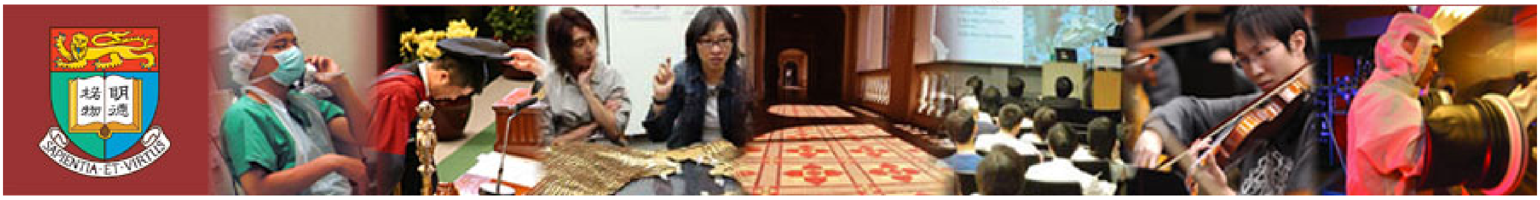

Title	Factors affecting outcomes of a semantically-based treatment for anomia
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Citation	
Issued Date	2008
URL	http://hdl.handle.net/10722/123878
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Factors Affecting Outcomes of a Semantically-based Treatment for Anomia

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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, 2008.

Abstract

Anomic studies are recently interested in identifying factors that may predict treatment outcomes. This study investigates linguistic and nonlinguistic factors affecting outcomes of a semantically-based treatment, i.e. semantic feature analysis (SFA) (Boyle & Coelho, 1995) with semantic priming (SP). A Cantonese-speaking brain-injured patient, CBF, with mild semantic disruption received an identical treatment (SFA + SP) in Law, Wong, Sung, & Hon (2006) and his therapy outcomes were compared with one of their patients, MTK. The patient in this study showed significant progress on naming performance with generalization of treatment effects to semantically-related untreated items. However, he was unable to maintain the treatment benefits at follow-up. Cross-study comparison of treatment outcomes between the two patients highlights the role of semantic processing abilities in foreseeing treatment outcomes and the significance of detailed description of patients' cognitive abilities using nonlinguistic cognitive assessments, such as TONI-3 (Brown, Sherbenou, & Johnsen, 1997).

INTRODUCTION

Anomia is one defining feature of aphasia subsequent to brain injuries. Its severity ranges from a pause in connected speech to word-finding difficulty in confrontation naming (Boyle & Coelho, 1995). In psycholinguistic models, anomia can be the result of damage to semantic processing, phonological encoding, access from semantics to phonology, or any combination of the above (Whitworth, Webster, & Howard, 2005). Given the centrality of semantic system in lexical processing in naming, aphasic studies have largely focused on identifying linguistic factors such as semantic processing abilities that may help clinicians predict anomic therapy outcomes in terms of item-specific treatment effects, generalization, and maintenance of treatment gains (Fink, Brecher, Schwartz, & Robey, 2002; Law et al., 2006; Law, Wong, & Wong, in press; Martin, Fink, & Laine, 2004).

Recently, some researchers have attempted to take an anomic patient's semantic processing ability (language performance) into consideration to foresee treatment results. For instance, Law et al. (2006) have studied a semantic treatment, a combination of semantic feature analysis (SFA) and semantic priming (SP), on three Cantonese anomic patients with different degrees of semantic, phonological, and cognitive deficits. They found that treatment progress limited to those with mild semantic impairment, and treatment effects generalized to semantically related and unrelated untrained stimuli. However, only one of the patients, MTK, could maintain the treatment benefits for at least one month after the therapy was completed. In contrast, no change was observed for the third patient with severe disruption to semantic system. Subsequent application of the same treatment protocol to two Cantonese-speaking anomic individuals with moderate-to-severe degrees of semantic impairment, Law et al. (in press) found limited treatment effects on their naming performance. They concluded that treatment outcomes are likely to be predicted by the degrees of semantic deficits.

Martin et al. (2004) also found the role of semantic processing ability in predicting therapy outcomes. They treated two English-speaking patients, one with phonological encoding deficits and the other with additional impairment to semantic system, by using contextual priming. The results showed that the patient with better semantic processing abilitt demonstrated robust benefit from the treatment in terms of trained items while the other did not. A similar case was also found in Fink et al. (2002). Their findings are consistent with Law et al.'s (2006) view that the milder the degrees of semantic deficits, the greater treatment benefits aphasic patients will obtain.

As the ultimate goal of rehabilitation for aphasic patients is to enhance their word-retrieval ability within everyday settings with unpredictable demands, it is worth investigating factors that may contribute to the generalization of treatment effects to untrained items. Howard (2000) suggests that occurrence of generalization is related to one’s ability to self-generate cues. Hence generalization to unrelated items in a semantically-based treatment such as SFA is dependent on whether an individual could internalize cueing strategy which enables him/her to use the technique without any guidance after the therapy is terminated. This internalization is, to certain extent, related to an individual’s residual semantic processing ability as it relies on verbal cueing and his/her understanding of semantic features of stimuli (Boyle, 2004; Coelho, McHugh, & Boyle, 2000). Therefore treatment generalization is more likely to be found in individuals with higher semantic processing ability. This may be the case for the two patients, MTK and YSH, in Law et al. (2006).

In spite of the importance of linguistic assessments on a patient’s semantic processing ability in predicting therapy results, some aspects remain poorly explained. For instance, individuals with similar degrees of semantic deficits demonstrated differences in generalization effects, treatment duration, and maintenance (Law et al., 2006; Martin et al., 2004) or patients with the same deficits responded differently to an identical treatment (Hickin, Best, Herbert, Howard, & Osborne, 2002; Lowell, Beeson, & Holland, 1995). Although a theoretical account could not be offered, some researchers have recognized the potential contribution of cognitive abilities in predicting treatment outcomes.

