This is the Pre-Published Version.
This is an Accepted Manuscript of an article published by Taylor & Francis in Clinical Linguistics & Phonetics on 24 Mar 2019 (Published online), available at http://www.tandfonline.com/10.1080/02699206.2019.1594382.

Modified Semantic Feature Analysis for Anomia: A Single Case Study

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Preferred running head: Modified semantic feature analysis for anomia

Abstract

Semantic feature analysis (SFA) is a treatment approach designed for patients with lexical retrieval difficulty caused by semantic deficits. During training, a structured framework (e.g. requiring the patient to name the category, function, and colour of the target items) is usually provided to facilitate the patient in thinking of the semantic features of the target items. Nevertheless, the use of a structured framework potentially limits the variety of semantic features activated for lexical retrieval. This study investigated the effectiveness of modified SFA training to address this potential limitation. An odd-man-out task was carried out in the modified SFA training with an anomic patient with impaired access to the phonological output lexicon. The task aimed to encourage a detailed comparison of semantic features among items in the same category. It is hypothesized that activations of more distinctive semantic features belonging to the target items will result in greater extent of generalizations in the lexical processing. The patient's abilities in naming semantic features at the beginning and at the end of each treatment session were compared. Besides, accuracy and error patterns in oral and written naming in the initial and post-treatment assessment were also compared. The results showed a significant increase in the number of semantic features retrieved within treatment sessions. Moreover, a significant improvement in oral picture naming was also observed subsequent to the modified SFA training. Finally, the results of the error analyses further supported that the modified SFA was effective in promoting overall lexical processing. The findings indicated that both quantity and distinctiveness of concepts activated in the semantic system are essential to effective lexical retrieval. Theoretical and clinical implications were also discussed.

Keywords: Semantics, anomia, treatment

Background

Studies of lexical processing investigate how words are represented in and retrieved from the mental lexicon. By employing the cognitive neuropsychological approach, studies have demonstrated that word finding difficulties could be a consequence of independent impairments in different distinct cognitive components (Kay & Ellis, 1987; Warrington & Shallice, 1984). According to the logogen model proposed by Ellis and Young (1998), the cognitive components involved in lexical processing include a central semantic system responsible for storing the internal representation of meanings, which is connected to different modules responsible for storing lexical entries (e.g., the phonological and orthographic output lexicons). Under this framework, the failure to retrieve a lexical item for production can result from damage to semantic processes, access from the semantic system to the lexical level, encoding at the lexicon, or any combination of the above (Fink, Brecher, Schwartz, & Robey, 2002). In the current study, the role and mechanisms of the semantic system in the process of lexical retrieval were investigated by examining the effect of a treatment that promoted semantic processes on the naming performance of a patient with word-finding difficulties associated with impaired assess to the phonological output lexicon subsequent to brain damage.

It is important to understand how the semantic system works given its critical role in the lexical process. One classic theory, the spreading activation theory (e.g., Collins & Loftus, 1975; Quillian, 1967), proposed that lexical retrieval starts with the activation of two or more concepts. A concept can be considered a node in the semantic network, and the properties of the concept are stored by linking with other concepts. For example, 'car' is a concept that is linked with other concepts such as 'drive', 'the car I own', 'transportation', and 'fast'. The relational links have different "criterialities" that represent how essential each link is to the meaning of the concept. Using the 'car' example, 'transportation' may have a higher criteriality than 'fast' because the function of 'transportation' contributes greatly to the definition of 'car'. When an intersection is found between the activated concepts, it is evaluated within the communication or linguistic context to retrieve the target lexicon that matches the appropriate meaning within the context. For example, both 'car' and 'airplane' are retrieved when 'fast' and 'transportation' intersect, and 'airplane' will eventually be selected if the conversation is about flights. In the case that context is not available, the retrieval of a specific lexical item would depend on activating as many related concepts as possible to allow an intersection that represents solely the target lexical item.

