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Original Research Article

Identifying the loci of lexical semantic breakdown in aphasia and the choice of therapy techniques

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ABSTRACT

Background: Word finding would be more challenging in a person with aphasia because of a breakdown in lexical semantics. Words may be difficult to locate if they are not stored appropriately or readily available. In addition, the inability to access language could be the result of a weakness in either the lemma node, leading to verbal paraphasia, or the phoneme retrieval, leading to phonemic paraphasia. Commonly used to avoid this lexical semantic gap, cueing allows for clearer communication. SFA and PCA methods are also used to aid in the search for appropriate words.
Materials and Methods: The study was carried out on persons with anomic aphasia. After determining the source of the lexical semantic breakdown, the goal of this research was to determine an appropriate therapeutic strategy. There were 12 people with anomic aphasia who participated in the research. Tasks tapping phoneme judgment and semantic judgment were given to the participants.
Results: Two individuals withdrew out of the study, while four subjects fared poorly on PCA (group 1). Six subjects performed poorly on the semantic judgment test (group 2). Training for Group 1 used PCA, while training for Group 2 used SFA. After training, participants' ability to recall names and verbs was evaluated using the Boston Naming Test and the Action Naming Test.
Conclusion: After training, participants in both groups showed considerable improvement on the retests of the naming and judgment tasks.

1. Introduction

The most common symptom of aphasia is the difficulty in finding words, but this is not unique to any one type of aphasia[1] (Godecke, Hird, Lalor, Rai & Philips, 2012). The inability to recognize a word, known as anomia, might result from a lack of storage or access deficit[2] (Dell, Lawler & Harris & Gordon, 2004). As words in the mental dictionary would eventually impoverish, it becomes difficult to retrieve the word[3] (Damasio & Tranel, 1993). In simple terms, it is hypothesized that lexical elements deteriorate as a consequence of aphasia. Conversely, when vocabulary is preserved but access to these words is limited, we speak of an "access deficit"[4] (Goodglass & Wingfeild, 1997). Disabilities that affect one's ability to gain entry can be broken down into two categories: lexical-semantic and phonological components[2] (Dell, Lawler & Harris & Gordon, 2004). When someone has trouble recalling the phonological components of a word, they are assumed to have a phonological deficit, on the other hand, when they

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have trouble recalling the lexical components of a word, they have a lexical-semantic deficit. The three-step model of word retrieval best explains the lexical-semantic activation. The three-stage lexical access model specifies three steps to get a word from the dictionary[5] (Dell, Schwartz, Martin, Saffron & Gagnon, 1997). An input word's conceptual properties are triggered at the first step of conceptual activation. If the target word is "dog," then visual cues like "four legs," "fur," and "a tail" may be used. After the activation of the notion, the lemma node is activated. During the lemma node activation process, a group of lemma nodes connected to the target would be made active. In the previous example, animals like cats, horses, goats, and so on are all examples of active lemma nodes. There could be a nomination for a single lemma node. The target would line up with the lemma node that has been switched on. Finally, the phoneme retrieval step would activate the phonemes related to the chosen lemma node from the phonological input lexicon. In the phonological input lexicon, phonemes are assumed to exist in their purest form. These phonemes are picked up via the phonological input lexicon[5] (Dell, Schwartz, Martin, Saffron & Gagnon, 1997).

In patients with aphasia, paraphasia is a prevalent kind of language difficulty. It implies an accidental switch of words. It's possible, but not certain, that the new word will have some sort of relationship to the original one[4] (Goodglass et al., 1997). The new word could share a similar meaning with the original word or sound like it. If the substituted word is related to the original word semantically, it is termed as semantic paraphasia while the term phonemic paraphasia is used when the substituted word and original word are related phonemically. Semantic paraphasia shows faulty activation of the lemma node, whereas a phonemic paraphasia indicates faulty retrieval of phonemes. When the substituted word has no relation to the intended meaning, this is known as random paraphasia. There would be sporadic paraphasia if ideas weren't being actively processed in the brain. Paraphasia could thus be understood as an episode of aphasia characterized by a failure in lexical and semantic processing. A regular naming task could be used to pinpoint the locations of lexical semantic breakdown. The therapist would be better able to pinpoint areas of lexical semantic breakdown if paraphasia or cue reactivity in naming tasks were present[6,7] (Hird & Kirsner, 2010; Hilari, Needle, & Harrison, 2012).

A researcher can also determine the lexical semantic breakdown with the phoneme judgment task, but the semantic judgment task is more precise. The performance on the task can also be utilized to better comprehend the relationship between words and their meanings in a given language[8] (Raymer., Thompson, Jacobs, & Le Grand. 1997). Poor performance on a semantic judgment task may indicate an issue with lemma node activation, while poor results on a phonemic judgment challenge may indicate an issue with phoneme retrieval.

Aphasia patients may benefit from cues in regaining lexical semantic activation. This means that a signal can help a language grow by encouraging the creation of new vocabulary and structures. The cues are used mostly on a surface level. Assuming the lexical and semantic breakdown spots have been pinpointed, the cues will function technically more successfully. An individual who has difficulty stimulating their lemma nodes can get from a semantic clue. A person who has problems recalling phonemes, on the other hand, can benefit from employing phonemic cues[9] (Raymer., Thompson, Jacobs, & Le Grand. 1993). If a person has trouble understanding what is being said, they may need both phonemic and semantic cues to fill in the gaps.