There is increasing evidences suggesting that a nonlinguistic factor, cognitive abilities, may be more reliably related to treatment outcomes than language skills. According to Helm-Estabrooks (2002), executive problem-solving skills is a kind of cognitive abilities that 'allow us to plan intentional activities while flexibly adjusting our goal-directed strategies in keeping with situational changes' (p.182). In other words, it may help an individual internalize cueing strategies trained in a therapy and solve problems flexibly within everyday settings. In an aphasic study, Hinckley, Patterson, and Carr (2001) investigated treatment outcomes on 18 chronically aphasic patients with varied level of executive problem-solving abilities. They reported that patients with higher cognitive abilities measured by Raven's and Wisconsin card sorting test took less time to achieve passing criteria and were more likely to maintain their gains after the therapy. Similarly, Fillingham, Sage, and Lambon Ralph (2005a, 2005b) also showed that language test scores of aphasic patients were not likely to foretell treatment outcomes, whereas treatment duration and maintenance were related to their cognitive abilities.

Corroborating findings come from two Cantonese studies in which an ortho-phonological cueing method was applied to Cantonese-speaking anomic patients (Law, Yeung, & Chiu, 2008; Yeung & Law, 2008). Law et al.(2008) proposed the level of executive problem-solving skills as an account for the discrepant treatment results between the two patients who performed at comparable level on all semantic tests but differed in cognitive abilities measured by TONI-3. Moreover, they believed that the extent of treatment generalization may be related to patients' cognitive levels as well. Also, Yeung and Law (2008) further found that treatment success is significantly correlated with cognitive functions measured by TONI-3, the Behavioural Assessment of the Dysexecutive Syndrome (Wilson, Alderman, Burgess, Emslie, & Evans, 1996) and Attention Network Test (Fan, McCandliss, Sommer, Raz, & Posner, 2002). Such findings matched with those reported in the English literature, indicating that patients with higher level of executive problem-solving skills would take less treatment time to achieve passing criteria and have better maintenance than those with lower levels. Apart from that, Yeung and Law also raise a new issue that the extent of treatment generalization may be likely to be predicted by the level of cognitive abilities. In other words, higher cognitive abilities may enable a patient to have greater treatment generalization.

The present study was motivated by the findings that a linguistic factor (semantic processing ability) is likely to predict treatment outcomes and determine the occurrence of treatment generalization, and the conflicting findings that a nonlinguistic factor (cognitive abilities) may influence an anomic patient's reaction to treatment and thereby help foresee therapy results as well as the extent of generalization. As the role of cognitive functions in therapy outcomes may not be so evident in the majority of previous studies, the present study applied an identical SFA + SP treatment protocol in Law et al. (2006) to a Cantonese-speaking anomic patient, CBF, and it aimed at investigating the relationship between cognitive abilities and treatment outcomes by contrasting therapy outcomes of CBF with that of MTK in Law et al. The two patients were hypothesized to resemble each other in terms of language abilities but differed in executive problem-solving skills.

Besides evaluating the relationship between cognitive abilities and treatment outcomes, the effect of object familiarity on naming accuracy was also explored. The findings from Conley and Coelho (2003) revealed that patient demonstrated higher naming accuracy and more stable performance on high familiarity than low familiarity items. Hence it is hypothesized that better performance would be observed on high familiarity stimuli. In order to test the hypothesis, the level of familiarity (i.e. high versus low) of trained and untrained items was manipulated in the selection of stimuli.

With the respect to clinical practice, it is hoped that, in addition to language tests, the inherent importance of cognitive assessment to the expectation of positive therapy outcomes can be addressed and thereby help local speech therapists select treatment approach as well as making more precise prognosis for anomic patients.

While from a research perspective, it would supplement the findings of previous studies and the development of a theory of rehabilitation of anomia (Nickels, 2002b).

On the basis of previous findings, several predictions were made:

1. If the degree of semantic deficits was the determining factor for therapy results, treatment progress of CBF was expected to be similar as MTK.
2. If the status of cognitive abilities was related to treatment outcomes (i.e. the extent of generalization effects, treatment duration, and maintenance of treatment gains), differences in these regards would be observed for two patients with similar degrees of semantic deficits but differing in the level of cognitive abilities.
3. If familiarity of stimuli had effect on the naming performance, higher accuracy was expected in naming high familiarity than low familiarity items.

For ease of reference and comparison, the information on MTK in Law et al. (2006) is included wherever it is appropriate in reporting the findings of the patient in this study.

METHOD

Participant

An aphasic individual, CBF, with severe naming difficulties, was invited to participate in this treatment study. He was a right-handed native Cantonese-speaker, and at least one year post-onset at the start of the study. His background information, along with that of the patient, MTK, in Law et al. (2006), is given in Table 1.

Table 1 Background information on CBF in this study and MTK in Law et al. (2006)

	CBF	MTK
Age	74	40
Gender	Male	Male
Education	12 years	9 years
Onset date	June 2006	September 1994
Premorbid occupation	Civil servant	Worker in a photo shop
Assessment period	November – December, 2007	March – August, 2003
Treatmetn period	January – March, 2008	November 2003 – March 2004

Initial assessments and hypothesized nature of impairment

A series of language, memory, and cognitive assessments were carried out on CBF, including (1) an auditory discrimination task to assess his ability to process phonological input accurately; (2) a repetition task to evaluate his speech production; (3) oral naming of selected pictured in Snodgrass and Vanderwart (1980) to determine his severity of naming difficulties; (4) three verbal semantic tests consisting of synonymy judgement, spoken word-picture matching, and written word-picture matching to asses his semantic processing abilities; (5) two non-verbal semantic tests like the Pyramid and Palm Trees Test (PPTT) (Howard & Patterson, 1992) and the Associative Match test in the Birmingham Object Recognition Battery (BORB) (Riddoch & Humphreys, 1993) to evaluate the extent of semantic deficits in CBF; (6) a digit forward sequence task and the Chinese Rey Auditory Verbal Learning Test (Lee, Yuen, & Chan, 2002) to assess the intactness of phonological short-term memory and semantic short-term memory, respectively; (7) a task of reading aloud the names of the objects in the oral naming test to investigate if CBF is dyslexic; and

(8) the Test of Nonverbal Intelligence (TONI-3) (Brown et al., 1997) to see if executive problem-solving skills may be related to treatment outcomes, including treatment generalization and maintenance of treatment benefits. Normal performances on these tests are summarized in Appendix A.

