Effect of repetition protocol on verb naming and sentence generation in a Chinese anomia speaker

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A dissertation submitted in partial fulfillment of the requirement for the Bachelor of Science (Speech and Hearing Sciences), The University of Hong Kong, June 30, 2009.

Abstract

The present study investigated the effectiveness of using an error reduction protocol of repetition to manage verb naming deficit and the generalization effect on sentence generation on a 47-year-old anomic individual. A multiple baseline design was adopted in the verb naming treatment. Item-specific treatment effect was produced just in four sessions' time and the treatment gain was able to maintain for at least one month. However, generalization effect of improved verb retrieval on sentence generation was limited. Overall post-treatment performance in sentence formulation of the anomia subject remained far below the control performances. The possible reasons leading to the rapid progress made on verb naming, limited generalization effect to the ability to construct sentences and the implications of planning treatments to facilitate verb retrieval and sentence production in aphasia are discussed.

Introduction

Anomia refers to the word-finding difficulty in production contexts ranging from confrontation naming to discourse conversation (Goodglass & Wingfield, 1997; as cited in Nickels, 2002b). The majority of people with aphasia have a certain degree of word retrieval deficit, which is why anomia is considered to be the most pervasive symptom associated with aphasia (Nickel, 2002b).

The pervasiveness of anomia leads numerous researchers to explore and design different treatment approaches to ameliorate the difficulty. Those treatments' theoretical bases mainly rely on the model of psycholinguistics. Once there is disruption or degradation of one or more modules or the linkages between the three cognitive modules, namely the central semantic system, the phonological output lexicon and the phonological output buffer, semantic or phonological/lexical representations are weakened and word retrieval deficits can be resulted (Whitworth, Webster, & Howard, 2005).

Major anomia treatment approaches

Traditional anomia therapies can be broadly organized into the semantic approach and the phonological approach. These therapies attempt to improve weakened semantic and phonologic representations and to strengthen the mapping between them, which in turn activates the lexical representations above their threshold for successful naming (Nickels, 2002b). The semantic approach triggers semantic processing by using tasks such as auditory word-picture matching (e.g., Byng, 1988), pictures categorization (e.g., Kiran & Thompson, 2001), and describing semantic features of items to be named in semantic feature analysis (SFA) (e.g., Boyle & Coelho, 1995). For the phonological approach, tasks include making rhyme judgment (e.g., Howard, Patterson, Franklin, Orchard-Lisle, & Morton, 1985), a phonological cueing hierarchy for naming (e.g., Raymer & Ellsworth, 2002), reading aloud (e.g., Nickels & Best, 1996), provision of orthographic cues (e.g., Hickin, Best, Herbert, Howard, & Osborne, 2002) and repetition of target names alone (e.g., Mitchum & Berndt, 1994).

In fact, repetition is part of the protocol or a key component in a majority of semantic and

phonological treatments (Law, Wong, Sung, & Hon, 2006). As part of the protocol, repetition is employed as the last step in various cueing hierarchies (e.g., Hickin et al., 2002; Linebaugh, Shisler, & Lehner, 2005; Raymer & Ellsworth, 2002). Without employing a cueing hierarchy, repetition is also used to elicit correct production when patients fail to name the target items after cueing (e.g., Boyle & Coelho, 1995). Repetition alone was also found to produce effective and long-lasting improvement in word retrieval (e.g., McDonald, Makin, Nickels, Moses, & Taylor, 2006; Miceli et al., 1996; Mitchum & Berndt, 1994; Raymer & Ellsworth, 2002).

How repetition works to facilitate word retrieval?

By definition, repetition simply means repeating what is heard (Berndt, 1988) and comprehension may not be required. However, with reference to the model of psycholinguistics, its process is undoubtedly much more sophisticated. Figure 1 shows that with the presence of picture stimuli, one could process the input phonemes for repetition by the dual-route model.

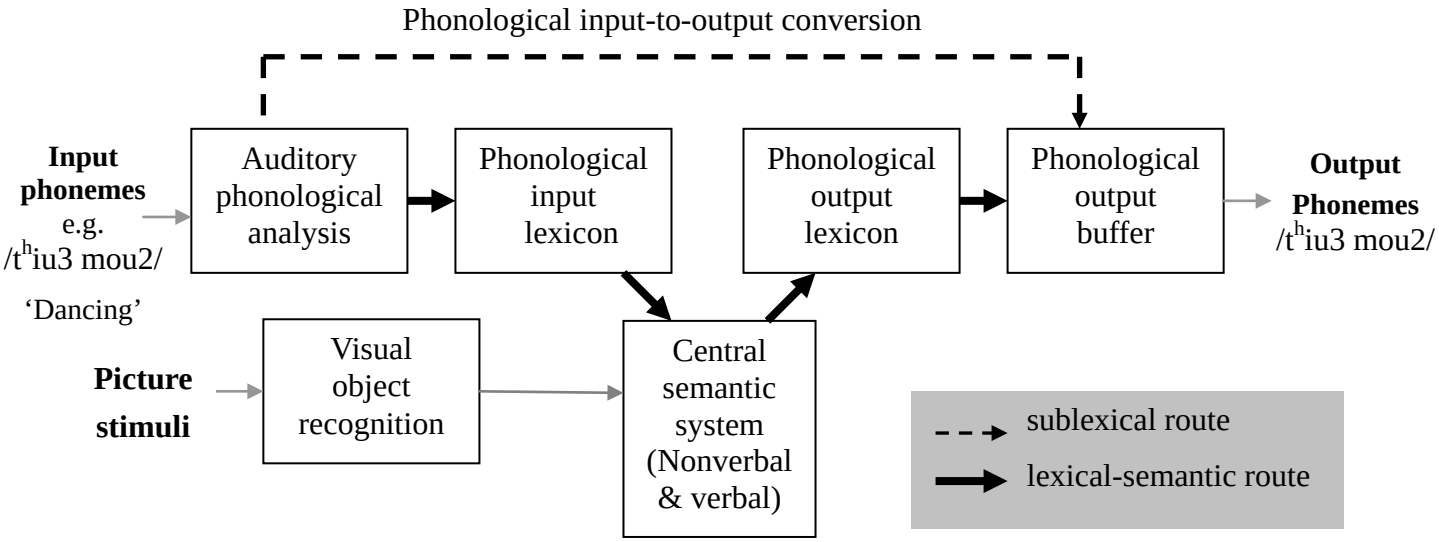

Figure 1. The dual-route model involves in repetition in the context of a picture

As illustrated in the figure, repetition can be a joint function of the lexical-semantic and sublexical routes when a picture stimulus is involved (Miceli et al., 1996). The picture stimulus evokes semantic processing in the semantic system, which cascades to the corresponding phonological information related to the picture (Nickels, 2001; as cited in Raymer & Ellsworth, 2002). Simultaneously, the sublexical mechanism maps the input phonemes directly onto the

output phonemes, which also provide phonological information for output (Miceli et al., 1996). Production of the correct phonological form can thus be activated by the summation of information from both routes. This mechanism is further proven by the effectiveness of repetition protocol on individuals with semantic (Raymer & Ellsworth, 2002) or phonological impairment (Miceli et al., 1996).

Advantages of using repetition alone as the treatment

Traditional anomia treatments provide a variety of cues to the patients when they fail to name the target items. They encourage guessing and thus errors are made inadvertently (Winter & Hunkin, 1999; as cited in Fillingham, Hodgson, Sage, & Lambon Ralph, 2003). According to the Hebbian learning rule of neuroscience, if patients are unable to filter the failed trials and errors are made consistently, a pattern of neural activity is elicited and incorrect associations will be reinforced (Fillingham et al., 2003). Therefore, this kind of errorful learning methods can be disadvantageous and errorless or error reduction techniques such as repetition should be explored.

By requiring the patients to repeat the correct responses immediately instead of providing cues to them after naming failures, the number of errors is reduced and a higher proportion of correct responses can be elicited. The reinforcement effect will then be more centralized on the correct responses. The effectiveness of repetition as an error reduction treatment is supported by the review on anomia therapies done by Fillingham et al. (2003). Ninety-two previous therapies were classified into errorful, error reduction and error elimination techniques and the three types of therapies were shown to be equally effective. It challenges the hypothesis that treatments involve more active and/or deeper processing on the part of the patients must be more effective. Another advantage of errorless techniques is that they are less frustrating for the patients, thus keeping them motivated to engage in the interventions (Fillingham, Sage, & Lambon Ralph, 2006).

