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Citation	
Issued Date	2009
URL	http://hdl.handle.net/10722/173672
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Treatment efficacy of semantic feature analysis (SFA)
on verb retrieval of a Cantonese anomic speaker

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

Abstract

This investigation examined the treatment efficacy of semantic feature analysis on verb retrieval. A single-subject multiple baseline design was employed on a 48-year-old Cantonese anomic speaker. The treatment effectiveness was investigated at single word level, in terms of treatment effect, generalization effect to semantically related items and maintenance effect. Significant treatment effect was demonstrated for treated items, with maintenance of the treatment gains for at least one month after treatment. Generalization to untrained, semantically related items was limited. The poor generalization effects were explained with the immaturity of self-cueing strategy and the limitation of semantic categorization of verbs. The results were also compared with previous anomic treatments on nouns. With the positive treatment outcomes, semantic feature analysis can be a possible treatment approach for verb training in Cantonese-speaking population. Semantic priming was recommended to implement into semantic feature analysis to maximize generalization.

Introduction

Anomia is a prevalent feature of language impairment following brain damage.

Word-finding difficulty is so persistent and extensive that it is noticed in both single word naming and conversation even after many years post-onset (Goodglass & Wingfield, 1997). It is also frequently the source of patient's poor self-confidence and frustration (Goldfarb & Halpern, 1989). Over the years, researchers have developed several processing models based on which effective treatments for word retrieval may be developed. Models taking the cognitive neuropsychological approach explain the problems of single word production.

As shown in Figure 1, the processing route of confrontation naming involves semantic system and other functional loci. Failures of oral naming can be the result of impairments in object recognition, semantic system, phonological output lexicon, phonological output buffer or the linkage between any two loci (Raymer et. al, 1997).

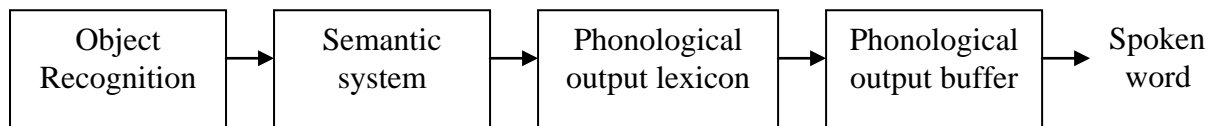


Figure 1. Processing of confrontation naming in cognitive neuropsychological model

Overview of Anomic Treatments for Noun Retrieval in English

It is generally accepted that both semantic and phonological processing play important roles in word retrieval (Raymer et al., 2007). Therefore, a great number of anomic treatments have employed facilitating approaches to compensate the underlying impairments, in which phonological or/and semantic tasks are involved. Phonological tasks may involve judgments of rhymes, orthographic and phonological cueing, or simply repetition (e.g. Nickels, 1992; Raymer, Thompsan, Jacobs & Le Grands, 1993). On the other hand, semantic tasks aim to improve word retrieval by increasing “the specificity of semantic representations of targets” (Hillis, 1998, p. 654). They commonly include semantic categorization (e.g. Nickels & Best, 1996), judgment on semantic properties (e.g. Kiran & Thompson, 2001) and word-picture

matching (e.g. Marshall, Pound, White-Thomas & Pring, 1990). One semantic treatment which has interested many researchers is semantic feature analysis (SFA). In this task, pictures are placed at the centre of *SFA* chart before naming is attempted. Subjects are then required to generate semantic features of objects, such as category, functions and relevant action, to assist confrontation naming (Nickels, 2002a). Improvement in naming performance was seen in the treated items and semantically-related untrained items in most studies involving the use of *SFA* (Boyle & Coelho, 1995; Coelho, McHugh & Boyle, 2000; Boyle, 2004). Coelho et al. (2000) and Boyle (2004) also reported positive gains in connected speech, apart from the treatment and generalization effects.

As illustrated above, most aphasic treatments aimed to facilitate word retrieval of objects but little attention was paid to verb retrieval. Only a small number of treatments on verb retrieval have been conducted (e.g. Raymer et al., 2007; Raymer & Ellsworth, 2002; Rodriguez, Raymer & Rothi, 2006; Wambaugh et al., 2004) and verb production training has not been explored in Chinese-speaking aphasic population. In view that verb deficit is frequently observed in many aphasic speakers and verbs possess important linguistic properties such as thematic roles and argument structures, which play an important role in the formation of sentences (Raymer et al., 2007), this study is motivated to investigate the rehabilitation of verb retrieval in Cantonese.

Comparison of Noun and Verb Retrieval

There is evidence that many aphasic speakers have relatively greater difficulties in producing verbs than nouns but some show more superior verb production (Berndt, Mitchum, Haendiges & Sandson, 1997). This double dissociation between verbs and nouns leads to the speculation that the verbs and nouns are distinguished in various perspectives in terms of lexical processing. Verbs and nouns, first of all, belong to different grammatical categories. Therefore, it was hypothesized that the two grammatical classes were activated separately

(Berndt et al., 1997). The distinction of verbs and nouns can also be derived from conceptual level, where verbs are mostly labels of actions while nouns refer to object names (Druks, 2002). As more semantic knowledge such as relational object is required to represent verbs, it has been proposed that the semantic representation of verbs might be more complex than nouns (Genter, 1981). A more detailed account for the conceptual differences between nouns and verbs is provided by Bird, Howards & Franklin (2001). They hypothesized the “extended sensory/functional theory” (ESFT) (p. 2), in which semantic knowledge are stored in the form of sensory and functional information. Nouns have a higher proportion of sensory features (e.g. a car has four wheels) than functional (e.g. a car is for transport), and verbs show the opposite ratio. As a result, if the extraction of functional features is impaired, the patients will have poorer action naming than objects, and vice versa (Bi, Han, Shu & Caramazza, 2007).

Review of Verb Retrieval Treatment at Single-word Level

With the locus of impairment in verb retrieval lies in semantic or/and phonological processing, the anomic treatments for verb retrieval made use of similar nature of tasks as in noun retrieval: mainly phonologically or/and semantically based. Anomic treatments on verbs showed similar results with that on nouns in which treatment effects were frequently revealed. However, most of the verb treatments did not show generalization effects to untrained items.

An early study of treatment of verb retrieval was carried out by Fink, Martin, Schwartz, Saffron and Myers (1992) on a single subject. In their study, direct cueing on phonology of the trained verbs were provided by either phonemic cue or repetition. The subject then formed a sentence with the trained verbs in picture description. This study only found positive treatment effects on trained verbs. A lexical-semantic task was utilized in McNeil et al. (1998), in which the subject was required to produce synonyms or antonyms of the target items verbally. The target items include four classes of words, including nouns, verbs, and

adjectives and proposition forms. Positive treatment and maintenance effects were found in trained verbs.