The results of the initial assessment of CBF in this study and MTK in Law et al. (2006) is shown in Table 2. While MTK's score on written word-picture matching was lower than CBF, they performed at comparable levels on both verbal and non-verbal semantic tests. Their relatively poor performance on spoken word- and written-word-picture matching may be taken to indicate mild semantic disruption. On the other hand, their impaired phonological output was evident from nearly intact or intact auditory discrimination ability with poor repetition. Therefore, it is hypothesized that the naming problems of CBF and MTK are attributed to compromised access from semantics to phonology and/or phonological output.

Table 2 Results of initial assessments

	CBF	MTK
Auditory discrimination (n = 40)	39 (97.5%)	40 (100%)
Repetition (n = 30)	27 (90%)	16 (53.3%)
Reading aloud object names (n = 217)	108 (49.8%)	51 (23.5%)
Oral naming (n = 217)	72 (33.2%)	80 (36.9%)
Verbal semantic test		
Spoken word-picture matching (n =126)	122 (96.8%)	120 (95.2%)
Written word-picture matching (n =126)	122 (96.8%)	103 (81.8%)
Synonymy judgment (n =60)	55 (93.2%)	55 (93.2%)
Non-verbal semantic tests		
PPT (n =37)	36 (97.3%)	35 (94.6%)
BORB (n =23)	22 (95.7%)	22 (95.7%)
Memory tests		
Digit forward sequence	8	5

Chinese Rey Auditory Verbal Learning Test		
Immediate recall (n =75)	12	17
Immediate recall after distraction (n =15)	2	4
Delayed recall (n = 15)	1	4
Recognition (n =15)	10	13
Cognitive test		
TONI-3: Raw score (percentile)	22 (50)	38 (81)

In addition to language performance, MTK and CBF scored below normal on the digit forward sequence task and the Chinese Rey Auditory Verbal Learning Test (Lee et al., 2002), suggesting that both their phonological and semantic short-term memories were impaired. Finally, as for TONI-3, MTK obtained higher score (81 percentile) than CBF (50 percentile), indicating that MTK had better cognitive abilities than CBF. In sum, we propose that CBF resembled MTK in semantic processing ability but differed in the level of cognitive abilities.

Materials

An initial set of stimuli including 256 black-and-white line drawings of objects belonging to 18 different categories was selected from *Aphasia Rehabilitation: A clinical and home therapy program outcome* (Jipson, 1987), *Boston Naming test* (Kaplan, Goodglass, & Weintraub, 1983), *British Picture Vocabulary Scale* (Dunn, 1982), *Picture Please! A Language Supplement* (Abbate & Lachapelle, 1979), and the picture set of Snodgrass and Vanderwart (1980). All stimuli were those pictured objects with names consisting of at least two and three syllables so as to avoid ambiguity in accuracy judgement.

Five normal control adults matched in age, education, and gender with CBF were asked to orally name all pictured objects to provide modal names and rate the familiarity and visual complexity of probe stimuli following the procedures in Snodgrass and Vanderwart (1980). The mean familiarity rating of each category of pictured objects was calculated. Pictures with 60% or above naming agreement were used in the baseline phase.

Treatment design

An identical treatment protocol employed in Law et al. (2006) was adopted in this study. The therapy followed a multiple-baseline design consisting of a baseline, two treatment phases, and a maintenance phase.

Baseline and selection of stimuli CBF was asked to name the selected picture set within 20 seconds for each picture without feedback in three separate sessions. Those items that CBF failed to name on two out of three occasions were selected. They were subject to the same procedure for the allocation of trained, generalization, and control items. The categories with the highest and the lowest mean familiarity values were first chosen based on the mean familiarity rating of each category in the normative data. The ones consisting of 10 or more items were used as high and low familiarity treated and generalization probes among these categories. Stimuli in each same category were allocated to the two probe types equally.

Categories that were semantically unrelated to the treatment and generalization stimuli were selected for the control probes. Information on the different probe types for CBF and MTK is given in Appendix B. For CBF, familiarity values across the three probe types of high and low familiarity items were comparable by using the student *t*-test. Meanwhile, difference between high and low familiarity stimuli was significant for each of the three types of probes ($p < 0.001$).

Treatment phase CBF received treatment three times per week regularly. At the beginning of every treatment session, all items of three probe types were randomly named by CBF without feedback or cueing so as to monitor progress over time. There were two treatment phases in which high familiarity treatment stimuli were introduced in Phase 1 followed by low familiarity trained items in Phase 2. The criterion for CBF to proceed to the next phase was 80% accuracy on treated items for three consecutive sessions.

The treatment procedure was identical for both treatment phases and followed exactly the procedure of SFA + SP described in Law et al. (2006). It would consist of the following sequence: (1) five pictures belonging to the same category would be presented simultaneously on the table; (2) one of them was randomly chosen and placed in the centre of the SFA chart (Appendix C) (Boyle & Coelho, 1995); (3) CBF was asked to name the selected picture; (4) no matter whether the initial response was accurate or not, he would be encouraged to generate six semantic features such as category, function, usage, properties, location and association of the pictured object; (5) the clinician would wrote down the features on the corresponding boxes in the chart; (6) after the discussion, CBF would be required to name the picture again; (7) for each unsuccessful trial, he was required to repeat the target name after the clinician. The session would finish when all trained stimuli of the corresponding phase were presented once. On average, CBF took one and a half hour to finish each session. Randomization of the presentation of the categories would be used across sessions in this phase in order to balance the fatigue effect and practice effect.

Home practice was given to CBF. He was provided with SFA charts and trained items in the corresponding phase to do home practice.

Maintenance phase When CBF successfully completed both phases 1 and 2, he would proceed to the maintenance phase, during which he would be probed on all probe items over three separate occasions in the second, third and fourth week after the last treatment session.

Control task Since he has a nearly normal digit span, the Chinese Rey Auditory Verbal Learning Test (Lee et al., 2002) would be administrated as a control task in both the baseline and maintenance phases.

