internal consistency and validity[3].

The aging brain manifests as reduced brain volume, neurons, and synapses. Abnormal protein aggregation emerges in the sixth decade and becomes more significant by the seventh decade. Positron emission tomography (PET) imaging and regional cerebral blood flow (rCBF) studies in the elderly show reduced prefrontal and frontal activity during cognitive tasks which translates to diminished cognitive processing capacity[4]. Even in the absence of brain pathology, aging impairs naming ability. Language in the elderly becomes more simplistic, gradual, and obscured. Regression of language usage in the aging population hinders quality of life in the elderly[5].

In addition to age, several other factors contribute to naming ability. A Thai study by Aniwattanapong et.al[6] suggested that being well-educated and male yielded better results on naming tests and that lower education was a risk factor for progressive cognitive decline. Cognitive processing ability correlates with physical health and is worsened by cerebrovascular disease. Diabetes mellitus also dampens processing speed, impairs lexicon, interferes with memory, attention, and executive function even in the absence of cerebrovascular disease[5].

In this study, we assessed naming ability in elderly patients with no prior history of brain pathology and in ischemic stroke patients without aphasia using confrontational naming and category naming. We hypothesize that ischemic stroke, even in the absence of clinically detectable aphasia, would impair naming ability in patients. Additionally, we also examined the relationship between naming and age, sex, education, handedness, comorbidities, and stroke location/type. This study hopes to highlight naming deficits in ischemic stroke patients and the elderly which may lead to better therapy and rehabilitation of this condition.

Materials and Methods

This study was an analytical, cross-sectional study conducted at the Neurological Institute of Thailand between June 1st to October 31st, 2022. The population included consenting elders who were non-stroke outpatients and ischemic stroke inpatients during this time frame.

The following operational definitions were applied in this study:

1. Aphasia: disorder of language due to brain damage
2. Ischemic stroke: cerebrovascular disease of a thrombotic or embolic nature.
3. Healthy elder: patients aged > 60 years without a history of ischemic or hemorrhagic stroke and/or other neuropsychiatric, neuroimmune, neurodegenerative brain pathology
4. Boston Naming test (BNT): a neuropsychological assessment tool that measures visual confrontational naming in patients with suspected aphasia
5. Category naming: spontaneous generative naming of items in a prespecified category within a 1-minute time limit

Inclusion criteria

- For the healthy elders group
  - Age >60 years
  - An outpatient at the Neurological Institute of Thailand
  - Thai national using Thai as their primary language
- For the stroke group
  - Age >60 years
  - An inpatient being treated for ischemic stroke at the Neurological Institute of Thailand
  - Assessed by main physician to be stable in neurological condition
  - Thai national using Thai as their primary language

Exclusion criteria

- For the healthy elders group
  - Participant has a history of cerebrovascular disease or other brain pathology
- For the stroke group
  - Assessed by main physician and found to have aphasia by bedside confrontational naming or found to have subscore in Thai NIH stroke scale (NIHSS-T) ≥1
  - In critical or non-stable condition unsuitable for participation in the study

Patient demographic data (age, sex, comorbidities, risk factors, handedness, languages, education level), clinical information (days post stroke, location of stroke, neurodeficits, NIHSS, TMSE/MOCA), and results from naming assessments including the 15-item Thai Boston Naming Test (T-BNT) and category naming were collected from eligible elders. The T-BNT contains 15 images with five of each being low, medium, and high frequency words. Patients were given 20 seconds to respond to the image with the correct word. Two parameters were recorded from the T-BNT including retrieval accuracy and retrieval latency. Types of errors were also noted including “no response”, “noun errors”, “semantic errors” (superordinates, inclass coordinates, contextual associates, materials from which target word was made), “phonemic errors”, “whole-part”, “unrelated errors”, “non-words”, “unrecognized correct”, “perseveration”, “neologism”, “negated response”, and “circumlocutions”.

Number of correctly named fruits within one minute were measured for category naming. The primary outcome was naming ability, as measured by accuracy and latency of the T-BNT and quantity of items during category naming. For the secondary outcome, the relationship between confrontational and category naming with age, sex, education, handedness, comorbidities, and stroke location/ type was examined.

Written informed consent was obtained from all patients. This study was conducted in accordance with Good Clinical Practice guidelines and the principles of the Declaration of Helsinki. Additionally, approval by the Neurological Institute of Thailand ethics committee was also obtained (No.65037)

Statistical analysis

Descriptive analysis was done on demographic data, clinical information, and naming assessments. Parametric and nonparametric comparisons of categorical and continuous variables were done using independent sample t-test and Mann-Whitney U test for univariate analysis, respectively. Linear regression was used for multivariate analysis. Any 2-sided p-value of < 0.05 was considered statistically significant. Statistical analysis was carried out using SPSS for Windows Version 17.0 (SPSS Inc., Chicago, Illinois, USA).