Subsequent studies investigated the combination of semantic and phonological tasks for verb retrieval deficits. Rodriguez et al. (2006) compared semantic-phonological (SP) treatment with gesture-verbal (GV) treatment on four aphasic individuals. Yes-no questions on semantic and phonological properties of target verbs were asked in SP treatment while modeling of gestures for the corresponding actions was implemented in GV protocol. Moreover, repetition of verbs was used in both treatments. While all participants in SP treatments improved their naming performance significantly, only one participant showed significant improvement in GV treatment. The authors thus concluded that the impaired mechanism of naming was only adequately activated in SP treatment. Similar SP treatment was also adopted by Raymer et al.'s (2007) study for verb retrieval. In addition to treatment effects, positive improvement was also found in subjective measures of communication effectiveness collected by questionnaires to caregivers.

With the simultaneous application of both semantic and phonological techniques in a single treatment, the factors affecting the treatment outcomes could not be dissociated. Raymer & Ellsworth (2002) thus applied phonological judgment and semantic judgment tasks separately on the same individuals. Similar effects were noted in phonological and semantic judgment tasks, with some generalization to sentence production. Wambaugh, Cameron, Kalinyak-Fliszar, Nessler and Wright (2004) modified the protocol by employing a cueing hierarchy. In semantic-cueing and phonological-cueing treatments, comparable positive training-specific effects were shown.

In contrast with the treatments mentioned above, Bastiaanse, Hurkmans and Links (2006) targeted at verb training in sentence production instead of single word level. The training protocol involved the training of target verbs and subsequent production of sentence in

pictures. Apart from the treatment effects on trained verbs, performances on naming untrained finite verbs and sentence production also improved significantly.

Review of Cantonese Anomic Treatments

There were several successful examples of using same treatment protocol for noun and verb retrieval in English community. Compared with English researches, previous studies on Cantonese anomic treatments focused on noun retrieval only (e.g. Law, Yeung & Chiu, 2008; Law, Wong, Sung & Hon, 2006). Studies of treatments for facilitating noun retrieval in Cantonese mainly include the use of ortho-phonological (OP) cueing and *SFA*.

Law et al. (2008) and Yau (2007) investigated the effect of *OP* treatment on Cantonese aphasic speakers. When provided with a phonemic cue of the target word, the subjects were required to produce the target words in picture naming. A phonological cueing hierarchy was given if the target words were not produced on the first trial. Positive treated and maintenance effects were resulted from the treatment program in both studies. Yau (2007) also reported generalization effects to untrained items which shared same initial as the trained ones. Although similar pattern was noted in Law et al.'s study, only two out of four subjects showed significant generalization effect.

The *SFA* approach was used in Law et al. (2006) to treat three Cantonese anomic speakers, and subsequently in a single-case study of Sy (2008). Semantic priming, in which pictured objects of the same category were trained together, was also implemented in their intervention. In the former study, significant improvement of naming performance was observed in treated and generalization items for two subjects, but not the one with severe semantic deficits. Significant maintenance effect was only seen in one patient. Coherent results were noted in Sy's (2008) study, in which the subject showed significant treatment effects, maintenance effect and generalization to semantically related but untrained items. In addition, a change of error distribution to higher rates of semantic errors in post-treatment

was also recorded in both treatments. Law et al. proposed that the increased semantic errors could be explained by the facilitative nature of *SFA*, in which the linkage between semantic and phonological representations of the targets could be strengthened.

Overview of the Present Study and Research Questions

Considering the previous examples in English studies, adopting treatment protocols of noun naming on verbs can be a feasible means of verb training. In view of the positive training and generalization effects of using *OP* and *SFA* treatments on noun retrieval in Cantonese, this study aims to explore the possibility of using *SFA* technique for verb retrieval on Cantonese-speaking population.

There are two reasons for choosing *SFA* treatment over *OP* treatment. First, the anomic participant of this study, WSH, had relatively preserved semantic processing ability. As mentioned before, it was more likely that *SFA* treatment would have favorable outcomes for those with better semantic processing (Law et al., 2006; Sy, 2008); therefore, it was expected that WSH would benefit from *SFA* treatment. Moreover, the ortho-phonological cueing method involves phonological training, which may not be applicable to Cantonese speakers with low phonemic awareness (Holm & Dodd, 1996). Thus, the *SFA* approach was preferred in this study.

The present study focused on the application of *SFA* on facilitating verb production in Cantonese with aphasia. The treatment program in Law et al. (2006) was adopted. The use of *SFA* intended to improve verb naming by strengthening the semantic network of verbs, which in turn would increase the level of activation in phonological output lexicon (Boyle, 2004).

To evaluate the efficacy of *SFA* on verb retrieval, the following research questions were set: (1) Was the *SFA* treatment effective in facilitating verb retrieval in Cantonese? (2) Would there be any generalization effect of *SFA* to untreated items? (3) Would the treatment gain (if

any) maintain after treatment? (4) Would the percentage of semantic errors increase significantly after treatment?

Method

Participants

A 48-year-old native Cantonese female, WSH, was invited to participate in this study. She suffered from cryptogenic stroke with left middle cerebral artery occlusion in February 2004 and right hemiparesis was resulted. She was right-handed premorbidly and mainly used left hand now. No significant motor-speech problem was noted. WSH had Form Five education level and was a merchandiser premorbidly. She had received speech therapy at Tuen Mun Hospital for one year in August 2006 and then at Tai Hing Centre of Community Rehabilitation Network for one month from April 2008. Speech therapy was ceased during the period of this study. A preliminary screening on verb naming confirmed the suitability of WSH as the participant (43% accuracy).

Five native Cantonese control subjects, matched in age (46 to 50 years old), gender and education level (Form three to Form six) with WSH, were also recruited to collect normative data for stimuli selection at the later stage. They were all native Cantonese speakers without any history of neurological impairment.

Initial Screening and Hypothesized Nature of Impairment

WSH was diagnosed to have moderate transcortical sensory aphasia with an aphasia quotient of 61.6 from the Cantonese version of Western Aphasia Battery (CAB) (Yiu, 1992) administered in April 2008. An initial assessment was then administered to locate the nature of WSH's verb naming difficulties. The normative performance of corresponding tests collected from other researches was summarized in Appendix A.