By observing different manifestations of semantic deficits among brain-damaged patients, studies have documented how disruptions in the semantic system impair the lexical retrieval process (e.g., Caramazza, Hillis, Rapp, & Romani, 1990; Warrington & Shallice, 1984). One common feature is the production of semantic errors, substituting the target items with semantically related items, in lexical tasks across different domains, including reading, writing, oral naming, and comprehension. For example, Caramazza et al. (1990) reported a neurologically impaired patient who demonstrated a comparable number of errors in oral naming, written naming, reading, and comprehension by substituting lexical items that were semantically related to the target items. Given that the semantic errors were observed in all four modalities of language processing, i.e. phonological input, orthographic input, phonological output and orthographic output, with similar degree of manifestations in that patient, they hypothesized the patient's problem is resulted from one single common cause. To explain the semantic errors produced, Caramazza et al. (1990) hypothesized that the patient was able to form intersections within the semantic network, but the activated concepts were not specific or distinctive to the target lexical item, hence resulting in semantic errors. For example, when the target lexical item to be retrieved was 'dogs', but only general concepts like 'mammals', 'with fur', and 'pet' were activated, intersections included 'dogs', ‘cats’, ‘rabbits’, and ‘hamsters’. In failing to retrieve distinctive concepts, the patient failed to identify the target lexical item from the set of activated items, hence producing semantic errors. Furthermore, the domain non-specific manifestations of the deficits (that the problem affects the input and output of both phonological as well as orthographic processing) were also taken as evidence to support a unitary modality-independent semantic system (Caramazza et al., 1990) in the cognitive system.

Semantic errors are very common among patients with aphasia. Nevertheless, deficit in the semantic system is not the only possible cause of semantic errors. Other common causes of semantic errors include access problems to the phonological output lexicon (e.g. Law, 2004) and heavy reliance of the lexical-semantic route in reading (e.g. Weekes & Robinson, 1997). Particularly, in a picture naming task, phonological representations are accessed by information from semantic features activated from the recognition of the target pictures. When there are disruptions in the access to the phonological lexicon and/or phonological representations in the lexicon resulted from brain damage, phonological representations that are semantically related to the stimulus would be activated. If one of the semantically related phonological representations is selected for production, a semantic error will be resulted.

To reduce the extensive impact on communication, treatment studies have been conducted to study how facilitating the retrieval of semantic features can promote the process of lexical retrieval. Semantic feature analysis (SFA) is a popular treatment approach that aims at improving the retrieval of conceptual information through accessing the semantic network (Massaro & Tompkins, 1992), and consequently improving lexical retrieval. SFA claims to reduce the threshold of the target lexical item to be retrieved by increasing the specificity of semantic representation and activating the semantic network connected to the target lexical item (Boyle & Coelho, 1995). During the training, the patient is prompted to identify the features of objects based on a given framework of the possible types of features (such as category, use, and location). After analysing the semantic features, the patient is prompted to name the objects to consolidate access between the activated semantic linkages and the target lexical items. The treatment effect is expected to be generalized intrinsically, because improving the linkages between the concepts of trained items will benefit the naming of untrained items since they may share similar linkages (Plaut, 1996). A review of treatment studies on SFA reported it to be an effective treatment for the promotion of lexical retrieval in general, although treatment effectiveness varied across individuals (Nickels, 2002). The majority reported significant improvements in patients' production of trained items after the SFA treatment (e.g. Boyle & Coelho, 1995; Conley & Coelho, 2003; Lowell, Beeson, & Holland, 1995) and maintenance of the improvements were also evident (e.g. Marshall, Neuberger, & Phillips, 1992). Some patients were further reported to demonstrate generalization to untrained stimuli (Boyle & Coelho, 1995; Conley & Coelho, 2003), while some did not show generalization (Lowell, Beeson, & Holland, 1995). In general, it was reported that patients with less degree of impairment of semantic access (e.g. Boyle & Coelho, 1995; Conley & Coelho, 2003; Lowell et al., 1995) and patients who demonstrated good performance in nonverbal cognitive tests (Law, Wong Sung & Hon, 2006; Lowell et al., 1995) would benefit from the SFA treatment.

The effectiveness of SFA in Chinese has been reported in Law et al. (2006), which investigated the factors that contributed to the individual differences in responses to SFA by three Chinese anomic patients with or without semantic processing deficits. A significant improvement and generalization to untrained items were observed in two patients who scored within normal range in the non-verbal semantic tests, while no change was observed in the patient who scored below average in the non-verbal semantic tests. Law et al. (2006) concluded that the effectiveness of SFA depended on the severity of the semantic deficits and the level of cognitive ability, as the patients who scored within normal range in the non-verbal semantic tasks and relatively intact cognitive abilities responded better to SFA.