Results

Clinical features and demographics

A total of 40 patients participated in this study of which 20 patients were elderly outpatients with no known brain pathology and 20 were inpatients with ischemic stroke without aphasia. The healthy elders were neurological outpatients being treated for non-brain parenchymal disease e.g. carpal tunnel syndrome, polyneuropathy, trigeminal neuralgia. All patients were right-handed. There was a statistically significant difference in age and sex between the two groups. The healthy elders were slightly older (67.5 vs. 63.5 years, p=0.019) and were mostly women (male sex 25% vs 75%, p=0.002). The stroke group overall had a more years of education (15 vs. 12 years, p=0.080). More patients in the healthy elders group had hyperlipidemia (p=0.038), while more in the stroke group used alcohol (p=0.006). The majority (80%) of strokes were anterior circulation and were mostly small vessel disease (70%) with a mean NIHSS score of 3.8. Anterior circulation strokes included lesions of the internal capsule, corona radiata, centrum semiovale, basal ganglia, and subcortical white matter while posterior circulation strokes included lesions of the cerebellum, thalamus, and pons.

Table 1: Baseline characteristics

	Healthy elders	Stroke	p-value
Age *yrs; median (IQR)*	67.5 (65-72.25)	63.5 (61.25-69.25)	0.019*
Male sex *n (%)*	5 (25%)	15 (75%)	0.002*
Education *yrs; median (IQR)*	12 (7.25-19)	15 (12-19)	0.080
Underlying disease(s) *n (%)*			
Diabetes mellitus	1/20 (5%)	4/20 (20%)	0.151
Hypertension	7/20 (35%)	9/20 (45%)	0.519
Hyperlipidemia	9/20 (45%)	3/20 (15%)	0.038*
Smoking	3/20 (15%)	8/20 (40%)	0.077
Alcohol	2/20 (10%)	10/20 (50%)	0.006*
Heart disease	0/20 (0%)	3/20 (15%)	0.072
Previous stroke	0/20 (0%)	5/20 (25%)	0.017*
Location of stroke *n (%)*	-	Anterior circulation 16/20 (80%) Posterior circulation 4/20 (20%) Small vessel 14/20 (70%) Large vessel 6/20 (30%)	
Days after stroke *days; median (IQR)*		2 (2-2.75)	
NIHSS score *points; median (IQR)*	-	3.8 (1-9)	

Primary outcomes

Table 2: Univariate analysis of primary outcomes

	Healthy elders	Stroke	p-value (CI)
Boston naming test			
Accuracy *word; median*	12.3	12.45	0.813 (-1.13. to 1.43)
Latency *seconds; median*	2.36	3.25	0.019* (0.16 to 1.62)
Category naming *words; median*	13.6	12.75	0.457 (-0.16 to 1.62)

Univariate analysis was performed for each primary outcome. Accuracy in performing the T-BNT did not significantly differ between the groups, while latency to correct response was significantly faster in the healthy elders group (2.36 vs. 3.25, p=0.019). Healthy elders performed slightly better on category naming (13.6 vs. 12.75), but this was not statistically significant.

Age and sex differed significantly for both groups and are known confounding factors of naming ability. Consequently, multivariate analysis was performed with age, sex, and education as covariates. Accuracy for the T-BNT (p=0.45) and category naming (p=0.29) did not differ between the groups, but latency for the T-BNT showed near statistical significance (p=0.063).

Secondary outcomes

Table 3: Types of errors

	Healthy	Stroke
No response	18 (32.73%)	18 (33.96%)
Noun errors		
Semantic errors		
○ Inclass coordinates	12 (21.82%)	11 (20.75%)
○ Contextual associates	6 (10.91%)	2 (3.77%)
○ Material from which target word was made	8 (14.55%)	7 (13.21%)
Phonemic errors	2 (3.64%)	
Perceptual errors	3 (5.45%)	3 (5.66%)
Whole part		2 (3.77%)
Unrelated errors	6 (10.91%)	9 (16.98%)
Circumlocutions		1 (1.89%)
TOTAL	55	53

In both groups, errors were similar in terms of types and proportion. The most predominant type of error was "no response" followed by "inclass coordinates". The least frequent type of error was "phonemic errors" for the healthy elder group and "circumlocution" for the stroke group. For description of error types, please refer to Appendix 6.