Although WSH performed satisfactorily on noun naming from Snodgrass & Vanderwart (1980) (74.2%) and from the reading and writing screening test by Law and Leung (1999)

(86.7%), she scored much lower in oral naming of verbs in both selected pictures from Tse (2005) (43.0%) and in the same Law and Leung screening test (60.0%).

To account for WSH's oral naming impairment in verbs, several neuropsychological tests were performed. In the visuospatial tests from Birmingham Object Recognition Battery (Riddoch & Humphreys, 1993), WSH achieved 100% accuracy in the three tests. This indicates that her visual input analysis and object recognition was intact. While spoken word-picture matching and written word-picture matching was near the normal range, WSH scored over two standard deviations below the norm in synonym judgment ($SD = - 2.9$). Since the two matching tasks involve objects only while judgment of synonym involved nouns and verbs, it is suggested that WSH's representation of action verbs was impaired (Han & Bi, 2009). This was consistent with the impaired performance on verbs in oral naming (60.0 %) and written naming (70.0 %) in the screening test (Law & Leung, 1999).

To sum up, WSH's difficulties in oral naming of verbs were attributable to the deficits in semantic processing, impairment in phonological output lexicon and/or access to it from semantic system.

The cognitive functioning of WSH was also assessed. WSH's performances on digit forward sequence (6 digits) and Chinese Rey Auditory Verbal Learning Test (44/75) (Lee, Yuen & Chan, 2002) were below average, reflecting disrupted short term memory. She achieved 75th percentile in the Test of Nonverbal Intelligence (TONI-3). This revealed her abstract problem-solving skills was fairly good.

Stimuli

A set of 193 black-and-white action line drawings was first selected based on the Cantonese normative study of verb naming in Tse (2005), all of which had 60% or above naming agreement.

The five control subjects were required to verbally name the initial picture set and rate the familiarity, age of acquisition (AOA) and visual complexity of each picture. The procedures followed Tse (2005) (see Appendix B). The naming agreement of each picture was then calculated as the percentage of subjects giving the same naming response. Only those pictures ($n = 172$) with at least 60% naming agreement were retained as the possible items in the treatment phase of this study.

Treatment design

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

Baseline phase. Three sessions were carried out in one week to measure the baseline performance of WSH on verb naming. WSH was asked to name the 193 potential stimuli without feedback in random order within 15 seconds for each picture. Her responses were audiotaped and the last self-corrected response was scored with reference to Wambaugh et al. (2004) and Tse (2005). Alternative acceptable action names were accepted as correct. Comparing the highest accuracy (88/193) with the lowest (97/193) in WSH's performance, the fluctuation of naming accuracy was 9.27% (less than 10%), ensuring a stable baseline.

Pictures that WSH failed to name in at least two out of three sessions ($n = 101$) were chosen for the treatment phase. Taken together the criterion of naming agreement into consideration, a total of 88 pictures remained. Fifteen items each were then assigned to the treated items, the generalization items and control items according to the semantic categories of verbs (i.e. verb classes), as proposed by Levin (1993). Under Levin (1993)'s classification, commonly occurring English verbs were grouped under 49 verb classes, each member of which shared similar semantic meanings. Among the three probe types, the treated and generalization items were semantically related (e.g. 'climb' 爬樹 and 'ride' 騎馬 as the verbs of motion) while the control items were semantically unrelated to other two probes (e.g.

‘bake’ 焗, a verb of creation/ transformation). The average ratings of familiarity, AOA and visual complexity were comparable across the probes (for familiarity rating, $F(2, 42) = .449$, $p = .641$; for AOA rating, $F(2, 42) = 1.551$, $p = .224$; for visual complexity rating, $F(2, 42) = .224$, $p = .800$). No significant interaction effects among the ratings were also noted, with range of p value from .246 to .981. In addition, the length of syllabus, ranging from one to three, was balanced across the probes. The sharing of same initial phonemes was also minimized to avoid possible phonological generalization across probe types. The details of the probe items with their rated values and initials are listed in Appendix C

Treatment phase. Two to three treatment sessions per week were carried out. The treatment was suspended after treatment session five for one week due to the Chinese New Year Holiday. At the beginning of each session, WSH was asked to name all of 45 probe items once in order to monitor the progress over the treatment. No cueing or feedback on naming was provided. The presentation order of probe items was randomized across sessions.

This treatment protocol basically followed the *SFA* approach in Law et al. (2006). Since the semantic representations of verbs are different from nouns, the *SFA* chart was modified to adopt verb production. This consists of seven semantic properties, including purpose, body parts, tools, related objects/people, location, description of action and result (see Appendix D). In the treatment, an action picture was chosen randomly and WSH was required to name the picture. Regardless of the correctness of the response, she was required to generate at least five semantic features in the *SFA* chart. Afterwards, WSH was required to name the picture again. For details, please read Law et al. (2006). The treatment session would be ended when all treated items were trained once. Home practice was provided with *SFA* charts and treated items. WSH was also asked to record the number of times of revising the *SFA* charts in home practice. The treatment phase was terminated when 85% accuracy (13/15) or above was achieved in naming treated items over three consecutive sessions.

Maintenance phase. To evaluate the preservation of treatment gains, a maintenance phase was included. It was initiated from the second week after the end of the treatment phase. Three weekly sessions were taken and WSH was required to name all probe items once in each session.

Control Task

In order to assure the treatment effects were not the result of general improvement of WSH, a control task was administered. The Chinese Rey Auditory Verbal Learning Test (Lee, Yuen & Chan, 2002) was chosen as the control task. It measures memory function and verbal learning ability, not involving any naming procedure. The test was carried out in the first and third session of both baseline and maintenance phases, respectively.

Data Analysis

Scoring system. All naming responses of WSH were audiotaped and transcribed orthographically. The scoring criteria were the same as in baseline. Erroneous responses were classified into (1) semantic errors including (a) semantically related verbs, (b) semantically associative nouns/ adjectives, (c) description of pictures, (2) phonemic paraphasia, (3) partial response, (4) English response, (5) semantically related jargon and (6) No response/ Do not know. See Table 2 for definition and example.

Reliability. To compute inter-rater reliabilities of scoring accuracy and error assignment, a Year 4 student of Speech and Hearing Sciences was asked to analyze 20% of the subject's naming responses randomly taken from all sessions. A point-to-point agreement was adopted. The agreements for scoring accuracy and error assignment were 98.4% and 85.7% respectively.

Statistical analysis. The McNemar's test was used to investigate any significant treatment or generalization effects of the *SFA* protocol. The best performance in baseline and

that in treatment/maintenance phase were compared within probes for treatment, generalization and control probes.