Data analysis

McNemar’s test was used to investigate whether there was significant improvement in naming different probe types over the course of therapy. The comparison contrasted CBF’s best performance in baseline with the highest accuracy on trained, generalization, and control probes during treatment sessions.

To rule out the possibility that repeated naming attempts alone may contribute to improvement in naming accuracy of treated and generalization items, contrast would be made between treatment and generalization stimuli, treatment and control items, and generalization and control probes by using the Chi-square test.

To study the effect of object familiarity on generalization and control stimuli, CBF’s highest accuracy on high familiarity and low familiarity items during the whole treatment period would be contrasted by using the Chi-square test.

Scoring criteria and reliability

CBF’s naming responses would be scored as either correct or incorrect. Only modal names were judged as correct while incorrect responses would be classified as (1) semantically-related (e.g. banana→orange), (2) phonologically-similar (e.g.狗 /kau^{2}/ [dog]→豆 /tau^{6}/ [bean], (3) pure jargon (i.e. non-word response without apparent relationship with the targets), (4) jargon containing target morpheme (e.g.大笨象 /tai^{6} pɐn^{6} tsœŋ^{6}/ [elephant]→打不象 /ta^{2} pɐt^{7} tsœŋ^{6}/ [non-sense word]), (5) unrelated (e.g. 鹽樽 /jim^4 tsœn^1/ [saltcellar]→貓 /mau^1/ [cat]), (6) perseveration (repetition of previous response), and (7) no response.

Intra-rater reliability and inter-rater reliability would be performed on 20% of CBF's naming responses by a final year student of Speech and Hearing Sciences according to the scoring criteria. Point-to-point agreement was measured.

RESULTS

CBF needed 10 and eight sessions to complete Phase 1 and Phase 2 respectively. His naming accuracy of trained, generalization, and control items is depicted in Figure 1. (MTK's performance is attached in Appendix D). Table 3 provides the results of statistical analyses, the accuracy rates for each comparison and the sessions from which they were respectively obtained. The difference in error distribution over the baseline sessions and after the treatment is illustrated in Table 4.

CBF responded well to the SFA + SP treatment. In addition to considerable progress on both high familiarity (Phase 1) and low familiarity (Phase 2) trained stimuli, treatment effects significantly generalized to high familiarity untreated items that are semantically related to treatment stimuli. Similar to low familiarity generalization probes, his performance on low familiarity control items remained low over the course of the treatment. Significantly higher naming accuracy on treatment probes than semantically related and unrelated untrained items was evidenced by the contrasts between treatment and other probe types. No difference was found between the generalization and control items. It is noted that for both generalization and control probes CBF’s naming performance was better on high familiarity stimuli than on low familiarity items though the differences were not significant.

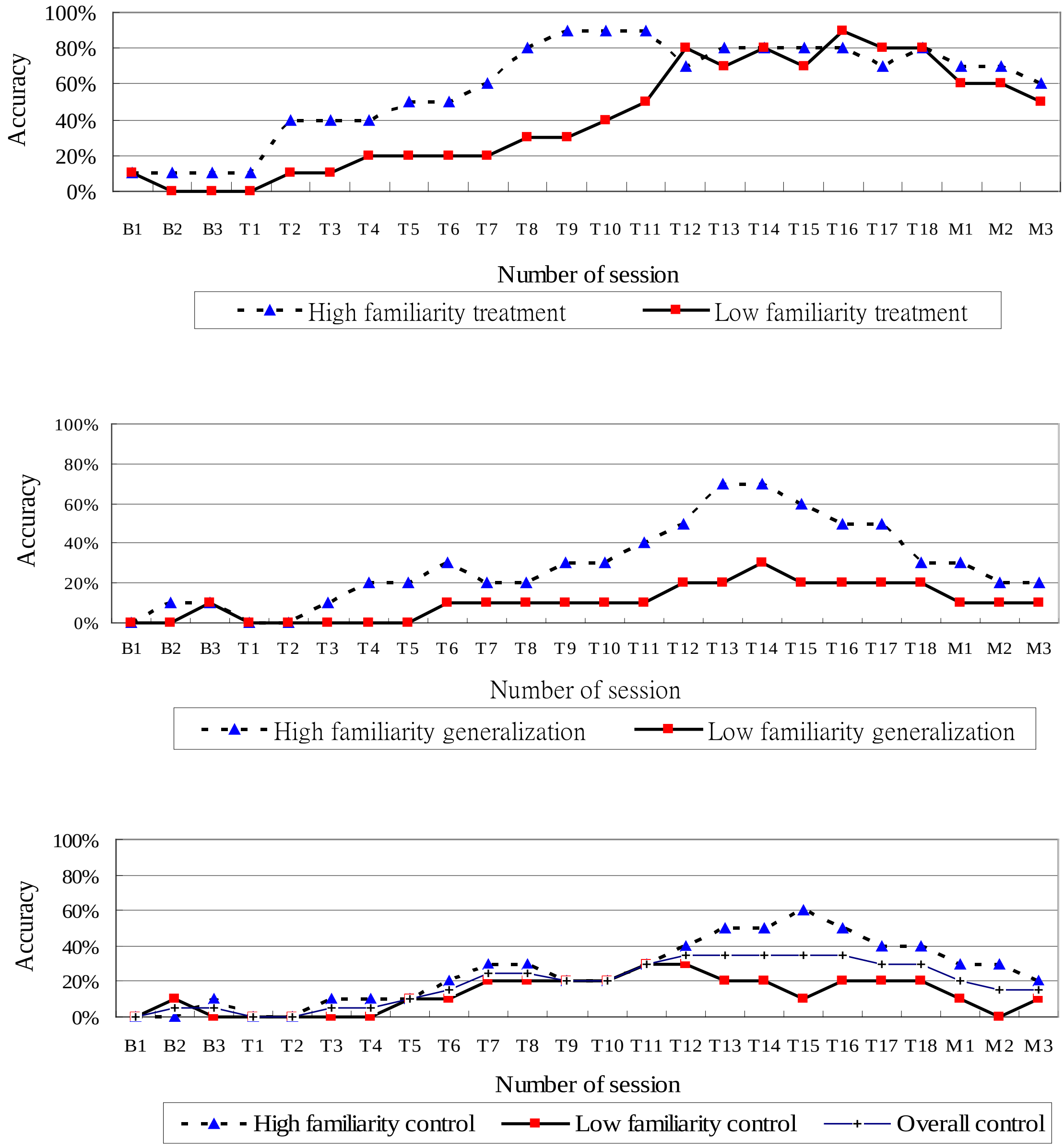

Figure 1 CBF’s performance on treatment items (top), generalization items (middle), and control items (bottom)