Thus far, the conduction of SFA has mainly involved a step that requires the patient to identify semantic features based on a structured framework provided during treatment. There are two major issues in using structured frameworks. First, a structured framework limits the number of semantic features elicited. As mentioned previously, in situations without contextual support, lexical processing depends on activating as many semantic features as possible to allow an intersection that represents solely the target lexical item. Limiting the activated semantic features that are based on a structured framework may not be sufficient to elicit the target lexical item in the naming process. Second, the semantic features elicited from the structured framework may not have high criterialities for certain lexical items and activating them may not lead to the effective retrieval of the specific targets. For example, a framework that includes category, colour, and function may be applied to the lexical item 'durian', but the semantic features may not be distinctive enough for the target since features of high criteriality like 'smell' are not included in the framework, and this may result in multiple intersections found (e.g., 'mango' and 'lemon'). Hence, besides the severity of semantic deficits that may affect a patient's response to treatment (Law et al., 2006), the varying degrees of generalization may also be attributed to the use of a structured framework in the treatment design.

The current study aimed to eliminate the restrictions caused by the application of structured frameworks to maximize the generalization of treatment effects by adopting modifications in the SFA training. To demonstrate the effectiveness of this modified SFA training, a single case intervention study was conducted following the suggestions of Howard, Best, & Nickels (2015) and Martin & Kalinyak-Fliszar (2015) on a neurogenic patient with naming problems characterized with access problems to the phonological output lexicon. In this modified SFA training, an odd man out task was designed to encourage the patient to generate as many distinctive semantic features of the target items as possible in response to the requirements of comparing and contrasting features of object names belonging to the same categories. Using this design, all semantic features were self-generated by the patient and a greater variety of semantic features were elicited. Finally, all the features identified were "distinctive" among the stimuli sharing the same category since the odd-man-out task required a detailed comparison of features among items. Given that retrieving lexical items depends on activating as many related concepts as possible, it was expected that the modified SFA training task would result in generalization to a greater variety of untrained lexical items.

Method

Participant

FKH, a 21-year-old right-handed male speaker of Cantonese who underwent a surgical treatment for arteriovenous malformations 16 months before the study was invited to participate in this treatment study. He was a third-year university undergraduate student when he was first assessed in the current study. No visual, hearing, or motor impairment was reported.

Initial assessment of FKH's language and cognitive abilities. An initial assessment of FKH's cognitive, oral, and written language abilities was carried out, including:

Standardized language assessment:

1. Cantonese Aphasia Battery (CAB; Yiu, 1992)

Cognitive screening:

1. Hong Kong-Oxford Cognitive Screen (HK-OCS; Kong et al., 2015), which assesses five core cognitive domains (attention, language, memory, number, and praxis)

Non-verbal semantic tasks:

1. Subtests in the Birmingham Object Recognition Battery (BORB; Riddoch & Humphreys, 1993), including minimal feature match, foreshortened match, object decision, and associative match
2. Pyramids and Palm Trees Test (PPTT; Howard & Patterson, 1992)

Verbal semantic task:

1. Synonym judgement in Law (2007), in which FKH had to decide whether two aurally presented words had a similar meaning

Comprehension tasks:

1. Spoken word picture matching
2. Written word picture matching

A subset of the 260 black-and-white drawings taken from Snodgrass and Vanderwart's (1980) picture set was used in the comprehension tasks, each with 126 trials. In each trial, the client was presented with an object name (in spoken or written form) and three randomly ordered pictures including the target, a semantic distractor sharing the same word length with the target, and an unrelated distractor.

Naming tasks:

1. Oral picture naming
2. Written picture naming

The full set of 260 black-and-white drawings taken from Snodgrass and Vanderwart's (1980) picture set was used in the naming tasks.

Reading tasks:

1. Reading aloud monosyllabic and disyllabic words

2. Lexical decision tasks using monosyllabic and disyllabic words

Writing task:

1. Writing-to-dictation of monosyllabic and disyllabic words

Insert Table 1 about here

Table 1 above summarizes FKH's performance on these assessments. FKH's performance is analysed using the cognitive neuropsychological approach in the following. The results revealed that FKH had poorer performance in the oral and written naming as well as writing-to-dictation tasks confirmed that he suffered from anomia and dysgraphia. The poor performance in the synonym judgement task indicated certain degrees of deficits in semantic processing. Nevertheless, the relatively preserved performance in the spoken and written word picture matching tasks indicated good comprehension abilities with preserved phonological and orthographic input lexicons as well as the semantic system. Finally, the relatively preserved performance in the written lexical decision and word reading tasks also indicated preserved reading abilities. The better performance on reading than naming is consistent with the predictions from the summation hypothesis that accessing to phonological representations via both semantic and orthographic information in reading aloud tasks is easier than via only semantic information in the naming task (e.g. Law, 2004). The preserved performance in reading aloud, in contrast with the impaired naming performance probably indicated an access problem to the phonological output lexicon. Hence, it is expected that FKH would benefit from the SFA treatment.