Besides, to examine whether repeated attempts may account for changes in naming performance on treatment and generalization items, the Fisher's exact test was performed across probe types, that is, between treatment and generalization items, treatment and control items, generalization and control probes. In each contrast, the highest accuracies of each probe type in the treatment and maintenance phase were compared.

Finally, this study was interested in investigating the possible effects of the *SFA* treatment on production of verbs. An analysis of WSH's error distribution before and after treatment was performed.

Results

WSH responded to the *SFA* treatment favorably. She took eight treatment sessions to achieve the passing criteria, with 100% accuracy in the last two treatment sessions as the highest score in the treated probes. The performance of WSH on different probe types across different phases is depicted in Figure 2.

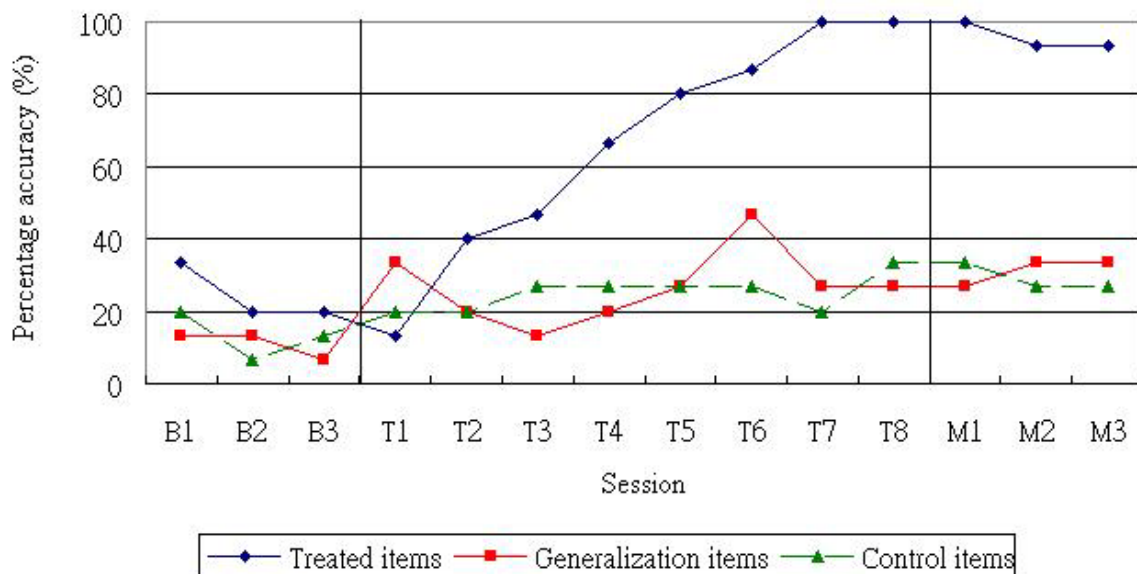


Figure 2. WSH's performance on probe items in baseline (B), treatment (T) and maintenance (M) phases

As shown in Figure 2, low accuracies were observed in all probes (less than 40%) before treatment started. Significant improvement in treatment probe was seen during treatment sessions. Although there was a trend of improving naming performance of generalization items from the third to sixth treatment session, both generalization and control probes remained low throughout the study.

A series of statistical analyses was carried out to investigate the treatment efficacy of *SFA* on verb retrieval (see Table 1). Significant improvement of naming performance was observed in treated items. In generalization and control items, the differences were insignificant. Comparing all probe types, the naming accuracy of treatment items was significantly greater than the two probe items, while the performance in generalization and control items were similar.

For maintenance effect, comparison was made between the last treatment session and last maintenance session on treated items. Although the naming accuracy dropped by one item to 93.3% (14/15) in the maintenance phase, the reduction was minor. On the other hand, the naming performance of two untrained probe types remained stable.

Table 1

Results of statistical analysis of naming performance of WSH

<i>McNemar's test</i>			
	Comparison of best performance	χ^2 (1)	<i>p</i>
Treated items	33.3% (B1, B3) vs. 100% (T7, T8, M1)	8.10	.0044*
Generalization items	13.3% (B1, B2) vs. 46.7% (T6)	3.20	.0736
Control items	20.0% (B1) vs. 33.3% (T8, M1)	.17	.0683
<i>Fisher's exact test</i>			
	Comparison of best performance		<i>p</i>
Treatment vs. generalization	100% (T7, T8, M1) vs. 46.7% (T6)		.0022*
Treatment vs. control	100% (T7, T8, M1) vs. 33.3% (T8, M1)		.0002*
Generalization vs. control	46.7% (T6) vs. 33.3% (T8, M1)		.7104

Note. B = Baseline, T = Treatment, M = Maintenance; * indicates significant effect ($p < .05$)

Table 2 lists the types of error while table 3 provides the error distributions of different probe types during baseline and the maintenance phase. A dramatic reduction of ‘no response/ do not know’ was observed. Furthermore, the greatest percentage increase of error types was ‘semantically related jargon’, followed by ‘description of pictures’ and ‘partial response’. On the contrary, semantic errors of true words, including semantically related verbs and nouns/ adjectives, was comparable before and after treatment (from 54.9% to 53.1%).

Table 2

Classification of error types with definition and examples

Error types	Definition	Example
1. Semantic errors		
a. Semantically related verbs	The response and the target shared similar semantic properties but not synonymous.	‘dive’ → ‘swim’ (跳水 → 游水)
b. Semantically associative nouns/adjectives	The response and the target were semantically related but the response was not a verb.	1. ‘ride’ → ‘rider’ (騎馬 → 騎士) 2. ‘itch’ → ‘itching’ (/au1/痕 → 好痕)
c. Description of the picture	The response described the superficial feature of the picture.	‘wave’ → ‘move hand’ (打招呼 → 揮揮手)
2. Phonemic paraphasia	The response was recognizable words with substitution of one phoneme/ tone or more when compared with the target.	扒 /p ^h a4/ → 趴 /p ^h a1/
3. Partial response	The response was part of the target but it was not semantically associative nouns.	操兵 → 操
4. English response	The response was correct but in English.	跳舞 (‘dance’) → dance
5. Semantically related jargon	The response was a jargon but contained the target or with semantically associated phonemes.	‘shave hair of lamb’ → ‘cut lamb’ (剃羊毛 → 剪羊咩)
6. No response/ Do not know	The subject did not respond within 15 seconds or respond with ‘don’t know’.	-