As the criterion level of 80% accuracy or more in naming low familiarity treatment stimuli (Phase 2) was achieved for 3 consecutive sessions (T16-T18), CBF proceeded to the maintenance phase. The top panel in Figure 1 reveals that the treatment gains began to wear off and there was a noticeable and greater reduction in naming accuracy of low familiarity than high familiarity stimuli over the maintenance period. Decline in naming performance was also observed for generalization and control items.

Table 3 Results of statistical analysis of naming accuracy

McNemar's test				
Treatment items	High Familiarity (B1: 10% vs. T9: 90%)	2.83	p=0.0078	s.
	Low Familiarity (B1: 10% vs. T16: 90%)	2.83	p=0.0078	s.
Generalization items	High Familiarity (B2: 10% vs. T13: 70%)	2.45	p=0.0313	s.
	Low Familiarity (B3: 10% vs. T14: 30%)	1.41	p=0.5000	n.s.
Control items	High Familiarity (B3: 10% vs. T15: 60%)	2.23	p=0.0625	n.s.
	Low Familiarity (B2: 10% vs. T11: 30%)	1.41	p=0.5000	n.s.
Chi-square test with Yate's correction				
Treatment vs. Generalization items	Overall (T16: 85% vs. T14: 50%)	4.10	p=0.0428	s.
Treatment vs. Control items	Overall (T16: 85% vs. T12: 35%)	8.44	p=0.0037	s.
Generalization vs. Control items	Overall (T14: 50% vs. T12: 35%)	0.41	p=0.5224	n.s.
Generalization items	Highvs. Low familiarity items (T13: 70% vs. T14: 30%)	1.80	p=0.1797	n.s.
Control items	High vs. Low familiarity items (T15: 60% vs. T11: 30%)	0.81	p=0.3687	n.s.

B = baseline; T = treatment; s. = significant; n.s. = not significant

Table 4 illustrates changes in error distribution between baseline and the last three maintenance sessions. Across the baseline phase, CBF's error responses were dominated by pure jargon (51.5%) with far fewer semantic errors (9.9%). After the treatment, changes included a dramatic increase in semantic errors (9.9% → 61.8%) and a more moderate reduction in pure jargon (51.5% → 22.8%). The contrasts between treatment and other probe types revealed a more drastic reduction in erroneous responses in naming trained items than other probe types regardless of the level of familiarity. It was also noted that for both generalization and control probes, CBF made more semantic errors in naming high familiarity stimuli (87% and 59.1%) than low familiarity items (63% and 28.6%) after the training. Finally, for control items, there were far fewer pure jargons in naming high familiarity probes (18.2%) than low familiarity stimuli (46.4%) after the therapy was completed.

As for the control task, CBF's performances on the verbal learning test before and after treatment were unchanged, 12/75 vs. 12/75 in immediate recall. Inter-rater reliability and intra-rater agreements performed on 20% of the CBF's naming responses using point-to-point judgment were 98% and 99% respectively.

DISCUSSION

The naming performance of CBF shows that he benefited from the combined treatment protocol of semantic feature analysis and semantic priming (i.e. SFA + SP). Treatment effects were not only item-specific, but generalized to semantically-related untrained probes. His naming performance on high familiarity stimuli was

Table 4 Error distribution in baseline and maintenance phase

Error type	Tx-H		Tx-L		Gen-H		Gen-L		Con-H		Con-L		Total	
	B1-B3	M1-M3	B1-B3	M1-M3	B1-B3	M1-M3	B1-B3	M1-M3	B1-B3	M1-M3	B1-B3	M1-M3	B1-B3	M1-M3
Total no. of errors	90% (27/30)	33.3% (10/30)	96.7% (29/30)	43.3% (13/30)	93.3% (28/30)	76.7% (23/30)	96.7% (29/30)	90% (27/30)	96.7% (29/30)	73.3% (22/30)	96.7% (29/30)	93.3% (28/30)	95% (171/180)	68.3% (123/180)
Semantic error	14.8% (4/27)	80% (8/10)	13.8% (4/29)	76.9% (10/13)	10.7% (3/28)	87% (20/23)	0% (0/30)	63% (17/27)	10.3% (3/29)	59.1% (13/22)	10.3% (3/29)	28.6% (8/28)	9.9 (17/171)	61.8% (76/123)
Pure Jargon	55.6% (15/27)	20% (2/10)	48.3% (14/29)	15.4% (2/13)	50% (14/28)	13% (3/23)	55.2% (16/29)	14.8% (4/27)	51.7% (15/29)	18.2% (4/22)	48.3% (14/29)	46.4% (13/28)	51.5% (88/171)	22.8% (28/123)
Jargon containing target morpheme	22.2% (6/27)	0% (0/10)	20.7% (6/29)	7.7% (1/13)	17.9% (5/28)	0% (0/23)	20.7% (6/29)	11.1% (3/27)	20.7% (6/29)	18.2% (4/22)	6.9% (2/29)	0% (0/28)	18.1% (31/171)	6.5% (8/123)
Unrelated	0% (0/27)	0% (0/10)	10.3% (3/29)	0% (0/13)	17.9% (5/28)	0% (0/23)	13.6% (4/29)	11.1% (3/27)	17.2% (5/29)	4.5% (1/22)	24.1% (7/29)	17.9% (5/28)	14% (24/171)	7.3% (9/123)
Persevera-tion	7.4% (2/27)	0% (0/10)	6.9% (2/29)	0% (0/13)	3.6% (1/28)	0% (0/23)	10.3% (3/29)	0% (0/27)	0% (0/29)	0% (0/22)	10.3% (3/29)	7.1% (2/28)	6.4% (11/171)	1.6% (2/123)

Tx-H = high familiarity treatment items; Tx-L = low familiarity treatment items

Gen-H = high familiarity generalization items; Gen-L = low familiarity generalization items

Con-H = high familiarity control items; Con-L = low familiarity control items

B = baseline; M = maintenance

consistently better than low familiarity items. However, he was unable to carry over the treatment gains after the training. Finally, subsequent to the treatment, he produced more semantic errors and fewer irrelevant responses.