Materials

A total of 210 object names belonging to eight categories (including animals, electronic devices, daily objects, food, stationery, places, transports, and sports) were selected as the treatment stimuli.

Treatment design

A multiple-baseline treatment design consisting of baseline, treatment, and maintenance phases was conducted.

<u>Baseline phase.</u> Pre-treatment baseline was obtained in three sessions within two weeks. In each session, FKH was asked to name as many semantic features as possible within 30 seconds for each object name presented in written form. The average number of features named was obtained. Stimuli in each session consisted of 24 object names from eight different categories, including training items and untrained generalization targets (i.e., items in the same categories as the training items).

<u>Treatment phase.</u> At the beginning and the end of each treatment session, FKH was invited to name as many semantic features as possible within 30 seconds for each stimulus in the stimuli set of the particular session, presented in written form and in random order. In each session, the stimuli set consisted of three categories: (1) 12 treatment stimuli of that session; (2) 12 untrained stimuli sharing the same category as the treatment targets; and (3) 12 untrained stimuli not sharing the same category as the treatment targets. The average number of features named for each category of words pre- and post-session was obtained.

In each session, the odd man out task was carried out immediately after the pre-session baseline taking. In each trial of the task, three object names from the same-category were presented in written forms[1]. The patient and the clinician took turns to identify the odd one among the triplets and name the features that distinguished it from the other two. There were no intended answers, and any one of the three stimuli could have been the odd one if the player could explain his/her choice. For example, for 'dog', 'dolphin', and 'turtle', 'dog' could be the odd one because "it does not live in water"; 'dolphin' could be the odd one because "it has no legs"; and 'turtle' could also be the odd one because "it is not a mammal". The clinician's turns also served as cues to facilitate the patient in thinking of similar features. For example, the clinician's turn "'dolphin' is different because it lives in water" would provide cues for the patient to consider the feature of "places where animals live" as a potential answer: "'turtle' is different because it can live both in water and on land". In each training session, at least seven sets of triplets of training items were given for the odd-man-out task. Each set of triplets was replaced when both the clinician and FKH agreed that no more features could be identified to distinguish the items. Altogether, 12 two-hour training sessions within five months were carried out using the modified SFA training.

Post treatment assessment. Oral and written picture naming tasks using black-and-white pictures from Snodgrass and Vanderwart (1980) and the writing-to-dictation task conducted in the initial assessment were carried out.

Control measure. A digit span task was selected as the control measure as in Law et al.'s (2006) study, in which FKH had to repeat the exact sequence of digits presented verbally by the clinician. The task was conducted in both the pre- and post-treatment assessment.

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[1] The object names were presented in written forms because of FKH's close-to-perfect performance in the written word picture matching task. Besides, presenting the object names in written forms also prevented FKH from relying solely on visual distinctive features in achieving the requirement of the odd man out task.

Data analysis

Treatment effects were measured in terms of (1) within session treatment effect on semantic features naming, (2) within session generalization effect on semantic features naming, and (3) overall generalization effect on picture naming.

Within session treatment effect on semantic features naming. The average number of features identified for the treatment stimuli between the pre- and post-session were compared using a paired t-test.

Within session generalization effect on semantic features naming. Two within session generalization effects were measured. The within session within-category generalization was obtained by comparing the pre- and post-session average number of features identified for the untrained same-category stimuli using a paired t-test. The within session untrained-category generalization was obtained by comparing the pre- and post-session average number of features identified for the untrained-category stimuli using a paired t-test.

Overall generalization effect on picture naming. The oral and written picture naming accuracies and writing-to-dictation accuracies between pre- and post-treatment were compared using McNemar's test.

All statistical tests were conducted using the Statistical Package for Social Sciences (IBM Corp., 2017) and a significance threshold of $p < .05$ was selected.

Results

Within session treatment effect on semantic features naming

Figure 1 below shows the pre- and post-session average number of semantic features named for the treatment targets. The results of paired t-test showed that FKH named significantly more semantic features of the trained items immediately after treatment across sessions [t(11) = 6.707, *p* <. 05].