Table 3

Comparison of error distribution of probe items between baseline and maintenance of WSH

Error types	B1 – B3	M1– M3
<i>Total number of errors</i>	113	66
Semantic errors	66 (54.9%)	44 (53.1%)
<i>Semantically related verbs</i>	29 (25.7%)	18 (27.3%)
<i>Semantically related nouns/ adjectives</i>	33 (29.2%)	17 (25.8%)
<i>Description of pictures</i>	4 (3.5%)	9 (13.6%)
Phonemic paraphasia	1 (0.9%)	0 (0%)
Partial response	7 (6.2%)	8 (12.1%)
English response	0 (0%)	1 (1.5%)
Semantically related jargon	5 (4.4%)	12 (18.2%)
No response/ Do not know	34 (30.1%)	1 (1.5%)

Note. B = Baseline; M = Maintenance

WSH's performance on the control task, i.e. immediate recall of the Chinese Rey Auditory Verbal Learning Test, was recorded as 38/75 (37/75, 39/75) and 39/75 (39/75, 39/75) in average for baseline and maintenance sessions, respectively. Her scores before and after treatment were similar indicating that the cognitive functioning of WSH maintained relatively constant.

Finally, it was noted that in the first session, WSH required clinician's provision of semantic features for 47% of trials during the generation of semantic properties for treated items. The clinician's assistance was then dropped to less than 5% in the last treatment session. Besides, WSH was compliant in doing home practice. She revised the filled *SFA* chart for treated items for eight to ten times for each week during the treatment and maintenance phase.

In summary, in view of the significant improvement on treated items alone with the absence of general improvement, treatment-specific effect was evident in WSH. Significant maintenance effect was also noted, which lasted at least one month after treatment.

Generalization to untrained items was not evident. With regard to changes in error distribution, the greatest decrease was ‘no response/ do not know’, with noticeable increase in ‘semantically related jargon’ and ‘description of pictures’.

Discussion

This study investigated the efficacy of *SFA* strategy on verb naming in a Cantonese speaker. The outcomes of the current treatment were similar to previous application of *SFA* to facilitate noun production, in which the treated items showed significant improvement and durability of its gain (e.g. Boyle & Coelho, 1995; Law et al., 2006). On the other hand, the generalization effect to semantically-related items was not observed in verb retrieval. This was inconsistent with the findings in most of the previous treatments for noun naming.

Specific Treatment Effect

In order to confirm the treatment effect was treatment-specific, any spontaneous recovery or general improvement should be excluded (Franklin, 1997). WSH was at least four years post onset. This minimized the occurrence of spontaneous recovery. Also, as indicated by the Chinese Rey Auditory Verbal Learning Test, the control task, the verbal memory abilities of WSH remained relatively stable. This suggested that the treatment effect was not contributed by general improvement.

Repeated naming attempts were provided when WSH was required to name all probe items in each treatment session. Nickels (2002b) claimed this could possibly improve the naming performance due to lexical activation of the items even without any feedback or cueing. However, the changes in naming accuracy of the three probe items were not uniform. The naming performance of treated items was superior to that of generalization and control probes, while the latter two probe items did not improve significantly. Besides, the accuracy of all stimuli was relatively stable during the baseline phase (less than 40%). The

considerable increase in accuracy of naming treated items only occurred after the treatment was initiated. Therefore, the possibility of improvement due to repeated naming was rejected.

Mechanism underlying SFA on Verb Retrieval

As treatment-specific effect of *SFA* was revealed in verb retrieval, one may suspect how *SFA* works in verb naming. Similar to noun retrieval, a number of semantic properties of the target verb were generated to facilitate word retrieval. As suggested by Nickels (2002a), *SFA* was facilitative in nature. By stimulating the semantic features repeatedly, the semantic network and its connection with the phonological output could be strengthened (Kiran & Bassetto, 2008). From the result of synonym judgment in the initial assessment, the semantic representation of action verbs in WSH was likely to be impaired or degraded. The application of *SFA* to activate the semantic network matched with the underlying deficits of WSH. A treatment would be effective if the underlying impairment was targeted (Kiran & Bassetto, 2008). Thus, WSH responded to the treatment favorably.

Absence of Generalization to Untrained Items

Although treatment-specific effect was guaranteed, the *SFA* intervention demonstrated little generalization to untrained, semantically related verbs. One possible explanation of the limited improvement in untrained items was WSH's inability to fully utilize self-cueing strategies. As reported in the result, WSH was not able to self-generate nearly half of the semantic features for treated items in the first treatment session. A large proportion of the features provided by her were non-specific such as body parts. This may imply that WSH may not be able to actively generate sufficient semantic features to facilitate verb retrieval. Generalization may be achieved by internalizing the *SFA* as a strategy, in which appropriate and specific semantic properties are retrieved during word-finding difficulty (Nickels, 2002a). Referring to this, two proposals are provided. First, WSH was not able to employ *SFA* as a self-cueing strategy when naming untrained items. On the other hand, as WSH showed

abilities to produce some semantic features during training, another account was given. In this case, WSH may learn to use the *SFA* strategy to self-generate semantic features, but only non-specific semantic knowledge (e.g. body part) was retrieved. Consequently, the retrieval of these semantic features may not be enough to access the target words.

While no significant generalization effect was found on action naming in the current study, improvement in untrained stimuli on object naming with the use of *SFA* was frequently observed in the previous findings (e.g. Law et al., 2006; Boyle, 2004; Sy, 2008). Nevertheless, the treatment outcomes of *SFA* on verb retrieval resembled most previous semantic-based protocols on action naming, in which generalization to untrained items seldom occurred (e.g. Wambaugh et al., 2004; Raymer et al., 2007). With the discrepancy of treatment results between nouns and verbs, the poor generalization to untrained verbs could be traced back to the differences between the two classes of words.

The limitation of verb categorization may account for the absence of generalization in this intervention. Each semantic category of the stimuli was selected and named from verbs under one verb class (e.g. verb of motion). According to the Levin (1993), verb class was defined as a number of verbs sharing one or more ‘meaning components’ and demonstrating ‘similar behavior’ (p.17). Nevertheless, many verbs actually belong to multiple verb classes under Levin’s (1993) classification. Due to the limited number of potential action verbs left (i.e. 88 pictures) in the baseline phase, it was inevitable to include verbs with multiple verb classes within a semantic category in this study. For instance, ‘fly’ (飛) and ‘climb’ (攀爬) was classified under the semantic category of ‘verbs of motion’. Simultaneously, they also represent verb of existence and verb of change of state, respectively. As illustrated, a verb class may not be well-defined. Given each verb class represents certain semantic features, each semantic category in the stimuli may contain many semantic features. This was different from nouns, in which multiple semantic categories seldom occur and the semantic concepts

of categories are clear. For instance, ‘cat’ belongs to the category of ‘animals’, and ‘animals’ are defined as ‘living organisms which feeds on organic matter and are able to respond rapidly to stimuli’ (Soanes & Hawker, 2005). Therefore, with many semantic features within a semantic category, generalization to untrained verbs would be less direct and thus more difficult to be captured than nouns.