Table 4: Incidence of low/medium/high frequency errors

	Healthy elders	Stroke
Low frequency (responses)	42	34
Medium frequency (responses)	11	16
High frequency (responses)	2	3

A total of 100 attempts were recorded for each type of word frequency (5 words of each frequency type with 20 participants per group = 100 attempts). Both groups made the most errors with low frequency words, followed by medium frequency, and the least errors with high frequency words. High frequency word errors were comparable between the two groups (2% vs. 3%).

Table 5: Univariate analysis of small and large vessel strokes and naming

	Small vessel	Large vessel	p-value (CI)
Boston naming test			
Accuracy *words; median*	12.43	13.14	0.952 (-2.38 to 2.52)
Latency *seconds; median*	2.91	4.04	0.117 (00.31 to 2.56)
Category naming *words; median*	13.43	11.17	0.135 (-5.30 to 0.78)
NIHSS score *points*	2.5	4	0.428
Education *yrs; median*	16	13.5	0.174
Age *yrs; median*	64.5	61	0.031*

Patients with small and large vessel disease strokes did not significantly differ in accuracy and latency of the T-BNT and category naming. Patients with large vessel disease were significant younger (61 vs. 64.5 years, p=0.031).

After multivariate analysis with age, sex, and education as covariates, our results show that the presence of large vessel disease compared to small vessel disease did not significantly affect accuracy (p=0.984), latency (p=0.08), and category naming (p=0.085).

Table 6: Univariate analysis of anterior and posterior circulation strokes and naming

	Anterior circulation	Posterior circulation	p-value
Boston naming test			
Accuracy *words); median*	13	14	0.250
Latency (seconds)*; median*	2.72	4.48	0.1860
Category naming (words)*; median*	13	12.5	0.703

Patients with anterior and posterior circulation strokes did not significantly differ in accuracy and latency of the T-BNT and category naming.

Table 7: Univariate analysis of right and left side strokes and naming

	Right side	Left side	p-value
Boston naming test			
Accuracy *words); median*	13	13	0.941
Latency (seconds)*; median*	2.67	3.16	0.603
Category naming (words)*; mean*	13.64	11.67	0.160

Patients with right and left sided strokes did not significantly differ in accuracy and latency of the T-BNT and category naming.

Discussion

In this study, naming ability of non-aphasic stroke patients and of elderly patients with no prior history of brain pathology was assessed using confrontational naming and category naming.

Even after adjustment for age, sex, and education, healthy elders and stroke patients did not differ in all naming tasks, including accuracy and latency times on the T-BNT as well as category naming. This may be due to inadequate sample size, but also differing baseline characteristics between the 2 groups. The stroke group was significantly younger, predominantly male, and were better educated, which were all favorable factors for naming ability[4, 6]. Only latency times were significantly better for the healthy elder group in univariate analysis (p=0.019) and nearly statistically significant in multivariate analysis (p=0.063).

Slower latencies observed in stroke patients may be multifaceted in origin, representing naming dysfunction in conjunction with impaired cognitive processing. Even in the absence of cortical lesions and clinical aphasia, subcortical lesions can cause language dysfunction. The term subcortical aphasia has been used to describe language disorders arising from subcortical lesions. Research in neuroimaging suggest that the thalami and basal ganglia are responsible for language processing and modulation. Basal ganglia injury may result in disconnection of periventricular white matter tracts between Broca's and Wernicke's area. Subcortical deafferentation may lead to functional cortical language dysfunction by diaschisis, supported by SPECT studies showing cortical hypoperfusion corresponding to subcortical lesions. Meanwhile, the thalamus is also credited by various studies as the center for subcortical language processing, especially the pulvinar/lateral posterior thalamus, the anterior thalamic nuclei, and the ventral anterior nucleus[7]. On the other hand, slow naming latency may also be a product of psychomotor retardation. There is a well-established link between the presence of leukoaraiosis and cognitive impairment. Therefore, it is difficult to ascertain whether slowing of naming latency seen in stroke patients in this study was a consequence of naming dysfunction, psychomotor retardation, or both[8].

Patients in the healthy elders group were older and had fewer years of education than the stroke group which may have put them at a cognitive disadvantage to begin with. However, in our study education level did not significantly impact naming. In other studies, education has been shown to offer resilience against language impairment. In a Thai study by Aniwattanapong et al.[6], highly educated patients in their eighties retained naming ability while less educated patients in the seventies began to struggle with confrontational naming. Moreover, less than 12 years of education was found to be a risk factor for progressive dementia.