Importance of verb production in communication and treatment of verb naming

Despite treatments of anomia have been studied extensively, the studies largely focus on noun naming and there is a “relative dearth of verb therapy” (Conroy, Sage, & Lambon Ralph, 2006).

Indeed, deficit of verb retrieval is frequently demonstrated in non-fluent and fluent aphasic speakers (Berndt, Mitchum, Haendiges, & Sandson, 1997a). According to Mätzig, Druks, Masterson, and Vigliocco (2008), it is more common for the aphasic speakers to have relative verb deficits than relative noun deficits. Hence, it is essential for the clinicians to provide therapies which address verb retrieval difficulty.

The scarcity of verb therapies can be due to the fact that verb naming "demands more processing control" than noun naming along several dimensions (Conroy et al., 2006) and thus more difficult to be taught. First, verbs have a "looser fit" in conceptual-semantic fit as they depict processes, states, actions, and events that engage temporal relations (Conroy et al., 2006), as a result their meanings have lower imageability (Mätzig et al., 2008). For nouns, they have a "tighter fit" with their meanings as they often depict physical entities (Conroy et al., 2006) and hence are of higher imageability. Second, verbs have shallower semantic categorization than nouns as they share less common semantic features, whereas nouns have exemplars that share common semantic features and are well-grouped as categories (Mätzig et al., 2008) that may assist in naming. Third, pictures of verb naming are more visually complex than those of noun naming. More than one referent, object and action could be involved in the picture representing a verb, leading to greater conceptual burden when one tries to identify the right action from the other elements and inhibit other incorrect responses in naming (Berndt et al., 1997). The study of Mätzig et al. (2008) suggested that even normal subjects made errors of "misinterpretation of picture". In short, verb retrieval is inherently more difficult than noun naming.

Loverso, Prescott, & Selinger (1988) suggest that verbs are the predicate cores of sentences as they "specify the relationships that exist among some set of concepts" (p.47). Syntactically, verbs act as the "semantic-syntactic interface" of sentences (Edmonds, Nadeau, & Kiran, 2008) and they prime the activation of closely related nouns when formulating sentences. For example, the verb "吠" (bark) could activate the subject e.g., "小狗' (The puppy) to form an one argument

sentence “小狗吠” (the puppy barks); whereas the verb “修理” (fix) could accesses both an agent e.g., “工人” (the worker) and a theme e.g., “電器” (electrical appliance) to form the sentence “工人修理電器” (The worker fixes the electrical appliance) with the argument structure that is two place obligatory. Therefore, if verb retrieval is impaired, activation of the lemmas of the other related nouns could be hampered. This further results in an inability to construct the predicate argument structure of the sentence (Marshall, Pring, & Chiat, 1998) and verbal fluency is compromised. On the basis of this mechanism, some researchers thereby studied the generalization effect of verb naming treatment on sentence production (e.g. Mitchum & Berndt, 1994; Raymer & Ellsworth, 2002; Edwards, Tucker, & McCann, 2004). Raymer and Ellsworth (2002) used a repetition protocol to treat verb retrieval of the subject WR. Upon the presentation of each picture stimulus, WR was required to repeat the target word overtly for three times, rehearse the word covertly, reattempt naming and repeat overtly for three times again. These procedures resulted in item-specific treatment effect. Generalization effect on sentence generation for the treatment items was also found to be significant in terms of using more appropriate verbs in more semantically and grammatically correct sentences.

Previous Cantonese anomia treatment studies

Anomia therapies for Chinese-speaking aphasic individuals are relatively scarce. Yet, all of them included repetition as part of the protocols. Law et al. (2006) adopted semantic feature analysis and semantic priming for treating object naming. Repetition of the target word was required if they failed to give the correct response after defining semantic features. Significant treatment, generalization and maintenance effects were found in one of three subjects who had relatively mild semantic processing disruption. Besides, Law, Yeung, and Chiu (2008) employed an orthophonological cueing protocol to manage noun naming of anomia subjects. Written letter cues representing the initial consonants of target nouns were provided for them to self-generate phonological cues to facilitate word retrieval. If failed, cueing hierarchy utilized repetition as the

last step. Significant item-specific treatment effect and maintenance effect for at least one month were shown in all four participants. In short, these treatments incorporating repetition as part of the protocol produced promising treatment and maintenance effect. Another point to be highlighted here is that all mentioned treatment studies in Chinese focused on noun naming. So far there has not been any anomia study of verb naming in Chinese.

Overview of the present study

In light of the pervasiveness of repetition as part of many effective treatment protocols, and there was no research studies done on verb naming in Chinese, the current study aimed to investigate the effectiveness of using repetition alone as a treatment protocol to facilitate verb retrieval. Considering the centrality of verbs in verbal fluency, generalization effect of successful verb retrieval to sentence generation was also explored.

Based on the findings of the treatment studies in English, the following predictions were made:

1. Positive treatment outcomes would be shown on treated items regardless of the nature of word retrieval deficits, semantically based, phonologically based or a combination of both.
2. No improvement would be seen for untrained control items.
3. The treatment gain in the treated verbs was expected to maintain beyond the treatment phase.
4. Generalization effect on sentence generation would be restricted to the treated items only.

Methods

Participants

LKC was a 47-year-old woman who suffered from ischemic stroke in January, 2006. She was a native Cantonese speaker, right-handed and was 35 months post-onset at the start of the study. She had received education up to Secondary 5 in Hong Kong and she worked as a technical service assistant in a hospital for three years premorbidly. She had received speech therapy at Yau Ma Tei Specialist Clinic once per two months since onset. Besides, she had taken part in the speech therapy program provided by the Division of Speech and Hearing Sciences of the University of Hong Kong and the Hong Kong Society for Rehabilitation. The program offered

weekly speech therapy session from February to May 2008. Currently, LKC is working part-time as a helper in a furniture store six days per week and four hours per day.

Five normal Cantonese speaking females whose age (44-50 years old) and educational level (from Secondary three to Secondary six) matched with LKC were recruited as control subjects.

Initial assessment and hypothesized nature of deficits

A Cantonese version of the Western Aphasia Battery (CAB) (Yiu, 1992) was administered at the start of the study. LKC was classified as having conduction aphasia (aphasia quotient: 75.6).

LKC's naming deficits were demonstrated by her performance in oral naming of pictures from Snodgrass and Vanderwart (1980). She attained 79.7% (173/217) accuracy which was worse than the norm with more than 3 standard deviations (mean= 216.5; SD = 0.53) (Yeung, 2009). This indicated that there were deficits along the lexical-semantic route.

A series of neuropsychological tests were carried out to determine the loci of her naming impairment (See Appendix A). LKC achieved 100% accuracy in three visual-spatial analysis tests in the Birmingham Object Recognition Battery (BORB) (Riddoch & Humphreys, 1993), which indicated that the module of visual object recognition was largely intact. Besides, LKC scored 100% (23/23) and 97.6% (36/37) respectively in the associative match test of BORB (Riddoch & Humphreys, 1993) and the Pyramid and Palm Tree Test (PPTT) (Howard & Patterson, 1992), reflecting that her non-verbal semantic processing was essentially preserved.

Verbal semantic tests were also implemented. LKC achieved 96.8% (122/126) (range: 124-126; Yeung, 2009) accuracy in spoken word-picture matching and 97.6 % (123/126) accuracy in written word-picture matching of the same set, which were performed slightly below the normal range. However, she achieved only 70% (42/60) accuracy on a synonym judgment task, which was more than three standard deviations below the mean (Mean = 56.79; SD = 3.31). These results indicated that her processing of single words requiring more specific semantic information was impaired. However, whether there was only deficit in the verbal semantic system cannot be determined as spoken word-picture matching of the same set of stimuli used in assessing oral

naming (Snodgrass and Vanderwart,1980) was not done. If the nature of naming deficit was only restricted to the verbal semantic system, performances in oral naming and spoken word-picture matching of the same set would be comparable; if post-semantic deficits were involved, her performance in oral naming would be relatively worse than that in spoken word-picture matching. However, since spoken word-picture matching was not carried out and such comparison cannot be made, deficits in the post-semantic level cannot be ruled out. To sum up, LKC's naming impairment can be attributed to disrupted verbal semantic processing and post-semantic deficits.