Insert Figure 1 about here

Within session generalization effect on semantic features naming

Figures 2 and 3 below show the pre- and post-session average number of semantic features named for the untrained same-category stimuli and those of the untrained different-category stimuli, respectively. The results of the paired t-test showed that FKH named significantly more semantic features of the untrained same-category items immediately after treatment across sessions [t(11) = 2.677, *p* < .05]. Similarly, significantly more semantic features of the untrained-category items were named immediately after treatment across sessions as indicated in the results of paired t-test [t(11) = 5.897, *p* < .05].

Insert Figure 2 about here

Insert Figure 3 about here

Overall generalization effect on picture naming

Tables 2 and 3 below summarize the pre- and post-treatment oral and written picture naming by FKH, respectively. The results of McNemar's test showed significant improvement in oral picture naming [$X^2(1) = 10.37$, $p < .05$] but not in written picture naming ($p > .05$).

Insert Table 2 about here

Insert Table 3 about here

Tables 4 and 5 below summarize the distribution of errors produced by FKH in the oral and written picture naming tasks, respectively. The results of the chi-squared tests showed that the pre- and post-treatment distribution of errors produced by FKH were significantly different in both the oral picture naming task [$X^2(5) = 28.86$, $p < .05$] and the written picture naming task [$X^2(3) = 11.56$, $p < .05$].

Insert Table 4 about here

Insert Table 5 about here

Discussion

SFA is a facilitative treatment approach that aims at strengthening existing linkages within the semantic system and between the semantic system and the output lexicon used by anomic patients in naming tasks (Coelho, McHugh, & Boyle, 2000). In the current study, the effectiveness of the modified SFA was examined.

Treatment effect on naming semantic features

FKH's increase in the number of semantic features named and generalization to untrained items in the post-baseline within session indicated a positive response to the intervention and an immediate treatment effect. The improvements in naming the semantic features of the treated and untreated same-category items indicated that the modified SFA training was effective in helping FKH to identify more semantic features of the object names presented.

Furthermore, the increase in the number of semantic features named in the untreated category items indicated that FKH was able to internalize compare and contrast strategies when he was prompted to name the semantic features of the untrained items. The results in this study, therefore, are consistent with previous findings (Lowell et al., 1995), as generalization to untreated items and the use of the self-cueing strategy were observed.

In the modified SFA training, the odd-man-out task encouraged FKH to actively compare the features among items in the same categories. Since items in the same categories were presented in each trial, the semantic features generated were expected to be sufficient to distinguish a target item from other items in the same category. For example, in one of the sessions, FKH only named the category ‘fruit’, colour ‘yellow’, and function ‘to be eaten’ for ‘lemon’ in the pre-treatment baseline, the features of which could match other fruits like ‘mango’. In the post-baseline, he added distinctive features of ‘lemon’ like ‘sour taste’ after training. Such improvement in identifying distinctive semantic features was expected to promote lexical processing. The results of the picture naming task partially supported this.

Overall generalization effect on picture naming

The results of previous studies have documented that SFA training is effective in improving lexical processing (e.g., Law et al., 2006; Lowell et al.,1995). The manifestations of the improvements were usually reported in two measures, including naming accuracy and error types.

Naming accuracy. The results showed that FKH demonstrated significant improvement in oral naming accuracy after the modified SFA treatment. Consistent with previous studies that used the SFA treatment (e.g., Boyle & Coelho, 1995; Lowell et al.,1995), the results also indicated that the modified SFA treatment was effective in promoting oral naming accuracy.

The improvement in oral naming accuracy was attributed to improved ability in generating the semantic features of objects that were distinctive among other objects in the same category. The unchanged forward digit span of 5 in both the pre- and post-treatment control measures further supported that the improvements in naming accuracy should be attributed to the treatment given instead of any spontaneous recovery that might have occurred. As proposed, the modified SFA was effective in increasing the specificity of the semantic representations of the target lexical items (Boyle & Coelho, 1995), hence facilitating (Coelho et al., 2000) the retrieval of target lexical items in the naming tasks. Given FKH's relatively preserved semantic system as hypothesized based on the initial assessment results, the improvement in oral picture naming accuracy after receiving the modified SFA treatment was also consistent with Law et al.'s (2006) suggestion that SFA treatment is particularly effective for patients with less severe semantic deficits. Based on the assumption of a unitary semantic system (e.g., Caramazza et al., 1990), it was originally expected that comparable improvements in written naming would also be observed after the modified SFA treatment. Although FKH demonstrated some improvement in written naming accuracy, the improvement was not strong enough to reach a statistically significant level. Nevertheless, the improvement in written naming accuracy was evident in the distribution of error types produced.