In our study, age did not significantly affect naming in contrast to prior research. After 70 years of age, naming ability declines more noticeably compared to seniors up to a decade younger. Slowing of cognitive processing in elders have been explained by various theories such as the inhibitory hypothesis which posits that prefrontal cortex degeneration leads to increased distractibility by external stimuli. Elders also have reduced response to external stimuli and poorer attention[4]. They are also more cautious and take longer to respond to questions than the younger generation[9].

Gender advantage in naming ability has been documented in a previous study where Thai elderly males without Alzheimer's disease performed better on naming tests than their female counterparts across all age groups despite correction for IQ, education level, and underlying diseases. This difference has been attributed to superior cognitive reserves in males, better academic opportunities, and possibly estrogen deficit in menopausal women[6]. In our study, male sex did not provide an advantage in naming.

As a result of these age, sex, and education disparities, the healthy elders group's performance on naming tasks may be been hindered, accounting for merely a potential difference between naming latency in the two populations. It is, however, interesting to note that with progressive age, Boston naming test scores not only become worse, but also become more variable among individuals of the same age[10]. This may suggest that an interplay of various factors beyond what we have accounted for in this study may influence naming ability.

Semantic errors that were "inclass coordinates" were prevalent in both groups and involve naming words that are in the same category as the target word. Common examples in our study were naming "school" or "church" for *house* or "dice" or "hilo" for *dominoes*. The neurolinguistic theory of "dual stream model" suggest that the ventral/what and dorsal/how stream are responsible for semantic (lexical/knowledge association) and phonological encoding (auditory/articulatory), respectively. Applying this theory, errors in both groups were mainly semantic in nature and may point to predominance of pathology in the ventral/what stream[11].

Linguistic factors may contribute to relative preservation of high frequency words in both groups. Our results are in concordance with Pitres' Law, where more frequently used words are more likely spared relatively to less frequently used words[1]. Words learnt in early childhood and high frequency words are more accurately and quickly named than words learnt in late childhood or less frequently used[9]. High frequency words, therefore, may have minimal differentiating power in comparing naming impairment in the two populations.

The presence of aphasia is a sensitive predictor of large vessel disease[12], therefore we initially predicted that patients with large vessel strokes will have poorer naming ability. However, our results indicated that type of vessel disease did not cause a difference in naming ability. Furthermore, location of stroke whether anterior vs. posterior or right vs. left sided strokes also did not significantly affect naming. This may be due to the fact that strokes with aphasia were excluded to begin with. Additionally, the majority of strokes in this study were subcortical in nature and were minor strokes which may less likely result in naming dysfunction.

Limitations

The sample size for both the elderly and stroke groups were quite small and participants were from a single neurological hospital which may not be representative of the general population. It is also possible that participants in the healthy elder group had previously undiagnosed brain pathology since they were not required to undergo brain imaging prior to inclusion into the study. Patients with subcortical lesions presenting with dysarthria were also included in the stroke group, therefore it is possible that slower naming latencies may be due to psychomotor slowing rather than language dysfunction. Since age, sex, and education level are known confounders of naming ability, future studies should focus on including participants who are more congruent in these respects. In this study, the oldest participants were in their mid-seventies. Induction of older participants may be helpful in studying the effect of more extreme age on naming ability. In this study, only naming was formally assessed while other language domains were not. A complete assessment of all language domains in a future study may further elucidate the disparity between language dysfunction in non-stroke and stroke elders.

Conclusion

In this study, we assessed naming ability in patients with ischemic stroke without aphasia and in elderly patients with no prior history of brain pathology using confrontational naming and category naming. The relationship between naming ability and age, sex, education level, and stroke type were also examined. Even in the absence of clinically detectable aphasia, stroke patients tended to be slower in naming latency than their control counterparts. Age, sex, education, stroke location, and vessel types were not shown to impact naming ability. High frequency words were relatively spared compared to low frequency words. Going forward, the 15-item Thai Boston Naming Test and category naming may be feasible bedside tools for clinicians to assess language dysfunction in stroke patients beyond standard tests such as the NIHSS.

Disclosure

The authors of this study declare no conflicts of interests.