With respect to the lack of generalization effect in this study, it is important to suggest modifications to enhance the extent of generalization. Integrating semantic priming (SP) into *SFA* for verb training can be one of the areas to explore. *SP* is a technique to train semantically-related items in a group for facilitating word retrieval. It works by activating the overlapping semantic features of the items (Renvall, Laine, Laakso & Martin, 2003). The additional semantic activation is then transferred to lexical nodes, which in turn increases the activation of the targets and their semantically-related items. The *SP* can be implemented into *SFA* by presenting a number of items in the same semantic category simultaneously, as seen in Law et al. (2006) and Sy (2008). Positive generalization effects to untrained items were observed in both Cantonese and English studies (e.g. Law et al., 2006; Sy, 2008; Marshall et al., 1990; Renvall et al., 2003). Thus, by applying *SP* into the *SFA* treatment for verb retrieval, the possibility of generalization to untrained, semantically-related items can be maximized.

Maintenance Effect

WSH was able to maintain treatment gains for treated items for at least one month subsequent to treatment. To account for the maintenance effect, the following two reasons are suggested. The first would be constant revision of treated items. As WSH was highly motivated to improve and was able to read on her words, she practiced the *SFA* charts for each verb regularly even after the maintenance phase. The frequent drill of the home practice allowed regular activation of semantic features of treated items (Law et al., 2006). As a result,

the semantic representation of the verbs could be strengthened consistently, which facilitated the verb retrieval in the maintenance phase.

Another possibility was related to the self-monitoring skills of WSH. Self-monitoring skills allow one to become aware of the correctness of his/ her own response, which is important in self-assessing the maintenance of the treatment (Hughes, 1985). It was noticed that WSH was able to discriminate the accuracies of her responses. This illustrated that she was likely to self-monitor her production during home practice. This strategy would reinforce correct naming of verbs, thereby increase the durability of the treated verbs (Hughes, 1985). Hinckley & Carr (2001) (cited in Fillingham, Sage & Ralph, 2005) proposed that the self-monitoring abilities were positively related to cognitive abilities. This is consistent with WSH's fairly good score on *TONI-3* (75th percentile), which is a cognitive test on problem-solving skills.

Changes of Error Pattern

The changes in error distribution before and after intervention often reveal changes in lexical access, which helps readers understand further how *SFA* treatment works on verb retrieval (Drew & Thompson, 1999). Since *SFA* is assumed to facilitate word retrieval by strengthening semantic network around the targets, semantically related words are also activated during the selection of lexical outputs (Boyle & Coelho, 1995). Therefore, it is reasonable to predict that the percentage of semantic errors would rise after training. However, comparable rates of semantic errors were recorded, which was different from previous verb retrieval treatments (Kemmerer & Tranel, 2000; Wambaugh et al., 2004). This similar level of semantic errors before and after treatment in the case of WSH may apparently contradict the facilitative nature of *SFA*. A closer look at the error statistics reveals that the percentage of semantic errors was high in baseline (54.9%). Consequently, further increase in semantic errors was attenuated. Besides, a large increase in 'semantically related jargon' was

noticed in WSH. Since ‘semantically related jargons’ contained part of the target words (e.g. 扒荷包 ‘steal-wallet’ → 扒小偷 ‘steal-thief’), they could be regarded as semantic related with the targets. Therefore, by considering both semantic errors and semantically related jargons, the error pattern supported the notion that *SFA* facilitated word retrieval by activating semantically-related words.

Other error types also revealed the changes of lexical processing in WSH brought by the *SFA*. WSH showed a drastic decrease of “no response/ do not know” in naming. This may reflect that the access to particular lexical items was improved (Yau, 2007). In addition, the large increase in ‘partial response’ indicates that the *SFA* treatment led to more approximated responses (Drew & Thompson, 1999).

An interesting observation of WSH’s naming responses was the production of responses of different word classes, especially nouns, that were semantically related to the target. The phenomenon was similarly noted in several studies in verb retrieval (e. g. Berndt et al., 1997; Wambaugh et al., 2004). The production of other word classes was thought to be a retrieval strategy to stimulate the activation of correct verbs (Kemmerer & Tranel, 2000). In this self-prompting strategy, nouns and adjectives which were semantically related with the targets might be retrieved to trigger the correct production. During *SFA* training, similarly, nominal semantic features (e.g. body parts and related objects) were generated to help retrieval of verbs (e.g. shower ‘花灑’ for bath ‘沖澡’). Therefore, *SFA* training was naturally echoes with the nature of the self-prompting strategy, both of which reflect nominal semantic properties of the verbs.

Treatment Duration

An additional point which is worthwhile to discuss is the treatment duration of WSH. WSH took eight sessions to complete the treatment phase. Referring to the *SFA* treatment on noun retrieval in Cantonese, three participants required 10 to 17 sessions to meet the

termination criteria of phase one and one participant even could not reach the criteria within 20 sessions (Sy, 2008; Law et al., 2006). This indicated that WSH required shorter treatment duration than other four participants. Since the treatment required the participants to learn the *SFA* strategy for word retrieval, the general ability of the participants may play an important role in treatment duration. A substantial difference between WSH and the previous participants on noun retrieval was noted in their performance on noun naming. While the four anomic participants could only achieve 12.9 % to 36.9% for minimum and maximum scores in the oral naming test of Snodgrass & Vanderwart (1980), a higher accuracy on the same test was observed in WSH (75.1%). Another measure which reflects their difference would be the *TONI-3*. WSH's score on *TONI-3* (75th percentile) was at a upper rank when compared with other participants in previous studies, who obtained 13th to 81th percentile in the cognitive test. The results of oral naming and cognitive test may reflect that the general ability of WSH was more superior than those receiving *SFA* treatment on nouns. With better general ability, WSH may respond to the *SFA* treatment faster, leading to a shorter period of treatment time.