Materials

A set of 193 line drawings which were culturally appropriate based on the results of Tse (2005) were used for action naming. These pictures were originally downloaded from http://crl.uscd.edu/~aszekely/ipnp/ 7lgpno.html and had been used for collecting normative data for action naming in seven other languages (Bates et al., 2003; as cited in Tse, 2005).

The control subjects were asked to orally name the pictured actions and to rate the familiarity of the actions, estimate the age of acquisition (AoA) of the verbs, and rate the visual complexity of the pictures (See Appendix B for the scales). The name for an action with more than 60% naming agreement was considered as the modal verb. Those pictures with less than 60% naming agreement were excluded in this study.

Procedures

Verb naming treatment design

A multiple baseline treatment design consisting of a baseline, a treatment, and a maintenance phase was adopted.

Baseline phase. Three baseline sessions were carried out within one week. LKC was asked to orally name the actions depicted in the 193 pictures which were randomized in each session. Potential stimuli were then chosen from those pictures that she failed to name correctly in at least two out of three sessions (n= 50). A total of 40 stimuli were then assigned to the treatment items (n=20) and the control items (n=20). The two groups of items were comparable in terms of initial

phonemes, semantic categories (Levin, 1993), word length in syllable, the structures of the multisyllabic verbal compounds (Bates, Chen, Tzeng, Loi, & Opie, 1991) and argument structures complexity the verbs allow (See Appendix C). The student *t*-test also showed that there were no significant differences in familiarity (p= .945), AoA (p= .966), and visual complexity of the pictures (p= .356) in the two probe types.

The digit span test was chosen as the control task. LKC had impaired short-term memory of a reduced span of 4 in the forward digit span and 3 in the backward digit span. It was carried out in the first session of baseline and again in the last session of the maintenance phase.

In addition to collecting baseline performance on verb naming, pre-treatment performance on sentence generation was also evaluated. Three test sessions within one week were given. Instead of using the picture stimuli, orthographic forms of the modal verbs of the 40 stimuli were used. This procedure was taken to minimize the effect of repeated exposure to the picture stimuli which would be used in the subsequent verb naming treatment. The 40 written stimuli were presented randomly in each session. The experimenter also read aloud the written verb shown in each trial. LKC was then required to construct a Cantonese sentence containing the target verb within one minute. No cues and feedbacks were given. Three out of the five normative subjects were invited to generate sentences using the same procedures for later comparison with the data of LKC.

Treatment phase. At the beginning of each session in the treatment phase, LKC was asked to orally name all 40 probes presented in random order. No cues and feedbacks were given during the process. After that, the repetition protocol was implemented on the treatment items only. Upon presentation of a picture stimulus, LKC had to attempt to provide the corresponding verb. If she could provide the modal verb or another appropriate verb for the picture, she had to repeat the named verb for two times; if she failed to do so, she would be provided the modal verb and repeated it for three times. In this way, the frequency of practices for all treatment items would be identical. A session would be ended when the treatment items had been practiced for two cycles. Home practice was not given. When LKC could name the treated stimuli for 85% (17/20)

accuracy in the pre-treatment probing in each session over three consecutive sessions, the treatment phase was completed.

Maintenance phase. Three weekly sessions were arranged beginning two weeks after the last treatment session. LKC was required to name all stimuli once in each session.

Post-treatment Sentence generation performance. Three sessions were carried out to study if there was any generalization effect on sentence generation after the maintenance phase of the verb naming treatment within a week's time. The same data collection procedures as in the baseline were implemented.

Scoring of response and Statistical analysis

Verb naming

The last naming response of each picture stimulus was scored. Correct responses were regarded as those identical to the modal verbs, or other appropriate verbs interpreted from the pictures, and also those contained half of the target phonemes (including tones and segments) (Law et al., 2008). Error responses were classified as (1) semantically-related verbs; (2) semantically-related nouns; (3) semantically-related adjectives; (4) partial responses; (5) jargons; (6) unrelated responses; (7) English response; (8) no response (Refer to Appendix D for definitions and corresponding examples)

The McNemar's test was used to measure changes on the treatment and control items. For each probe type, the session with best performance among the baseline sessions and the first treatment session would be compared with the session with the highest accuracy in the treatment or the maintenance phase. The effect size was further calculated to document the degree of change. It was measured by the d-index which was calculated by the d-formula: $d= (X_T-X_B)/ SD_B$ (Kromrey & Foster-Johnson, 1996). X_T is the mean naming accuracy during the treatment and the maintenance phase excluding the first treatment session, X_B represents the mean accuracy during the baseline phase and the first treatment session and SD_B is the standard deviation of the accuracies achieved during the baseline phase and the first treatment session.

Moreover, the Fisher's exact test was employed to determine if the changes in naming accuracies of the two stimulus types were due to the treatment effect or repeated naming attempts. Comparison would be made between the best performances of the two probe types from the entire treatment period.

Sentence generation

Sentences generated by LKC during the baseline period and at the maintenance phase, and by the control subjects on the treatment items and the control items were analyzed separately, totaling six sets of data. These data sets were compared along six parameters: (1) total number of correct sentences; (2) mean length of utterance in words; (3) mean number of closed class words per utterance; (4) mean number of the use of morphological rule per utterance; (5) total number of complex sentences; (6) different syntactic structures of the clauses containing the target verbs and their frequency. The syntactic structures would be categorized according to how many clause element(s) they contained and if there was any involvement of other constructions including serial verbs, pivotal, dative and passive. The five clause elements included subject (S), verb (V), object (O), complement (C) and adverbial (A) (See Appendix E for details). Qualitative comparisons were made between data sets of LKC before and after the treatment, and between data sets of LKC after the treatment with the control subjects'.

Reliability

20% of naming responses obtained in the probing of each session in the verb naming treatment (n= 80) and 10% of sentences generated by LKC and the control subjects (n=36) was selected randomly for inter-rater reliability checking by a practicing speech therapist who graduated from the Division of Speech and Hearing Sciences, the University of Hong Kong in 2008. The scoring and analysis systems described were adopted and point-to-point agreements were measured.

Results

Verb naming in response to intervention

LKC responded well to the treatment and she required four sessions only to complete the

treatment phase. Her naming accuracy of treatment and control items across the baseline (B1-B3), treatment (T1-T4) and maintenance phase (M1-M3) is illustrated in Figure 2. Table 1 provides the results of statistical analysis of the comparisons between the best performances of each probe types before (from B1 to T1) and after the treatment had begun (from T2 to M3), and between the highest naming accuracies of the two probes after the treatment was implemented (T2 to M3).