Distribution of error types. The results of the chi-squared tests showed that the distribution of error types between pre- and post-treatment were significantly different in both oral and written naming. A closer look at the distribution of errors indicated that the differences were attributed to the increased number of "no response" in the naming trials in both oral and written naming. It was observed that FKH occasionally self-corrected himself during the process and gave up when he could not retrieve an appropriate answer. Together with his relatively less severe anomia (scoring over 70% accuracy before the treatment), the increased number of "no response" probably reflected that he possessed a higher awareness of the semantically unrelated lexical items activated during the process (e.g., phonological errors, unrelated responses, and neologisms) and was able to reject them. Yet the "no response" given probably also indicated that he had sufficient semantic information to reject other semantically related lexical items, but the semantic information was still not sufficient enough to retrieve the target lexical items. On the other hand, in the case of more severe anomia problem, an increase in semantic errors may be resulted after the treatment.

In fact, the results also showed that after the modified SFA treatment, FKH's dominant type of error in both the oral and written picture naming tasks was semantic errors. To explain why individuals make semantic errors, it is expected that there are either too few semantic features activated during processing or that the semantic features are too generic and are not distinctive enough to reject semantically related items. In the modified SFA training, activating distinctive features in the semantic system was encouraged through a detailed comparison of features among items in the same categories using the odd-man-out task designed. Therefore, it was originally expected that FKH would have relatively improved in generating the distinctive features of objects after the modified SFA treatment, hence the number of semantic errors should have decreased. One possible reason was that there probably exist deficits in FKH's orthographic output lexicon. The persistent high percentage of orthographic errors before and after the treatment probably indicated that if particular orthographic units are lost in the orthographic output lexicon, simply promoting the semantic features activation will not be sufficient to "retrieve" them. Another possible reason for the absence of extensive generalization to naming tasks was that a step to encourage FKH to automatize the compare and contrast method as a self-cueing strategy in the process of naming was not included.

The repetition of naming lexical items has been found to be one of the crucial components in most successful SFA treatments (Law et al., 2006). This step is suggested to be essential in strengthening the linkages between the semantic system and the output lexicon. In the odd-man-out task, although more distinctive semantic features were activated, FKH was not further required to name the training items after treatment. This may have resulted in the less pronounced generalization observed. Future studies that incorporate an additional training phase with explicit instructions that encourage patients with semantic deficits to apply the modified SFA technique in naming tasks are recommended to warrant this.

Clinical implications

The current study documented that modified SFA is effective in improving patients' abilities to identify semantic features and distinguish items in the same categories. In addition, improved ability in generating semantic features also effectively improves patients' abilities in lexical retrieval. Clinically, modified SFA training is considered to have advantages compared with traditional SFA training. One common difficulty of conducting traditional SFA training is that anomic patients sometimes find that naming (several) features associated with a particular object can be equally difficult compared with naming the object directly. In modified SFA training, by presenting two additional objects alongside the target, the task of identifying the distinctive features associated with the target object appears to be a more concrete requirement comparatively.

Moreover, the reason for the need of a specific lexical item to represent a particular group of objects should be the features that distinguish it from the other groups of objects in the same category. Otherwise, the category name should be sufficient in representing the particular group of objects. Therefore, the modified SFA training introduced in this study should be a more direct way to help patients identify the essential features that facilitate the retrieval of the target lexical items in naming tasks.

Finally, to maximize the generalization from semantic features naming to lexical retrieval, it is recommended that an explicit instruction on semantic features that generate a self-cueing strategy in object naming be included in the SFA training.

Limitation and future studies

One limitation of the current study is the lack of a comparison between the original SFA and the modified SFA on FKH's lexical retrieval. Without the comparison, it is difficult to determine if the modified SFA has greater effect on FKH's naming compared to the original SFA. Therefore, the current study only provided initial evidence to support the effectiveness of the modified SFA. Subsequent study conducted in A-B-B-A design is recommended to compare the effectiveness of the original and the modified SFA treatment on naming improvements. Alternatively, it is also possible that combining the original and the modified SFA may produce a summation effect on naming improvements. In fact, it is also common in the literature that the original SFA can be combined with other treatment method such as semantic priming (e.g. Law et al., 2006) and response elaboration training (e.g. Conley & Coelho, 2003) to produce enhanced treatment effect. Future studies are needed to verify this hypothesis.