Future Directions

Since this study was the first treatment study on verb retrieval in Cantonese using the *SFA* protocol, and only a single participant was involved, the protocol needs to be applied to other anomic individuals to obtain a more thorough understanding of the *SFA* treatment on verbs. In the current study, WSH, who had a relatively preserved semantic processing, benefited from the *SFA* treatment. This concurred with the viewpoint of Law et al. (2006) that the treatment outcomes of the *SFA* could be predicted by the severity of semantic deficits. To promote a better understanding of the relationship between the degree of semantic deficits and the treatment effectiveness of *SFA*, individuals with more severe semantic deficits can be employed for further study.

As generalization to untrained verbs was absent in the current study, further research on applying semantic feature analysis with semantic priming is recommended to improve generalization in verb training. It is expected that semantic priming is able to provide additional semantic activation to the targets, which in turn helps retrieval of generalization items.

Given the present study was restricted to study the effects on verb retrieval at single words, production of verbs at sentence or discourse level was not explored. Improvement in sentence/ conversation production was observed in previous researches on verb retrieval (e.g. Raymer & Ellsworth, 2002; Bastiaanse et al., 2006). Thus, the area of investigation of further study can be extended to generalization to sentence/ conversation level in order to examine the effect of *SFA* treatment on participants' communication effectiveness.

Clinical Implications

This was the first study to adopt *SFA* for verb retrieval treatment in Cantonese aphasia. Given the positive treatment and maintenance effects obtained in the current study, the *SFA* can be applied as a possible treatment approach of verb deficits for local clinicians.

Conclusions

A study using semantic feature analysis to facilitate verb retrieval was implemented on a Cantonese speaker. The positive outcomes suggested that verb retrieval at single word level can be improved by *SFA*, in addition to noun retrieval. Item-specific effect was found while significant generalization to semantically-related untrained items was absent. The limited generalization was attributed to the underdevelopment of self-cueing strategy and the nature of semantic categories in verbs. The use of semantic priming was recommended to improve generalization of untrained items in further studies. Treatment gain was maintained for at least one month. Regular home practice and good self-monitoring abilities were highlighted as the important factors for the maintenance.

Acknowledgements

The author would like to express her sincere gratitude to Dr. Law Sam Po, the author's dissertation supervisor, for her valuable advices and support throughout the year. Thanks are extended to Ms. Olivia Yeung for her guidance and help during data collection.

Deepest thanks are given to WSH, the participant in the study, for her kindness and cooperation during data collection.

Special thanks would go to Ms. Erin So for her help and support during the process of dissertation writing.

Last but not least, the author would like to thank Mr. Tan and her friends for sharing her worries this year. Without Mr. Tan's computer, I won't be able to finish the dissertation writing as planned.

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Appendix A

Data of normative performance on language and neuropsychological tests

Task	Normal Performance
<i>Control group: Three subjects with ages ranging from 40 to 68 years and at least nine years of education (Law et al., 2006)</i>	
Spoken word-picture matching (<i>n</i> = 126)	Range: 124 – 126
Written word-picture matching (<i>n</i> = 126)	Range: 123 – 126
 <i>Control group: Fourteen subjects with ages ranging from 47 to 60 years and with education level ranging from Secondary one to University degree</i>	
Synonym judgment (<i>n</i> = 60)	Range: 51 – 60 (Mean = 56.79; SD = 3.31)
 <i>Control groups of 10 subjects closely matched in age and education with WSH (Law & Yip, 2004)</i>	
Oral picture naming (<i>n</i> = 217)	216.50 (SD = 0.53; Range = 216 – 217)
Pyramids & Palm Trees Test (PPTT) (<i>n</i> = 37)	31.90 (SD = 5.40; Range = 21 – 37)
Associative Match Test in Birmingham	21.90 (SD = 1.20; Range = 20 -23)
Object Recognition Battery (BORB) (<i>n</i> = 23)	
 <i>Control group: 50 male and female subjects with ages ranging from 20 to 46 years and with formal education of nine to 13 years (Lee, Yuen & Chan, 2002)</i>	
Digit forward sequence	8.92 (SD = 1.21)
Chinese Rey Auditory Verbal Learning Test	
Immediate recall (<i>n</i> =75)	50.59 (SD = 6.54)
Immediate recall after distraction (<i>n</i> =15)	10.89 (SD = 2.79)
Delayed recall (<i>n</i> = 15)	10.67 (SD = 2.77)
Recognition (<i>n</i> =15)	13.93 (SD = 1.38)

Appendix B

Procedures in collecting normative data on

modal name, and rating of familiarity, age of acquisition and visual complexity

1. The clinician explained the aim of the study, the procedures of data collection and the rating scales to the subjects.
2. Five practice trials of action picture naming were provided to familiarize the subjects with the procedures and the rating dimensions. To provide rating anchors, three sets of pictures showing a continuum of rating were shown once.
3. The subjects were asked to name the 193 black-and-white action pictures within 15 seconds when the pictures were presented one by one.
4. After naming each action picture, regardless of their naming response, the subjects were required to rate the familiarity and age of acquisition of the picture.

Rating the familiarity. A 5-point scale was used. The rating '1' indicated that the subjects had never performed, came contact with or thought of the actions (從不) and '5' represented they always performed or thought of the actions (經常). The rating '2', '3' and '4' indicated rarely (極少), sometimes(間中) and frequently (頻密) respectively.

Rating the age of acquisition. A 7-point scale with a 2-year range was used. The rating '1' indicated that the subject had acquired the action in the first 2 years of life, '2' between 3 and 4 years of life and '7' after 13 years old.

Rate of visual complexity. A 5-point scale was adopted. The rating '1' indicated the action was extremely simple (極簡單) while '5' represents extremely complex (極複雜). The rating '2' to '4' marked as simple (簡單), moderate (適當) and complex (複雜) respectively.