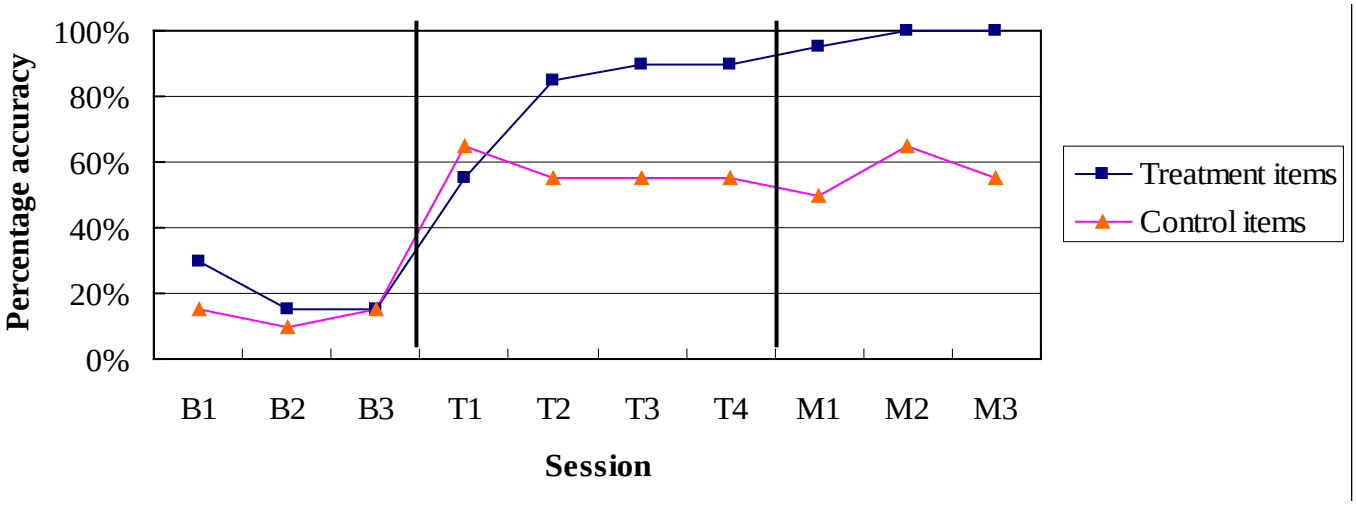

Figure 2. LKC's naming accuracy of treatment and control probes across sessions

Prior to the treatment, the naming accuracy of the treatment and control probes had unexpectedly increased from less than 30% in the baseline phase to 55% and 65% in T1 respectively as illustrated in Figure 2. Comparison was made between the two probe types in T1 by the Fisher's exact test and no significant difference was found ($p=.7475$). This indicates that they remained comparable before the implementation of treatment. Subsequently, significant naming improvement was only shown in the treatment probe ($p<.05$) and the effect size was large ($d= 3.42$). On the other hand, the change in control probes was insignificant ($p>.05$). Her performance on naming the control items remained fairly stable throughout the course of the treatment and maintenance phase as presented in Figure 2. The contrast between the best performances of treatment and control items revealed that LKC could name the treatment items significantly better than the control items ($p<.05$).Moreover, Figure 2 also shows that the treatment effect did not wear off over the maintenance period. Indeed, the naming accuracy continued to increase to a peak of 100% accuracy in the sessions M2 and M3.

Table 1

Results of statistical analysis of naming accuracy

McNemar's chi-square test			
Probe type	**Best performance before the treatment (B1 to T1) vs. Best performance from T2 to M3**	**McNemar χ^2**	**p value**
Treatment items	T1—55% vs. M2 & M3—100%	7.111	.0077 *
Control items	T1—65% vs. M2—65%	0.250	.671 (n.s.)
Fisher's exact test (2-tailed)			
Comparison made	**Best performance from T2 to M3**		**P value**
Treatment vs. Control items	M2 & M3—100% vs. M2—65%		.0083*

* = significant, (n.s.) = not significant

Error distribution before and after the treatment was also analyzed and illustrated in Table 2. The errors made in the treatment and control items were combined during the baseline (including the first treatment session) and the maintenance phase. There was a clear reduction in the proportion of errors which were semantically-related verbs and no response after the treatment, whereas the percentage of errors which were semantically-related nouns and adjectives had increased. The proportion of unrelated errors was comparable while partial and English responses and jargons remained low.

Table 2

Error distribution before and after treatment

Error type	***B1-T1***	***M1-M3***
Confrontation naming of verbs	(*n*=160)	(*n*=120)
Total number of errors	116	27
Semantically-related verbs	36 (31.0%)	3 (11.1%)
Semantically-related nouns	33 (28.4%)	11 (40.7%)
Semantically-related adjectives	17 (14.7%)	6 (22.2%)
Partial	0 (0%)	2 (7.4%)
Jargons	4 (3.4%)	0 (0%)
Unrelated	14 (12.1%)	5 (18.5%)
English	1 (0.9%)	0 (0%)
No response	11 (9.5%)	0 (0%)

B= baseline, T= treatment, M=maintenance

Sentence generation in response to treatment

Whether there was generalization of the treatment gain from verb naming to sentence generation was further investigated. Table 3 presents LKC's pre- and post-treatment performances of sentence generation of the two probe types with reference to the performances of the control subjects. For sentences generated with the treatment items by LKC, the total number of correctly produced sentences had increased by 15% after the treatment, accompanied with a slight increase in the mean utterance length, the number of closed class words and morphological rules used per utterance. On the other hand, the number of correctly generated sentences remained the same after the treatment for those with the control items. However, increases were also noticed in their mean utterance length, number of closed class words and morphological rules used per utterance but the extent was slightly less than the treatment items. Referring to Table 3, post-treatment performances of the number of correctly generated sentences of the treatment items and the use of morphological rules in both probe types seemed to be similar to or better than the control performances. Nevertheless, the mean utterance length and number of closed class words per utterance used were still far below the control performances.

The syntactic structures of the clauses containing the target verbs of the two probe types before and after the treatment for LKC were further analyzed and compared with the control subjects. They were grouped into five major categories as illustrated in Table 3. The category of formulaic sentences was included as LKC tended to use the four sentence frames that listed in the table as exemplars to construct many sentences. Before the treatment, formulaic productions had the highest frequency of occurrence for both probe types, followed by sentences with two clause elements. Those with one clause element of verb only, three or more clause elements and other constructions constituted the smallest proportions. After the treatment, the pattern of distribution of sentences generated in different syntactic categories was similar. Formulaic sentences remained most frequently exhibited and the category's occurrence rate had increased by around 10% in the two probe types. For sentences with two clause elements, although the category was

still the second mostly generated syntactic structure for the two probe types, their percentages had decreased by 12.6% and 13.6% respectively. The proportions of sentences with the clause element of verb only and other constructions were relatively constant and remained low. However, it is noteworthy that LKC generated a slightly higher proportion of sentences with three clause elements, more specifically the SVO structure, for the treated items (4.8% vs. 13.7%). Such increase was not observed in sentences created with the control items (4.5% vs. 4.5%).

Despite LKC seemed to have slight improvement in several aspects as described, she still performed very differently from the control subjects. Complex sentences constituted 42.0% and 32.7% of all correctly generated sentences by the control subjects respectively in the two probe types. In contrast, LKC did not produce any complex sentence at all before and after the treatment. Concerning the proportions of different syntactic structures of sentences created for both probe types, control subjects made use of three or more clause elements in more than half of the sentences (58.0% and 57.1% respectively), followed by using other constructions in around 20% of the sentences, totaling 80% or more in each of the two data sets. On the other hand, within the sentences generated by LKC with both probe types, the sum of the proportions of these two categories had never exceeded 15% even after the treatment. Lastly, the control subjects did not use any formulaic sentences that LKC used at all for any probe type, whereas LKC used them to construct 52.9% and 65.9% of the sentences with the two probe types after the treatment.

Control task

LKC's performances were unchanged for the control task of the digit span in the baseline and maintenance phase. Her forward digit span remained at 4 digits and her backward digit span remained at 3 digits.

Reliability

For the inter-rater reliability of the naming responses of the verb naming treatment, the point-to-point agreement of the classification of correct response and different error types was 87.5%; for the sentences generation task, the point-to-point agreements of the number of correct

Table 3. LKC's pre- and post-treatment performance on sentence generation in comparison with the control data

	Sentences generated					
	With treatment items (n=60)			With control items (n=60)		
	LKC (pre-tx)	LKC (post-tx)	Control	LKC (pre-tx)	LKC (post-tx)	Control
Total number of correct sentences	42 (70.0%)	51(85.0%)	50 (83.3%)	44 (73.3%)	44 (73.3%)	49 (81.7%)
Mean length of utterance (in words)	2.76 (116/42)	2.88 (147/51)	7.58 (379/50)	2.64 (116/44)	2.75 (121/44)	7.45 (365/49)
Mean number of closed class word / utterance	0.76 (32/42)	1.25 (64/51)	3.42 (171/50)	0.80 (35/44)	1.09 (48/44)	2.96 (145/49)
Mean number of morphological rule/ utterance	0.05 (2/42)	0.18 (9/51)	0.12 (6/50)	0.09 (4/44)	0.14 (6/44)	0.12 (6/49)
Proportion of complex sentences	0.0% (0/42)	0.0% (0/51)	42.0% (21/50)	0.0% (0/44)	0.0% (0/44)	32.7% (16/49)
Proportion of sentences with different syntactic structure						
With the clause element of verb only	**9.5% (4/42)**	**7.8%(4/51)**	**2.0% (1/50)**	**4.5% (2/44)**	**9.1% (4/44)**	**0.0% (0/49)**
With two clause elements	**38.1%(16/42)**	**25.5%(13/51)**	**18.0%(9/50)**	**31.8%(14/44)**	**18.2% (8/44)**	**14.3% (7/49)**
VO/ VA/ VC	21.4%	13.7%	8.0%	6.8%	6.8%	6.1%
SV	16.7%	11.8%	10.0%	25%	11.4%	8.2%
With three/ more clause elements	**4.8%(2/42)**	**13.7%(7/51)**	**58.0%(29/50)**	**6.8%(3/44)**	**4.5% (2/44)**	**57.1%(28/49)**
VOA/VOC/ VAA/ VCA	0.0%	0.0%	10.0%	0.0%	0.0%	12.2%
SVO	4.8%	13.7%	6.0%	4.5%	4.5%	4.1%
SVA/ SVC	0.0%	0.0%	20.0%	0.0%	0.0%	6.1.%
SVOA	0.0%	0.0%	6.0%	2.3%	0.0%	10.2%
Infinitive clause	0.0%	0.0%	16.0%	0.0%	0.0%	24.5%
Other constructions	**4.8% (2/42)**	**0.0% (0/51)**	**22.0%(11/50)**	**2.3% (1/44)**	**2.3% (1/44)**	**28.6%(14/49)**
Serial verb/Pivotal/Dative/Passive						
Formulaic sentences	**42.9%(18/42)**	**52.9%(27/51)**	**0.0% (0/50)**	**54.5%(24/44)**	**65.9% (29/44)**	**0.0% (0/49)**
V-particle (V-"先" /sin1/)	7.1%	7.8%	0.0%	9.1%	6.8.%	0.0%
V-asp -V-particle (V-"—" /yat1/-V-"先"/sin1/)	0.0%	5.9%	0.0%	6.8%	13.6.%	0.0%
SauxV (S-"會"will-V)	11.9%	33.3%	0.0%	9.1%	31.8%	0.0%
Infinitive clause- SVV (S-"識"know-V)	23.8%	5.9%	0.0%	29.5%	13.6%	0.0%