One may argue that the treatment progress may alternatively be due to repeated naming attempts (Howard, 2000; Nickels, 2002a) as all probe types were named once at the beginning of every treatment session. Nevertheless, our findings suggested specific treatment effects. First, trained items were named significantly better than generalization and control stimuli (see Table 3). Second, while naming accuracy of low familiarity treatment stimuli was gradually and consistently improved during Phase 1, clear progress on naming treated items in Phase 1 and Phase 2 was only evident with the initiation of the treatment phase (see the top panel of Figure 1). Third, while there was significant improvement in naming low familiarity trained items after the therapy, naming performance on low familiarity generalization and control probes remained poor, no more than 30% for both. Therefore repeated attempts at naming alone cannot explain improved naming performance. Furthermore, the possibility that CBF's treatment progress was related to general improvement is minimized as he was at least two-year post onset of CVA and demonstrated stable baseline performance on all probe types before the intervention commenced.

Given that CBF resembled MTK in semantic processing ability since they performed at comparable levels on all semantic tests, it would be reasonable to expect similar degrees of benefits from the same therapy and patterns of outcomes in the two patients. Table 5 summarizes the treatment outcomes of CBF in this study and MTK in Law et al. (2006) for ease of reference. The present finding is compatible with the previous reports that the degrees of semantic disruption is an important element in foreseeing treatment success (Law et al., 2006; Law et al., in press). It is proposed that semantic concepts of stimuli and the linkage between semantics and phonological representations are considered to be relatively preserved in patients with mild semantic deficits. As the function of SFA is believed to strengthen the existing semantic connections through activating the preserved semantic features of stimuli, lower retrieval threshold level is believed to be the result in a mildly impaired semantic system after a semantic treatment (Boyle & Coelho, 1995; Coelho et al., 2000). Hence CBF and MTK responded to SFA + SP treatment favorably and demonstrated similar treatment gains.

Table 5 Summary of treatment outcomes of CBF in this study and MTK in Law et al.

	CBF	MTK
Phase 1 treatment	Completed	Completed
Phase 2 treatment	Completed	Completed
Generalization to semantically related items	Yes	Yes
Generalization to control probes	No	Yes
Maintenance of treatment gains	No	Yes

Mild semantic disruption may also account for the generalization of treatment gains to semantically-related untrained items in both CBF and MTK. As mentioned in Introduction that SFA + SP treatment protocol relies on an individual's largely preserved semantic processing ability to understand semantic features of stimuli and self-generate verbal cues. We propose that CBF and MTK are able to make use of their relatively preserved semantic knowledge and the network between semantics and phonology to self-generate semantic cues and internalize this self-cueing strategy via explicit teaching of strategy of analyzing semantic features. Our results are consistent with Boyle's study (2004) and Coelho et al.'s findings (2000).

However, regarding treatment generalization, CBF and MTK clearly differed from each other in the way that there was significant treatment generalization to untreated control items only for MTK. This raises the question whether the degrees of semantic impairment alone can predict the extent of treatment generalization. An examination of their performance on the tasks in initial assessments (see Table 2) suggests that the condition of post-semantic processes including access from semantics to phonology and the phonological output level is unlikely to contribute to the difference. First, CBF's reading aloud ability was better than MTK's (49.8% vs. 23.5%), indicating his dyslexia was less severe than MTK's; furthermore, the former obtained higher accuracy on repetition task than the latter (90% vs. 53.3%). These observations suggest that CBF was in better status than MTK at post-semantic levels. Howard (2000) has claimed that generalization effects may be dependent on the establishment of self-cueing strategies for word retrieval based on a patient's retained abilities. Corroborating findings come from Law, Yeung, & Chiu (2008) that the extent of treatment generalization is related to an individual's ability to capitalize on the cueing technique, which may be related to their executive problem-solving skills indicated by TONI-3. Thus, we suggest that the discrepant results between CBF and MTK in terms of generalization effects are attributable to their different cognitive abilities as shown by TONI-3 percentiles: 81% for MTK and 50% for CBF. This suggests that MTK has a higher level of facility in turning semantic features analysis into a self-cueing strategy and employing the SFA technique when he experiences naming difficulties. Nevertheless, it is arguable that different magnitudes of generalization effects to untrained items can alternatively be attributable to incomparable probe types in the two studies (see Appendix B). While it is difficult to rule out this possibility, in light of the fact that previous treatment studies using SFA showed improvement in naming untrained items in patients with higher cognitive abilities (Boyle & Coelho, 1995; Law et al., 2006; Wambaugh & Ferguson, 2007), we propose that the difference in generalization effects for the two patients is related to their varied cognitive levels.