Conclusion

Modified SFA training was carried out on an anomic patient with impaired access to the phonological output lexicon to promote the activation of the most distinctive semantic features and a greater extent of generalization in lexical processing. FKH showed an increase in both the number of semantic features retrieved and semantic errors produced during the naming tasks after training. The improvement in oral picture naming accuracy after the treatment was also significant. The results confirmed that both quantity and distinctiveness of the concepts activated in the semantic system are crucial to effective lexical retrieval. Further studies that replicate the current findings are needed in the future.

Acknowledgements

We are grateful to FKH for his participation in the study.

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Table 1. FKH's performance on the initial assessments

Assessment Tasks	**Results**
Cantonese Aphasia Battery (CAB)	93.8/100 Diagnosis: Mild anomia
Hong Kong-Oxford Cognitive Screen (HK-OCS)	Normal in all 12 tasks
BORB^ – Minimal feature match	96% (24/25)
BORB – Foreshortened match	96% (24/25)
BORB – Object decision	Easy – 90.6% (58/64) Difficult – 85.9% (55/64)
BORB – Associative match	100% (30/30)
Pyramids and Palm Trees Test (PPTT)	96.7% (29/30)
Synonym judgement	68% (41/60)
Spoken word picture matching	97% (122/126)
Written word picture matching	100% (126/126)
Oral naming	76.2% (198/260)
Written naming	74.6% (194/260)
Lexical decision – monosyllabic words	97% (62/64)
Lexical decision – disyllabic words	94% (57/60)
Read-aloud – monosyllabic words	96.7% (176/182)
Read-aloud – disyllabic words	95% (118/124)
Writing-to-dictation	73.7% (199/270)

^ Birmingham Object Recognition Battery (Riddoch & Humphreys, 1993)

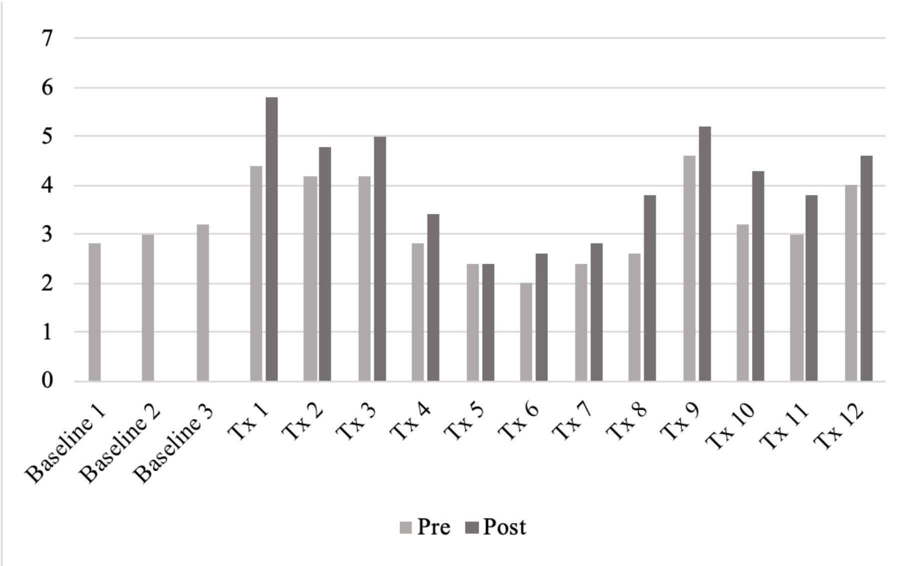

Figure 1. Number of semantic features named for trained items. Baseline = Pre-treatment baseline session, Tx = Treatment session.