Pre-tx= Pre-treatment, Post-tx= Post-treatment; S= subject; V= verb; O= object; C= complement; A= adverbial; asp=aspect marker; aux= auxillary; word in / /= Chinese transcription

sentences, mean utterance length, mean number of closed class words and morphological rules used per utterance, and proportion of complex sentences were 91.7%, 83.3%, 86.1%, 91.7% and 94.4% respectively. For the classification of sentences into different syntactic structures, the agreement was 86.1%.

Summary of main findings

To summarize, LKC was responsive to the repetition treatment and she had significant improvement in naming the treated verbs in just four sessions' time. The treatment effect could be maintained for at least one month beyond the treatment. In addition, slight improvement of her ability to generate sentences with the treatment items was observed in terms of creating more correct sentences, slight increase in mean utterance length, mean number of closed-class words, use of morphological rules per utterance and the number of sentences with SVO structure. However, her overall performance was still far below the control performances.

Discussion

Effect of repetition protocol on verb naming

The outcomes of the verb naming treatment confirmed the predictions that item specific effect would be obtained by using a repetition protocol and no generalization effect would be found on the untrained control items. These were evidenced by the significantly higher naming accuracy LKC could achieve on the treated items than the control items and the naming accuracy of the control items was kept relatively constant after the introduction of treatment. These indicate that the treatment gain could not be attributed to repeated naming as the frequency of exposure to the two probe types had been kept identical in circumstances other than the treatment. In addition, the performance of LKC on the control task of digit span remained unchanged. This shows that spontaneous recovery was not a factor. Therefore, LKC's improvement in naming the treated items was mainly due to the treatment provided. Besides, the prediction of maintenance of treatment gain beyond the treatment phase was also verified. Therefore, the error reduction treatment method of repetition of target words in the presence of target pictures is considered to

be a viable method to manage verb retrieval deficit in Chinese in terms of producing item specific effect and maintenance effect that lasted for at least one month.

Factors contributing to rapid improvement to the treatment

LKC had made rapid progress as she just required four sessions to complete the treatment phase. Several factors may account for such prompt effect.

First, the semantic and phonological activations provided by repetition with the presence of target picture were already adequate (Raymer & Ellsworth, 2002) for LKC who had relatively mild semantic processing and post-semantic level deficit. Semantic representations in the semantic system could be readily specified by the amount of semantic activation provided by the picture stimuli (Nickels, 2002b) and the activation was cascaded to the phonological output lexicon (POL). Together with the activation provided directly by the phonological forms given for repetition via the sublexical route, the activation threshold of lexical items would be further lowered (Hillis & Caramazza, 1994). The phonological forms of the target words would then be specified and retrieved very promptly.

Second, the number of errors made by LKC was few because of the error reduction nature of the repetition protocol. According to the principle of errorless learning, reinforcement of incorrect associations would be reduced to a great extent and fewer semantically nodes related to the target words would be activated in the POL. As a result of less activation of competitors, LKC could retrieve the correct representations more readily.

Third, the sentence generation task implemented before the treatment might facilitate word retrieval. Nickels (2002b) suggests that picture naming could be improved from preceding tasks utilizing the same stimuli regardless of different processing demands required. In fact, Raymer & Kohen (2006) had implemented a sentence-based word retrieval training and significant naming improvement of nouns and verbs was demonstrated in one of the two subjects.

Lastly, the rate of verb naming treatment could also have been accelerated by the provision of the orthographical and phonological forms of words in the sentence generation task in the

baseline phase. The orthographic input lexicon (OIL) could be accessed when LKC looked at the written stimuli (Wambaugh & Wright, 2007) and the semantic system (SS) was further activated when she tried to construct sentences. With the simultaneous provision of the phonological forms of the targets, connections between the OIL, SS and POL were strengthened. In later picture naming, it was observed that LKC attempted to write the target verbs occasionally by using her finger even though no written stimuli were presented. This showed that she might have associated some of the pictures with their orthographic forms as both types of stimulus could access the same semantic system. Word retrieval was accomplished with the activation of OIL (Wambaugh & Wright, 2007) instead of from the picture stimuli alone.

It is important to note that whatever effects bought about by sentence contexts and orthographic forms, they were not confined to the treated items only but to both probe types as can be seen by the similar degrees of increase in accurately naming both treatment and control probes from the baseline phase to the first treatment session. Nevertheless, further increase in naming accuracy was only shown in naming the treated items.

Pros and cons of repetition protocol

Using repetition as the treatment protocol has many advantages. First of all, it is a relatively easy method to be used as one is only required to repeat the name of the target word. Difficult and cumbersome procedures such as describing semantic properties or following a phonological cueing hierarchy were not needed and thus this causes less frustration to the anomic speakers. Due to the ease of its implementation, the use of computer generated pictures and repetition cues as a home programme is highly feasible (McDonalds et al., 2006). In addition, only 20 minutes were needed for LKC to complete one session. This can avoid fatigue as a result of long treatment sessions (Marshall, 1997). Moreover, as the repetition protocol mainly activates semantic and phonological information, it is applicable to individuals with or without semantic deficits. It is also worth mentioning that although LKC had deficits in repetition due to conduction aphasia and short-term memory deficits as shown by reduced digit span, she was

able to engage in the repetition treatment under the condition that the syllable length of the stimuli did not exceed three syllables. This reflects that patients may not need to have high cognitive abilities in order to benefit from this treatment, unlike other protocols where high executive problem-solving skills were linked to treatment success (Hinckley & Carr, 2001; Law et al., 2008).

Despite all the aforementioned advantages, the most apparent drawback of the repetition protocol would be its effect appears to be item-specific. Treatment generalization might be achieved by incorporating contextual priming (Martin, Fink, Laine, & Ayala, 2004), which is discussed below.

Effect of repetition protocol on sentence generation

Although LKC had significant improvement in retrieving the treated verbs, generalization effect to sentence generation was minimal. Table 3 shows that she produced more correct sentences and her mean utterance length, the number of closed-class words and frequency of morphonological rules had increased for the treated items. However, increased number of correct sentences could be achieved by using formulaic sentences as the compensatory strategy only. For the other three parameters, improvement was not only specific to treated items but also observed in the control items. One may argue that the degree of improvement was more for the treated items, but LKC's restricted use of closed class words (mainly with the particle"先" /sin1/ and the auxillary "會"(will)) and the morphological rule (only the reduplication of verbs as in V-"一"/yat1/-V) had complicated the picture and made true improvement hard to demonstrate.

When looking more closely into those sentences containing the clause element of subject created by LKC, it was noted that she had restrictive use of "我" (I) as the subject for both probe types prior to the treatment. After the treatment, only those sentences generated with the treated items had increase use of proper nouns as subjects for particular verbs. e.g., 工人(worker) was used for the verb 搬運 (carry); 小販 (hawker) was used for the verb 叫賣 (sell by calling out).