Appendix C

Details of probes items in the treatment

Probes	Semantic category	Modal name	Alternative name	Mean familiarity rating	Mean AOA rating	Mean visual complexity rating	Initial of modal name
Treatment probe	Verbs of motion	操兵	步操	2.0	5.0	2.8	ts ^h
		爬樹	搖	2.2	4.4	2.6	p ^h
		攀爬/山	爬山	2.6	4.8	3.4	p ^h
		划艇	爬艇	3.0	5.6	2.8	w
		揸車	駕駛	3.8	4.6	2.6	ts ^h
		開水喉	放水	4.8	3.2	2.6	h
	Verbs involving the body	喊	扁咀	3.6	4.0	2.6	h
		拉	拖	3.6	4.0	2.6	l
		晒太陽	-	3.8	4.8	2.4	s
		/au1/痕	俾蚊咬	4.2	4.4	3.2	ŋ
	Verbs of removal	磨刀	-	2.4	5.4	3.4	m
		摘	搵	3.4	4.6	2.8	ts ^h
吸塵		-	4.6	4.6	2.6	k ^h	
刷牙		-	2.6	4.8	3.4	ts ^h	
沖涼		-	5.0	3.2	2.0	ts ^h	
Generalization probes	Verbs of motion	騎馬	打仗	1.6	5.0	3.4	k ^h
		打保齡	-	2.8	6.2	2.0	t
		飛	打交/吠	3.0	4.2	3.8	f
		跳水	-	3.2	4.6	2.0	t ^h
		踩 roller	玩	3.2	5.6	2.6	ts ^h
		過馬路	-	5.0	3.6	2.8	kw
	Verbs involving the body	踢	-	3.6	4.6	2.6	t ^h
		吹口哨	-	3.6	5.0	2.4	ts ^h
		握手	拜訪/送	4.0	4.8	2.6	ŋ
	Verbs of removal	打招呼	揮手	4.6	4.2	2.8	f
		剃羊毛	剪羊毛	2.0	5.6	3.0	t ^h
		偷	扒荷包	3.2	5.8	3.0	t ^h
剃鬚		-	3.6	4.8	2.2	t ^h	
拖地		洗地/ 抹地	4.6	4.2	3.0	t ^h	
洗頭	-	5.0	3.6	2.6	s		

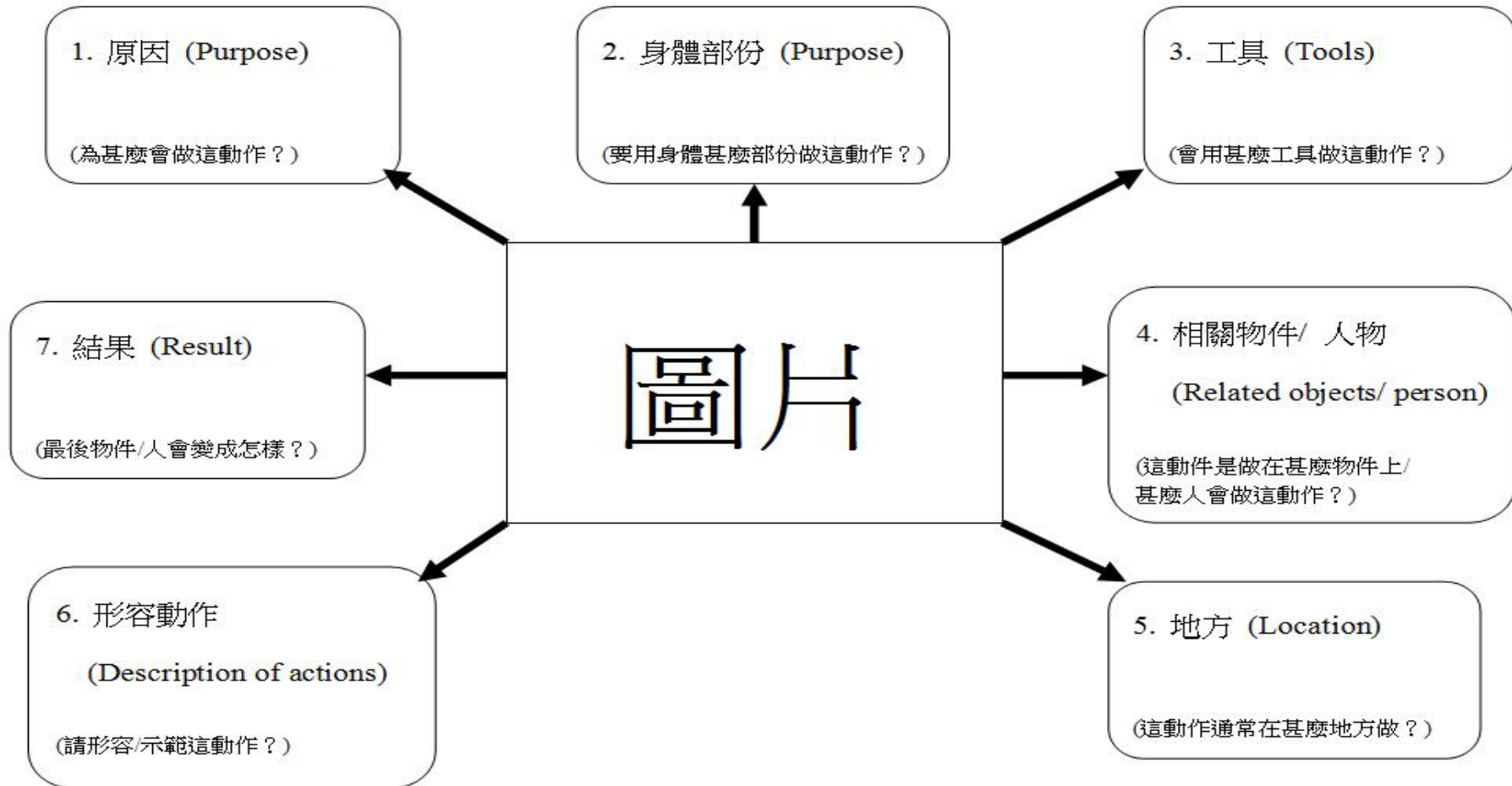
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(continued.../)

Control probes	Verbs of creation/transformation	雕刻	-	2.2	5.4	3.0	t
		燒烤	燒/ 烤	3.4	5.0	2.8	s
		捲髮	電髮	3.6	5.4	3.2	k
		焗	-	3.8	5.4	3.2	k
		煮	-	4.0	4.6	2.0	ts ^h
		縫(衣)	補衫/ 聯衫	4.2	4.6	2.6	f
		扭	-	4.2	4.2	2.8	l
		倒	斟	4.8	4.0	2.6	t
	Verbs of putting	搬貨/ 運	運輸	3.6	4.6	3.0	p
		包禮物	綁	3.8	4.8	3.0	p
		倒瀉	瀉	4.4	4.6	3.0	t
		晾衫	晒衫	5.0	4.6	2.4	l
	Verbs of changing possession	餵(雞)	-	2.4	4.4	2.2	w
	Verbs of sending/carrying	派信	-	4.4	4.0	3.4	p ^h
		送(禮物)	收禮物	3.8	4.4	2.6	s

Appendix D

The Semantic Feature Analysis (SFA) chart used in the treatment



(The design was based on Boyle (2004) and Levin, (1993))