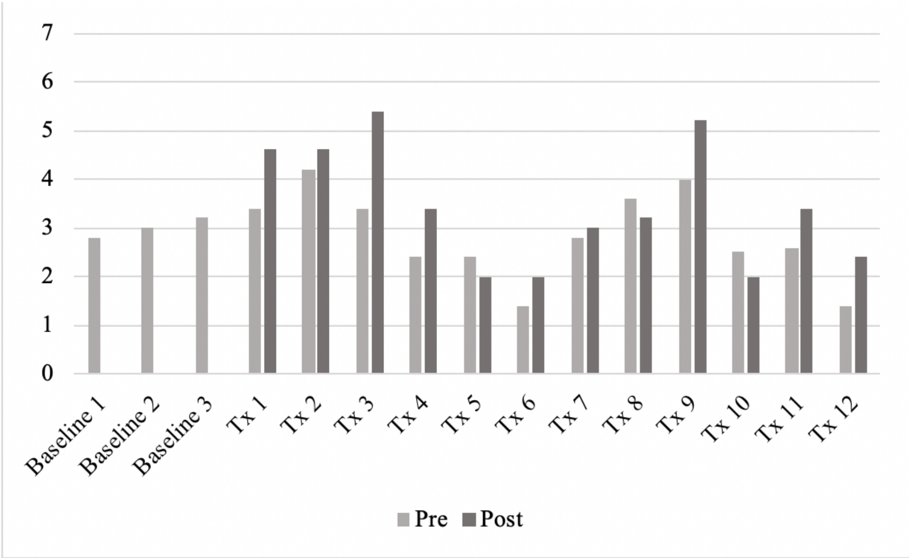

Figure 2. Number of semantic features named for untrained items of trained categories. Baseline = Pre-treatment baseline session, Tx = Treatment session.

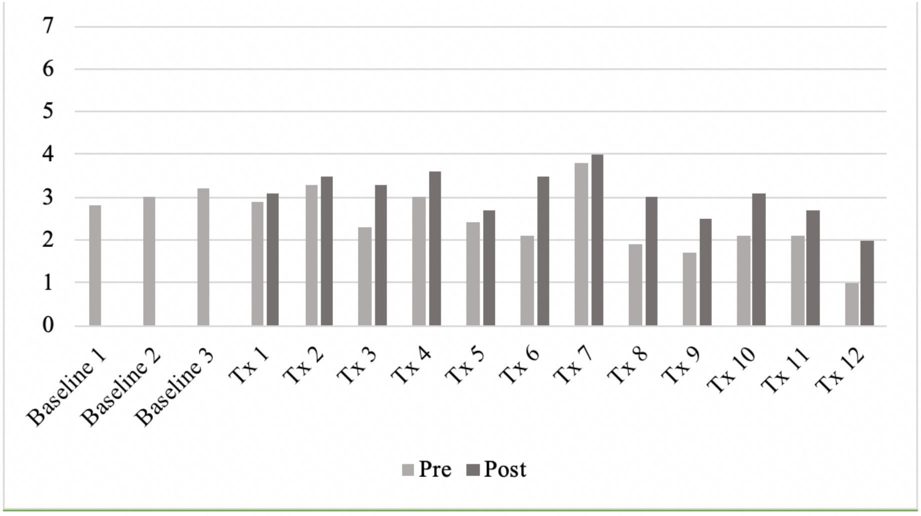

Figure 3. Number of semantic features named for untrained items of untrained categories. Baseline = Pre-treatment baseline session, Tx = Treatment session.

Table 2. FKH's pre- and post-treatment oral picture naming performance

	Incorrect (Pre[#])	Correct (Pre)	Total
Incorrect (Post[^])	25	14	39
Correct (Post)	37	184	221
Total	62	198	260

[#] Pre: Pre-treatment

[^] Post: Post-treatment

Table 3. FKH's pre- and post-treatment written picture naming performance

	Incorrect (Pre[#])	Correct (Pre)	Total
Incorrect (Post[^])	30	23	53
Correct (Post)	36	171	207
Total	66	194	260

[#] Pre: Pre-treatment

[^] Post: Post-treatment

Table 4. Distribution of errors in the oral picture naming task

	Pre-treatment	Post-treatment
Semantically related errors		
Substitutions using semantically related items	37 (59.7%)	28 (71.8%)
(e.g. 喇叭<trumpet>→ 長笛<flute>)		
Circumlocution	14 (22.6%)	0 (0.0%)
Phonological errors	6 (9.7%)	0 (0.0%)
(e.g. 梯[tai1]<ladder> → [dai1])		
Unrelated responses	4 (6.5%)	2 (5.1%)
(e.g. 溜冰鞋 <roller skate> → 手推車<trolley>)		
Neologisms	2 (3.2%)	0 (0.0%)
No response	0 (0.0%)	9 (23.1%)

Table 5. Distribution of errors in the written picture naming task

	Pre-treatment	**Post-treatment**
Semantic errors	34 (54.8%)	18 (34.0%)
(e.g. 西芹 <celery> → 生菜<lettuce>）		
Orthographic errors	22 (35.5%)	21 (36.6%)
(e.g. 貨車<truck>→ 貸車)		
Unrelated errors	3 (4.8%)	1 (1.9%)
(e.g. 頂針 <thimble> → 垃圾桶 <trash bin>）		
No response	3 (4.8%)	13 (24.5%)