This indicates that improved verb retrieval could prime the activation of agent to a certain extent as suggested by Edmonds, Nadeau, and Kiran (2008). They proposed that memory was structured and neural co-activation of related situational knowledge happened when a verb was activated. Hence once the semantic representation of a particular verb was strengthened upon the naming treatment, the access of more specific content words associated with that verb could also be strengthened (Wambaugh & Ferguson, 2007). This might account for the slight increase in the use of three clause element sentences with SVO structure for the treated items (from 4.8% to 13.7%). The improvement can be claimed confidently as in addition to the less restrictive use of subjects, the proportion of SVO sentences for the control items was remained relatively constant (remained at 4.5%).

Nevertheless, the generalization effect to sentence generation was still minimal. The sentence LKC generated remained dominated by formulaic sentences and those with two clause elements. Also, the mean utterance length and the number of closed class were far below the control performance. In addition, the improvement seen in constructing SVO sentences was actually small. Limited generalization could be due to the fact that repeated picture naming might address only part of the sentence generation mechanism (Berndt & Mitchum, 2001). In the repetition treatment, LKC was only asked to repeat the phonological form of the verbs. Although the thematic and semantic information could be accessed in the presence of pictures during repetition, their activation might be too weak to have an effect on formulating complete sentences for every stimulus. The verb naming treatment mainly focused on the specification of the phonological form of verbs (Berndt & Mitchum, 2001) while the fundamental structural relations of “who is doing what to whom” (Byng, Swinburn, & Pound, 1999, p. 107) was not clarified adequately. Byng et. al. (1999) suggested that clarification of relationships between the underlying conceptual message and language could be essential in enhancing the output of sentences. Hence, this may imply that for evident improvement in sentence production, treatment focusing on the relevant levels is necessary.

Differences between the present study and Raymer and Ellsworth (2002)

As mentioned in the introduction, Raymer and Ellsworth (2002) found that improved verb retrieval by using a repetition protocol could lead to parallel gain in one's sentence generation ability. However, the lack of noticeable generalization effect in the present study seems to contradict their findings. Several accounts are proposed for the discrepancy. First, pictures were provided for WR to generate sentences while only written words were provided for LKC. It is likely that more concrete information about the semantic and thematic characteristics of the verbs was available in the pictures, and this made the process of lexical selection in sentence constructions easier. The second difference lied in the methods of data analysis. Raymer and Ellsworth (2002) compared the performance of WR in generating sentences for the treatment items only in the last treatment session with the baseline performance without contrasting with the sentences formed with the control items. Therefore, whether the generalization effect was specific to the treatment items was unknown. Also, no data was obtained from control subjects for comparison. Whether WR's post-treatment performance approached the control subjects' performance and the discrepancy between them were uncertain. In fact, they had carried out one probing session in the maintenance phase and WR's accuracy in forming correct sentences was found to deteriorate from 55% to 40%. However, since only one session was carried out, whether her performance would wear off was questionable. In the present study, these problems had been addressed by including data of sentence generated with the control items, data from the control subjects and data from three sessions in the maintenance phase for more comprehensive comparisons. Moreover, the claim by Raymer and Ellsworth (2002) that WR had improved sentence generation ability was based on only one parameter i.e. the number of correct sentences produced. However, it is clear from our study that despite LKC's number of correct sentences for the treated items had increased to a level that was close to the control subjects', her performances in many other parameters remained poor. Therefore, whether there was any substantive generalization effect of the verb naming treatment carried out in Raymer and

Ellsworth (2002) is yet to be determined.

Limitations of the present study

Given that the sentence generation task implemented might have affected LKC's performance in later verb naming treatment, the precise effect of the repetition protocol alone could not be ascertained yet. Previous studies have shown that it took more than four sessions (as in the case of LKC) for the repetition protocols to exert their effect regardless of the number of stimuli included, the procedures of the treatment and the severity and type of deficits the patients had. Five one-hour sessions were needed in the study of Miceli et al. (1996), ten sessions were implemented in Raymer and Ellsworth (2001) and eight sessions were required in McDonald's et al. (2006) to reach performance criteria.

Furthermore, sentence comprehension was not specifically assessed in LKC. Though sentence comprehension and production could be dissociable (Law & Leung, 2000) in some cases, Berndt, Mitchum, Haendiges, and Sandson (1997) argued that lemma representations in productions are "modality neutral" and engaged in both comprehension and production in some other cases. Therefore, it was unsure that whether her limited improvement in sentences generation was related to any sentence comprehension deficits which were not addressed.

Suggestions for further study

In the present study, no generalization effect was shown on the control items. However, it may be premature to conclude that effects of repetition protocol could just lead to item-specific effect. In fact, it could be due to the stimulus included in the two probe types having diverse initial consonants and semantic categories, making generalization effect difficult to occur. Martin et al. (2004) had adopted the procedure of contextual repetition priming to treat noun naming. Three sets of stimuli that were phonologically related, semantically related or unrelated were trained in a repetition protocol. The participants could generally name the former two sets better than the unrelated set after the treatment. Therefore, future study may combine the repetition protocol with the technique of priming in order to strengthen the generalization effect

(Martin & Laine, 2000) in verb naming treatment.

In addition, the subject participated in the present study had rather mild deficits in semantic processing and the post-semantic level mechanism. Application of repetition with the presence of picture as the treatment protocol should be implemented on anomic patients with different severity levels and underlying impairment so as to investigate the extent of its effectiveness.

Lastly, this study is among the first to investigate the management of verb naming in Chinese and errorless treatment method was focused. Future studies may utilize errorful treatment methods such as the provision of semantic and phonological cueing to treat verb naming and contrast with the present study. Insights into whether verb naming, which is inherently more difficult than noun naming, is better managed by errorless or errorful treatments in Chinese speaking individuals could be gathered.

Conclusion

Although the use of repetition in anomia therapy is always regarded as the last resort, this study demonstrated its effectiveness in managing verb naming deficit successfully in a Cantonese anomic individual. Item-specific effect on treated items was observed and treatment gains could be maintained for at least one month. These results call for clinicians to reconsider the use of repetition protocol to manage anomia in either clinical settings or as a home program. However, despite the core role of verbs in sentence, generalization effect of improved verb retrieval on sentence generation was limited and the anomia subject still performed far below the control subjects. These suggest that merely focusing on the phonological form of the verb may not be adequate to produce far-reaching improvement in other language level.

Acknowledgment

I would like to express my deepest gratitude to my supervisor, Dr. Law Sam Po, for her devoted support and valuable advices on my dissertation. I would like to show my sincere thank to LKC who participated in my study for about four months' time. Besides, I would like to thank Dr. Carol To for her advices on sentence analysis. I also thank Dr. Lyndsey Nickels and Ms Belinda McDonalds for their generous provision of the PowerPoints of their unpublished studies. Last but not least, thanks to my friends and family for their encouragement all along.

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Appendix A

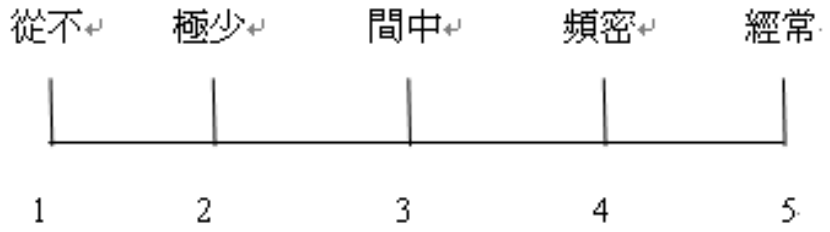
Results of initial assessments of LKC

Area of assessment	Task implemented	% Accuracy	Normative data
Visual object recognition	Minimal Feature View	100% (25/25)	
	Foreshortened View	100% (25/25)	
	Item Match	100% (32/32)	
Auditory phonological analysis	Auditory discrimination	97.5% (39/40)	
Nonverbal semantic processing	Associative match test of BORB	100% (23/23)	20-23; SD=1.20
	PPTT	97.3% (36/37)	21-37; SD=5.40
Verbal semantic processing	Spoken word-picture matching	96.8% (122/126)	124-126
	Written word-picture matching	97.6% (123/126)	
	Auditory synonym judgment	70% (42/60)	54-58
Semantic processing-lexical retrieval	Snodgrass oral naming	79.7% (173/217)	216-217; SD=0.53
	Snodgrass reading aloud	88% (191/217)	
Memory	Digit Span Forward (sequence)	4	Mean=8.92; SD=1.21
	Digit Span Forward (span)	4	Mean=9.00; SD= 1.25
	Digit Span Backward (sequence)	2	Mean=6.20; SD=1.70
	Digit Span Backward (span)	2	Mean= 6.30; SD=1.66
Attention	Balloon Test A (time)	61 seconds	
	Balloon Test B (time)	131 seconds	
	Balloon Test A (correct)	100.0	
	Balloon Test B (correct)	95.0	
Nonverbal Intelligence	TONI-3 Form A	Raw score: 23	21st percentile
Executive Functions	BADS	Conflict 52.45ms	