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APPENDIX

Appendix 1: Participant data collection form

Participant # :

Baseline characteristics

Age: Sex:

Underlying diseases:

Handedness: LEFT RIGHT Level of education:

Risk factors: Smoking Alcohol Illicit drugs Herbal Med Supplements

Nationality/Ethnicity:

Language(s): Thai English Other: ___________, ___________, ___________, ___________

Age of language(s) acquisition:

Clinical information

Days after stroke:

Location of lesion:

Hemisphere: LEFT RIGHT

Neurodeficit(s):

NIHSS/TMSE/MOCA:

Boston Naming Test

Replies/latency:

1)	2)	3)	4)	5)
6)	7)	8)	9)	10)
11)	12)	13)	14)	15)

Total correct: /15

Category naming

Total replies:

Appendix 2: Boston Naming Test word list and frequency categories

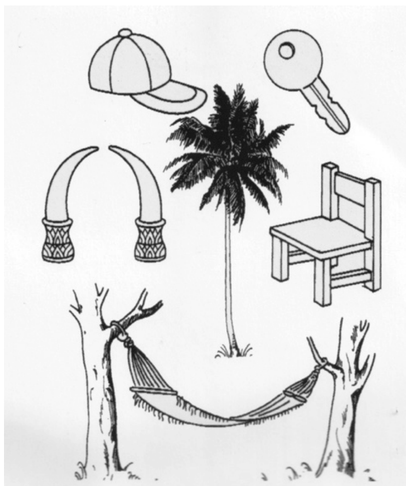
Word frequency	English	ไทย
High frequency	Tree	ต้นไม้
	Bed	เตียง
	Whistle	นกวีด
	Flower	ดอกไม้
	House	บ้าน
Medium frequency	Cactus	กระบองเพชร
	Funnel	กรวย
	Volcano	ภูเขาไฟ
	Mask	หน้ากาก
	Rhinoceros	แรด
Low frequency	Harmonica	หีบเพลงปาก/ฮาร์โมนิก้า
	Noose	บ่วง
	Sphinx	สฟิงซ์
	Canoe	เรือคานู
	Dominoes	โดมิโน่

Appendix 3: Boston Naming Test images

Appendix 4: Consent for use of the 15-item Thai Boston Naming Test (T-BNT)

Appendix 5: Thai NIH Stroke Scale (NIHSS-T)

แมงมุม
ทับทิม
ฟื้นฟู
ขอบคุณ
รื่นเริง
ใบบัวบก



คุณสบายดีหรือ
เท้าติดดิน
ฉันกลับบ้านทันทีหลังเลิกงาน
ใกล้โต๊ะอาหารในห้องครัว
เมื่อคืนฉันได้ยินเขาพูดทางวิทยุ

Appendix 6: Coding categories (adapted from Kohn and Goodglass, 1985)

1) No response: when the subject (a) said nothing, (b) responded only with a general comment ("that's a hard one", "I have one at home") or a question ("Is it alive?", "what kind of animal is that?"), (c) produced a broken-off noun phrase with a modifier ("a dog's—" for *muzzle*), or (d) produced less than a syllable ("k—")

2) Noun errors: (i) single nouns, (ii) noun + noun ("people boat" for *canoe*), (iii) adjective + noun ("wooden boat"), (iv) possessive noun + noun ("artist's board" for *palette*). Noun errors are divided into the following subcategories:

a. Semantic errors: were either superordinates ("plant" for *flower*), inclass coordinates ("airplane" for *helicopter*, "checkers" for *dominoes*), contextual associates ("desert" for *camel*, "easel" for *palette*), or materials from which the target was made ("rope" for *noose*, "paper" for *label*).
b. Phonemic errors: contains "significant" phonological elements of the target word
c. Perceptual errors: named an object which is visually similar to the target ("windmill" for *pinwheel*, "lasso" for *noose*)
d. Whole-part (and part-whole): named either a part of the target object ("erase" for *pencil*), a discrete physical entity which contained the target object ("clock" for *pendulum*, not "desert" for *camel*), or something present in the target picture ("canoe" for *paddle*")
e. Unrelated errors: neither semantically, perceptually, nor phonologically related to target word e.g. ("arm ram" for *pendulum*)
f. Non-words: phonological distortions of target words ("rhinosteros" for *rhinoceros*), as well as distortion of nontarget words ("hypnopotamus" for *rhinoceros*)
g. Unrecognized correct: subject continues naming the picture after producing the target word, or produced the target in a nontopical position ("you throw *darts* at it")
h. Perseverations: reutterance of a response (target or nontarget) which had been used to name one of the previous 10 pictures
i. Neologisms: phonologically flawed to the point of not being clearly recognized as an attempt to produce an English word

3) Negated responses: ("stapler, no", "It's not a stapler", "paperclip, no" for *stapler*)

4) Circumlocutions: (i) single adjective or adverb ("dangerous" for *darts*), (ii) -ing forms of verbs (in isolation) ("swimming" for *flippers*, "sleeping" for *cradle*), (iii) long nouns phrases and other multiword responses ("to swim with", "you wear it in the water" for *flippers*).