As for the finding that CBF was not able to maintain treatment progress while improvement in naming performance on all probe types was carried over for at least one month in MTK, two accounts are put forth. First, it is plausible that the higher level of cognitive abilities enables MTK to carry out goal-directed plan more flexibly than CBF for determining the appropriate time for implementation of the self-cueing technique (i.e. SFA) to overcome naming difficulties. In other words, MTK could more efficiently than CBF employ SFA technique to generate semantic knowledge of objects encountered and select the target from a set of possible responses (non-targeted items and semantically related items) to solve lexicon retrieval difficulties within everyday settings. Nonetheless, CBF's lower executive problem-solving skills may hinder his ability to apply the semantic strategy trained here in daily routine. The other possible factor may be the self-monitoring skills (i.e. the ability to monitor the accuracy of one's own naming responses) which tend to be positively related to executive problem-solving skills (Fillingham et al., 2005a, 2005b). Therefore, CBF's lower scores on TONI-3 may reflect relatively poor self-monitoring abilities. A recent study has argued that patients with better self-monitoring skills are capable of reviewing and evaluating naming performance with the use of cueing strategy on their own and thereby increase the chances of maintaining treatment gains (Fillingham et al., 2005a, 2005b). This account seems to be relevant to the case for CBF. In the course of the therapy, it was noted that CBF could not self-monitor or evaluate the accuracy of his own naming responses and self-correct erroneous productions. In other words, without guidance and feedback from clinicians during the maintenance period, relatively poor self-monitoring capacities might hinder CBF's ability to evaluate the effectiveness of using internalized self-cueing strategy and revise it as necessary. As a result, naming performance for all probe types began to lower over the maintenance period. The results are consistent with recent studies that patients with higher cognitive skills are more likely to carry over their gains after the therapy (Hinckley et al., 2001; Law et al., 2008). As CBF's cognitive functions (executive problem-solving skills and self-monitoring abilities) were solely measured by TONI-3 in the present study, further studies could shed light on the effect of non-verbal cognitive abilities on learning to apply semantic self-cueing strategy through assessing an individual's cognitive functions in greater depth.

Regarding the treatment duration, CBF took more sessions than MTK to complete both phases 1 and 2 (18 vs. 16). Given the fact that all probe types for CBF and MTK were not comparable (see Appendix B), and that the number of items in each probe type for CBF is also different from that for MTK (20 vs. 30). Hence the relationship between cognitive abilities and treatment duration cannot be addressed properly.

The contrast between CBF's error patterns before and after treatment reflects how the semantic treatment changes his lexical processing mechanism. SFA is believed to strengthen the connection between semantic and phonological representations and lower the threshold levels of the target by activating the semantic network surrounding the target item through discussion of its semantic features. Hence there is an expected increase in semantic errors with concurrent reduction in irrelevant responses subsequent to the training. This was found in CBF, as illustrated in Table 4. The changes in error distribution is compatible with the view that SFA is facilitative rather than remedial in nature (Coelho et al., 2000; Lowell et al., 1995). A closer observation of his error distribution suggests the possible effect of object familiarity. After the intervention, there were more semantically-related responses in naming high familiarity generalization (B1-B3: 10.7% → M1-M3: 87%) than high familiarity control stimuli (B1-B3: 10.3% → M1-M3: 59.1%). Given that generalization items are semantically related to treatment stimuli as they belongs to the same category, it is plausible that CBF's considerable progress on trained probes may enable him to recall items of the same category with the use of SFA cueing technique and semantic priming in naming semantically-related stimuli. To illustrate, in the initial stage of the treatment, it was observed that CBF was more prone to produce jargon when errors were made. Later on, he tended to retrieve semantically-related items in trying to retrieve the target name. This strategy was more frequently observed in naming generalization probes than control items. Finally, as for control items, far fewer pure jargons were made in naming high familiarity probes (M1-M3: 18.2%) than low familiarity items (M1-M3: 46.4%) after the training. To account for the observation, we adopt Nickels and Howard's (1995) suggestion about the intercorelations between familiarity and other variables such as imageability and age-of-acquisition (AoA). We propose that semantic representations of high familiarity control items are acquired earlier and stored in CBF's semantic system in a relatively complete form (Nickels & Howard); hence it may be easier for CBF to retrieve semantic features to activate the neighbours of the target words in naming high familiarity items. Although no significant difference between high and low familiarity generalization and control items was observed, we recognize the potential effect of object familiarity on naming accuracy, and suggest future investigation on this issue.

As indicated in Introduction, anomia affects not only a patient's confrontation naming but also discourse production (Boyle & Coelho, 1995). A growing number of studies found the potential contribution of a semantic treatment to aphasic patients' improvement in narrative production (Boyle, 2004; Coelho et al., 2000; Wambaugh & Ferguson, 2007). Nonetheless, changes in CBF's discourse production after the therapy were not investigated in this study. Future studies can be done to address the issue properly.

In conclusion, the present findings echo the view in a number of recent rehabilitation studies and have clinical implications for local speech-language therapists. Similar to the studies in Law et al. (2006; in press), we also addressed the importance of a patient's central semantic deficits in selecting an appropriate treatment approach, and predicting how well a patient may respond to a semantically-based treatment and whether generalization of treatment gains is likely to occur. Our observation of a possible relationship between treatment outcomes and cognitive functions (i.e. executive problem-solving skills and self-monitoring abilities) together with the findings in Fillingham et al. (2005a, 2005b), Hinckley et al. (2001), and Law et al. (2008) highlight the significance of detailed description of a patient's cognitive abilities using non-linguistic cognitive assessments, such as TONI-3, in clinical settings for predicting the extent of generalization effects and determining whether the patient is able to maintain therapy gains at follow-up.

ACKNOWLEDGMENT

I would like to take this opportunity to sincerely express thanks to my supervisor, Dr. Sam-Po Law, for her valuable guidance and support throughout this dissertation project. I am also grateful to CBF for his participation. Last but not least, I would also like to express heartfelt gratitude to Pang Ling Kwan for her continuous support. Without her, I won't be able to complete this project.

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Appendix A

Normal performances on language, cognitive and memory tasks

Task	Normal performance
Control group: Three subjects aged 40-68 years with at least 9 years of education	
Spoken word-picture matching (n = 126)	Range: 124-126
Written word-picture matching (n = 126)	Range: 123-126
Synonym judgment (n =60)	Range: 54-58
Auditory discrimination (n = 40) Repetition (n = 30)	Assumed to be 100% or approximate
Data from Law et al. (2006) with control group matched in age and education with CBF	
Oral picture naming (n = 217)	212.60 (SD = 2.76; 208-216)
BORB (n = 23)	22.10 (SD = 0.74; 21-23)
PPT (n = 37)	33.90 (SD = 5.07; 20-37)
Data from Lee et al. (2002) with control groups most closely matched in age and education with CBF	
Digit forward sequence	9.00 (SD = 1.25)
Chinese Rey Auditory Verbal Learning Test	
Immediate recall (n = 75)	50.71 (SD = 6.86)
Immediate recall after distraction (n = 15)	11.25 (SD = 2.40)
Delayed recall (n = 15)	11.25 (SD = 2.36)
Recognition (n = 15)	14.17 (SD = 0.92)