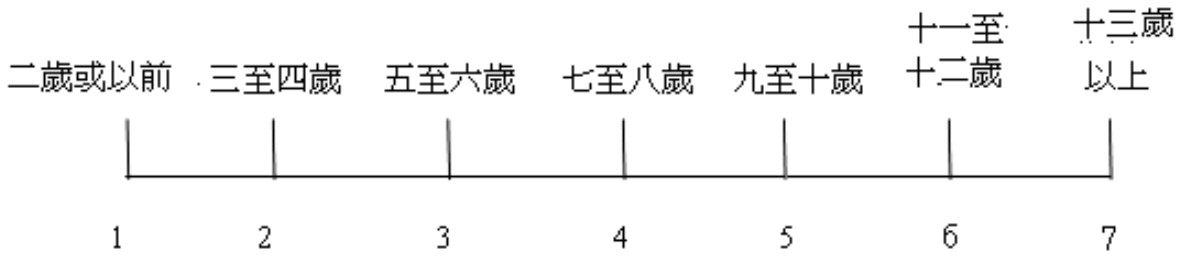
Appendix B

Rating scales of familiarity, age of acquisition (AoA) and visual complexity for the normal subjects

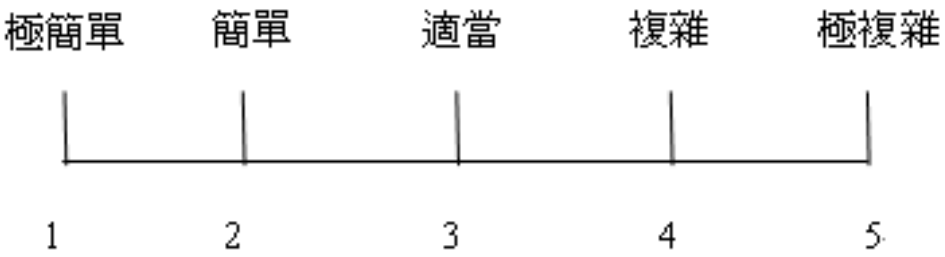
熟悉度： 評級分為五個級別。熟悉是指您在日常生活中經常見到、接觸到或者想到；相反，若您在日常生活中不曾見到、接觸到或者想到，就是不熟悉。一分代表“從不”，五分代表“經常”，兩、三、四分分別代表“極少”、“間中”以及“頻密”。



學習年齡： 評級分為七個級別。學習年齡是指您何時學會該動詞，學習範圍包括日常生活中及課堂上。一分代表“兩歲或以前”已學會，兩分代表“三至四歲之間”學會，如此類推，七分則代表“十三歲以後”才學會。



圖片複雜度：評級分為七個級別。圖片複雜度是指圖片線條的複雜度。一分代表“極簡單”，兩分至四分分別代表“簡單”、“適當”以及“複雜”，五分則代表“極複雜”。



Appendix C

Treatment items and control items used in the study

	Item	Familiarity	AoA	Visual complexity	Initial phoneme	Semantic category
Treatment Items	溶	4	3.4	2.3	y	change of state
	爆	3.6	4.8	2.8	b	change of state
	磨刀	2.4	5.4	3.5	m	change of state
	晒太陽	3.8	4.8	3.3	s	change of state
	打喊路	4	4	2.7	d	Involving the body
	打招呼	4.6	4.2	2.8	d	Involving the body
	踩	3.2	5.6	2.8	ch	Motion
	過馬路	5	3.6	2.8	gw	Motion
	爬樹	2.2	4.4	2.8	p	Motion
	煎蛋	4	5	2.7	j	Creation and transformation
	修理	2.8	6.2	3.5	s	Creation and transformation
	攪	4.2	4.2	2.7	g	combining & attaching
	量度	3.4	5.2	3.3	l	Measure
	落雨	4.2	4	2.3	l	Weather
	鑽	2	5.2	2.5	j	Cutting
	玩	3.2	3.2	2.3	w	Psych-verbs
	教	3.4	3.6	2.8	g	communication
	叫賣	4.8	4.2	3.7	k	change of possession
	吠	4	3.6	2.3	f	Sounds made by animals
	搬運	3.6	4.6	3.3	b	Putting

Distribution of words with different syllable length (n=20)		
1 syllable	2 syllables	3 syllables
8	8	4
Distribution of words with verbal/ verbal + nominal component (n=20)		
With verbal component only	With verbal and nominal component	
13	7	
Argument structure complexity (n=20)		
1 place (intransitive)	2 place optional	2 place obligatory
12	1	7

(Appendix C- Continued)

	Item	Familiarity	AoA	Visual complexity	Initial phoneme	Semantic category
Control items	沉	2.8	4.4	3	ch	Change of state
	點蠟燭	3	4.4	2.8	d	Change of state
	開水喉	4.8	3.2	2.8	h	Change of state
	食煙	4	4.4	2.5	s	Involving the body
	跪	3	4.2	2.7	gw	Involving the body
	舉手	3.6	4	3.3	g	Involving the body
	騎馬	1.6	5	3.7	k	Motion
	打關斗	3.6	4.6	2.7	d	Motion
	飛	3	4.2	3.8	f	Motion
	織	2	6.2	4	j	Creation and transformation
	扭	4.2	4.2	2.8	l	Creation and transformation
	畫畫	3.2	3.2	3.2	w	Creation and transformation
	綁鞋帶	5	3.8	2.8	b	combining & attaching
	磅 3	4.6	5.2	2.5	b	Measure
	切	5	4.4	2.3	ch	Cutting
	休息	5	4.6	3.3	y	psych-verbs
	摵	3.4	4.8	2.8	m	Contact
	照	4.2	4.8	3	j	Emission
	結婚	3.6	5	3	g	Social interaction
	落雪	2.4	4.4	2.8	l	Weather

Distribution of words with different syllable length (n=20)		
1 syllable	2 syllables	3 syllables
9	7	4
Distribution of words with verbal/ verbal + nominal component (n=20)		
With verbal component only	With verbal and nominal component	
13	7	
Argument structure complexity (n=20)		
1 place (intransitive)	2 place optional	2 place obligatory
13	1	6

Appendix D

Definition and example of different error types

Error type	Definition	Example
1. Semantically-related verb	The target verb and the response share similar semantic properties	過馬路→行路 'cross the road'→ 'walk'
	2. Actions that are always carried out by the same agent	飛→啄 'fly'→ 'peck' 攪→畢嘢 'stir'→ 'spoon'
2. Semantically-related noun	The response contains the objects involved in an action	教→黑板 'teach'→ 'blackboard'
3. Semantically-related adjective	The response contains an adjective describing the actions or the objects involved in the picture	休息→ 攰 'rest'→ 'tired'
4. Partial response	The response contains part of the verb but not only the noun	打關斗→打 'turn a somersault'→ 'turn'
5. Jargon	Non-sense words	煎蛋→分蛋 'fry an egg'→ 'divide an egg'
6. Unrelated error	The response contains a proper word but is not a semantically related verb, noun or adjectives of the target verb	玩→粘 'play'→ 'stick'
7. English response	The target verb is produced in English	教→ teaching 'teaching' in Chinese → 'teaching' in English
8. Do not know/ no response	Trial that the subject mentions "Do not know" or cannot give any response within 15 seconds upon presentation of pictures	

Appendix E

Parameters of sentence analysis and the detail of analysis

All targeted verbs in Chinese and English will be marked by □ in the followings

(1) Definition of errors made

Sentences with one or more of the following features are considered errors:

1. The syntactic function of the verbs was changed

   When a verb did not play the role of a predicate in the sentence constructed, then its syntactic function was said to be changed.

   e.g. Target verb: 騎馬 (ride a horse);

   sentence generated: 騎馬係一項好刺激嘅活動 'Horse riding is an exciting activity'.

   騎馬 had become a gerund representing the name of an activity

2. The verb was missing

   e.g., 我識關斗 'I know how to a somersault'. The verb "打" 'turn' was missed

3. The syntactical structure was wrong/ essential element was missing

   e.g., 生果檔叫賣 'The fruit stall is calling aloud in public to offer for sale'

   A proper agent that performed the action such as 'the hawker of the fruit stall' was missed.

4. Wrong content words were used and the sentence became illogical

   e.g., 教車師傅好難學嘅 'it's hard to learn driving teacher'

5. Phonological paraphasia of any word in the sentence including the target verb was NOT regarded as errors under the condition that the verb contained half of the target phonemes (including tones and segments).

6. No response/ responded as "Do not know"

(2) Average utterance length in word

1. All sentence final particles were excluded e.g., 呀 (ā), 啦 (la), 囉 (lo)

2. All aspect and verbal particles (Examples to be described in (3) number of closed class words per utterance below) were not coded as individual words as they could not occur without verbs or their meanings would be altered. They were counted with the verbs they were attached to.

   e.g., 食咗 (V: 'eat' + perfective aspect marker /jo/) was treated as one word and the utterance represented "eaten".

3. The verbs given for sentence generation were coded as one word, regardless of their number of syllables and structure of verbal compound (with verbal component/ both verbal and nominal components).

(Appendix E- Continued)

(3) Number of closed class words per utterance

Closed class words included the followings:

1. Adverbs (ADV)-

   Adverbs of quantity- e.g., 都 'also/ both', 淨係 'only';

   Adverbs of time- e.g., 以前 'before', 宜家 'now';

   Adverbs of frequency- e.g., 經常 'always', 每日 'everyday'

2. Classifiers (CL)-

   Measure (quantity) classifiers- e.g., 啲 'some', 班 'group'

   Sortal (type) classifiers- e.g., 個 (used with words denoting people and other items which do not have a more specific classifier)

3. Verbal particles (PRT)-

   Directional particles- e.g., 出 'out', 起 'up', 過 'over'

   Resultative particles- e.g., 好 'completion', 死 'hard/ to death', 完 'to the end/ finished'

   Exclamatory and affective particles-e.g., 先 /sin1/

4. Aspect markers (ASP)-

   Progressive 緊 /gan2/ (used to describe a dynamic ongoing activity)

   Continuous 住 /jyuh6/ (used describe a continuous activity without any change of state)

   Perfective 咗 /jo5/ (used to report an event seen as a whole or as completed)

   Delimitative 吓 /hah2/ meaning 'do… for a while' or 'have a …';

   一 /yat1/ meaning for a while

5. Question words- e.g., 未 'yet'

6. Negative markers- e.g., 唔 'no', 無 'none'

7. Prepositions- e.g., 同 'with', 喺 'at', 對 'to, towards'

8. Numerals- e.g., 一 'one', 兩 'two'

9. Conjunctions- e.g. 如果 'if', 就 'then', 所以 'so', 原來 'actually', 嘅時候 'when'

(4) Proportion of utterances with the use of morphological rule

1. When a word was inflected as a word phrase but the meaning remained unchanged, then a morphological rule was considered to be used

   e.g., reduplication of words, 出出入入 "go out and in" equals to the meaning of 出入

   use of the delimitative aspect marker "一" /yat1/ in reduplicated verbs -磅一磅

(Appendix E- Continued)

(5) Proportion of complex sentences

A sentence was regarded as complex if more than one clause was generated and one of the followings was included:

1. Relative clause- a clause that modify a noun phrase.

   e.g., 叫賣魚蛋個婆婆 'The old lady who sells the fishball'

2. Subordinate clauses include the followings were regarded as complex sentences:

   a. Time clauses- a clause that specifies the time to which the following main clause refers

      e.g., 我做完運動之後，都會好想休息一吓

      'After I finish doing exercises, I also want to rest for a while'

   b. Reason clause- a clause that expresses reason that explain the other main clause

      e.g., 我搵貨嗰陣時要跪喺度搵，因為太低喇

      'I have to kneel down when I am looking for stocks, it is because (the stocks are placed) too low.'

   c. Purpose clause-a clause states the purpose while the other main clause expresses the way to achieve the purpose

      e.g., 我的家人為咗健康都沒有食煙

      'For the sake of health, my family members do not smoke.'

   d. Concession clauses- a clause that admits or concedes a fact while the following main clause counteracts or contradicts.

      e.g., 雖然隻錶好貴, 但係我都會買 'Although the watch is expensive, I will still buy it.'

3. Conditional sentences

Remarks: For sentences with more than one clause generated but the connectives were not explicitly stated, they were also coded as complex sentences if some relationships could be implied.

e.g., 近排成日落雨，無得出街玩喇

'(Because) it keeps raining all the time recently, (so) we cannot go out to play'

(6) Proportion of different syntactic structures

1. All question tags that were irrelevant to the sentence generated were excluded (e.g., 好唔好呀).
2. Compound verbs, i.e. verb-object compounds, were analyzed as a single verb only if they were presented as a single unit. They should not be coded as verb and object separately.
3. If more than one clause was included in the sentence generated (for both simple and complex sentences), only the clause containing the verb would be used for syntactic analysis.

(Appendix E- Continued)

4. Different syntactic structures were grouped into five different categories. The first three categories were grouped according to how many clause elements the sentences were composed of and these clause elements include: subject (S), verb (V), object (O), adverbial (A) and complement (C). The five categories, their examples and the English translations were provided below.

Remarks: Due to the discrepancy of the grammatical structures in Cantonese in English, readers should not attempt to analyze the sentences by the English translations or inaccurate results will be obtained. e.g., the delimitative aspect marker "一" /yat1/ has the meaning of "for a while". It is not counted as an individual unit in Cantonese and is considered a part of the verb. However, "for a while" is considered as an adverbial in English.

I. With the verb clause only

e.g., 玩完 'played'

II. With two clause elements

a. VO- e.g., 搬運啲野 'carry some stuffs.'

b. VA- e.g., 小心過馬路 'cross the road carefully.'

c. VC- e.g., 教 到我傻 'Teaching drives me crazy.'

d. SV- e.g., 我結婚 'I get marry.'

III. With three clause elements or more

a. AVO/ VOA- e.g., 努力修理電梯 'Fix the elevator hard.'

b. VOC-e.g., 見到啲雀仔飛來飛去 'See the birds fly here and there.'

c. AAV/ VAA/ AVA- e.g., 近排成日落雨 'It rains always recently.'

d. AVC- e.g., 成朝開水喉開得好大聲

'Turning the water tap for the whole morning made a loud noise'

e. SVO-e.g., 你教吓我 'You teach me for a while.'

f. SVA-e.g., 我阿哥畫畫好叻 'My brother draws very well.'

g. SVC-e.g., 我過馬路會望前望後

'When I cross the road, I will look at the front and the back.'

h. SVOA/ SAVO-e.g., 我每日起身都會磅一吓體重

'When I get up everyday, I weigh my weight.'

i. Infinitive clause-e.g., 好想踩單車 'Really want to ride a bicycle.'

(Appendix E- Continued)

IV. Other construction

a. Serial verb construction-e.g., 扭開收音機 聽吓天氣 先

'Turn on the radio and listen to the weather forecast.'

b. Pivotal- e.g., 留心聽我教

'Attentively- listen to- me- teaching' could be regarded as two sentences

'Listen to me attentively' and 'I am teaching'

Me was the object of the first sentence but became the subject in the second sentence

c. Dative- e.g., 我織冷衫俾你

'I knit a sweater to you' Dative involved both the direct and indirect object and it indicated whom the direct object was given.

d. Passive- e.g., 個磅成日俾人磅

'The scale is always used to weigh by the others' The passive voice was used.

V. Formulaic sentences

a. V-particle **(V-"先" /sin1/)**: the verb with the verbal particle "先" /sin1/

e.g., 點爐燭先

'Light the candle'

b. V-asp-V-particle **(V-"一" /yat1/-V-"先"/sin1/)**: use of the delimitative aspect marker "一" /yat1/ in reduplicated construction of verb with the verbal particle "先" /sin1/

e.g., 玩一玩先

'Play for a while'

c. SauxV with the auxillary "會" (will) **(S-"會"will-V)**

e.g., 我會舉手

'I will raise up my hand'

d. Infinitive clause SVV with the verb "識" (know) **(S-"識"know-V)**

e.g., 我識畫畫

'I know how to draw'