Appendix B

Information on treatment, generalization, and control probes for CBF in this study and MTK in Law et al. (2006)

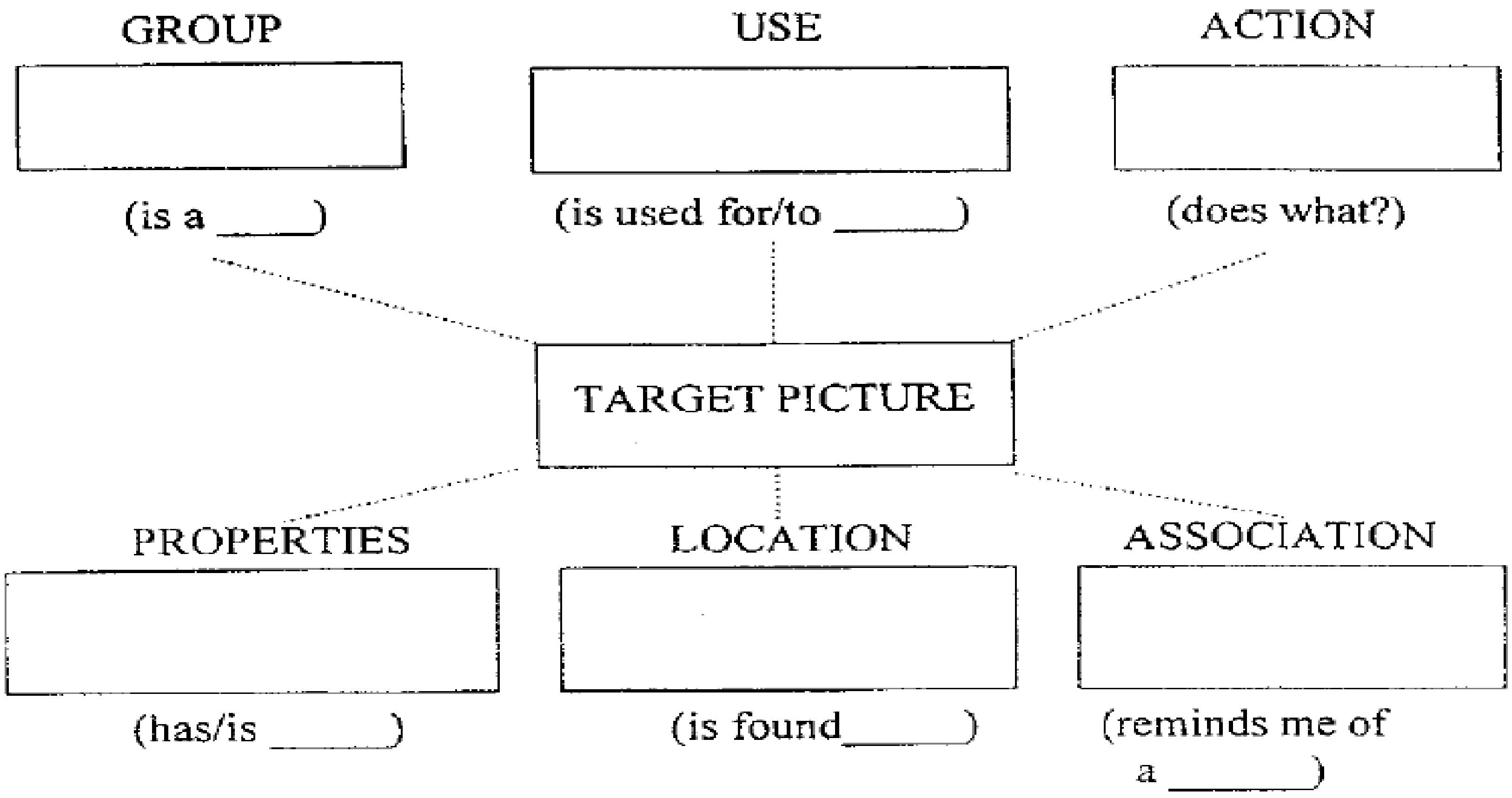
	CBF	MTK
Treatment items Phase 1 (CBF: n = 10; MTK: n = 15)	High familiarity: 4.48 (SD = 0.50) Clothing, Household items	High familiarity: 4.88 (SD = 0.18) Clothing, Fruits and vegetable, Kitchen utensils
Phase 2 (n = 10) (CBF: n = 10; MTK: n = 15)	Low familiarity : 2.60 (SD = 0.41) Recreation items, Animals	Low familiarity: 2.49 (SD = 0.76) Four-legged animals (n =8), Non-four legged animals (n =7)
Generalization items (CBF: n = 10; MTK: n = 15)	High familiarity: 4.50 (SD = 0.64) Clothing, Household items	High familiarity: 4.85 (SD = 0.22) Clothing, Fruits and vegetable, Kitchen utensils
(CBF: n = 10; MTK: n = 15)	Low familiarity : 2.62 (SD = 0.38) Recreation items, Animals	Low familiarity: 2.39 (SD = 0.79) Four-legged animals (n =8), Non-four legged animals (n =7)
Control items (CBF: n = 10; MTK: n = 15)	High familiarity: 4.22 (SD = 0.84) Toiletries, Furniture	High familiarity: 3.82 (SD = 1.30) Stationery, Means of transportation
(CBF: n = 10; MTK: n = 15)	Low familiarity: 2.58 (SD = 0.66) Musical instrument, Birds	Low familiarity: 2.52 (SD = 0.73) Musical instruments, Recreational items

Each semantic category had five items unless specified otherwise.

For CBF, the average length of syllables of high familiarity stimuli and low familiarity items is controlled to be 2.1 for each probe types.

Appendix C

Semantic feature analysis chart adapted from Coelho et al. (2000)



Appendix D

MTK's performance on treatment items (top), generalization items (middle), and control items (bottom) from Law, et al (2006)