Semantic feature analysis (SFA) and phonology component analysis (PCA) are two notable methods for remediating naming deficits, the techniques are based on the three-stage lexical access model[8] (Raymer,Moberg, Crosson, Nadeau,& Rothi, 1997). Experimental proof for SFA was derived from case studies of people who had suffered traumatic brain injuries. SFA is a methodical approach that places an emphasis on the cultivation of semantic qualities, hence facilitating the systematic recovery of words with no intervention on the part of the user. The strategy would center on expanding the semantic network that defines a specific concept. The methodology relies on the assumption that a larger semantic network will facilitate lexical semantic activation. PCA is another common method for addressing difficulties with word retrieval due to aphasia[10] (van Hees, Angwin, McMahon, & Copland, 2013). While using this method, you are expected to rely on your own internal cues. Instructions on how to create a suitable rhyme are given to those with aphasia. In addition, persons with aphasia should be able to recognize the initial and final sounds in the word[11] (Davis, & Pring, 1991), determine the exact number of syllables in a word. These strategies would enhance the phonological network surrounding the word, allowing a person with aphasia to remember it. A bottom-up approach is used to generate words[12] (Efstratiadou, Papathanasiou, Holland, Archonti, & Hilari, 2018). Those with aphasia who have problems recalling individual phonemes may benefit from PCA[10,13] (van Hees, Angwin, McMahon, & Copland, 2013; Sadeghi, Zahra Baharloei, Nahid & Modarres, Amin & Ghasisin, Leila, 2017).

Persons with aphasia who have trouble with naming generally receive treatment using PCA and SFA[14] (Drew, & Thompson, 1999). You can use only one method of therapy or combine several methods. The therapeutic strategies are chosen either fundamentally or according to the patient's performance on a naming task[15] (Nettleton, & Lesser, 1991). The current study was warranted because it would be more beneficial to select therapeutic strategies

according to objective criteria. Patients with anomic aphasia are compared between PCA and SFA based on their performance on phonemic and semantic judgment tasks.

2. Material and Method

2.1. Participants and procedure

Twelve volunteers, ranging in age from 37 to 56, were included in the study. All of the participants had a history of a CVA (Cerebro Vascular Accident). For an average of six to twelve months, these individuals were engaged in speech and language therapy. During the course of this study, all individuals took the Western Aphasia Battery, the type of aphasia and aphasic quotient was determined based on the performance on WAB. The current diagnosis of the participants was Anomic Aphasia at the time of testing. Convenient sampling was used to recruit the participants. All the participants' details are listed in Table 1.

Phonemic and semantic judgment task was administered on the participants. Fifty stimuli were used in each test. Twenty-five pairs of phonetically related words and twenty-five pairs of unrelated words were presented in the phoneme judgment task. It was explained to the participants that they should press 1 if the terms were associated and 0 if they were not. The number of stimuli and kind of responses in the semantic judgment test were identical to those in the phoneme judgment task.

Potential candidates took phoneme and semantic judgment tests to narrow down the number of people from whom to choose therapy methods. People who did poorly on the different tests were picked to take part in the therapy. We found that four of the twelve participants scored below 50% on the semantic judgment task but above 50% on the phonemic judgment task, and six of the twelve participants scored below 50% on the phonemic judgment task but above 50% on the semantic judgment task. Two people were eventually evicted from the study because they performed poorly on both tests, however they were asked to continue speech-language therapy.

2.2. Training and judgement tasks

Participants then received therapy for about 15 to 50 sessions, with each session lasting 25 minutes on an average. The phonemic component analysis (PCA) was administered to four individuals who performed poorly on the phonemic judgment test. The PCA sessions educated the participants on the basics of phonetics, such as the first sound, words that rhyme with the first sound, etc. These 20 sessions were done in terms of therapy. In the same lines, SFA training was provided to the group of six participants who performed poorly on the semantic judgment task. They were given information regarding the meaning, context, and use of the key word. In similar lines with PCA, therapy sessions were 30 minutes long. Following instruction in phonemic component analysis and semantic feature analysis, participants completed the Boston Naming Test and the Action Naming Test. The semantic and phonemic judgment tasks were administered on the participants post training.

3. Results

The primary goal of this research was to compare PCA and SFA in treating anomic aphasia by assessing their effectiveness on phonemic and semantic judgment tasks. Phonetic and semantic grouping performance was used to divide the participants. Participants who scored low on the phonemic judgment task were placed in Group 1. Participants who did poorly on the semantic judgment task make up Group 2. In order to hone their skills, Group 1 participants were exposed to phonological component analysis, whereas Group 2 members learned to use semantic feature analysis. There were six people in Group 1, and four people in Group 2. (Out of the original 12 individuals, 2 were cut since they performed poorly on phoneme judgment and semantic judgment, and therefore they were not included in the present phase). All participants in both groups attended therapy sessions lasting between 15 and 50 sessions. Both groups were given the Boston Naming Test and the Action Naming Test once the training was complete to evaluate their progress. There is a difference between the two tests, with the Boston Naming Test focusing on noun recall and the Action Naming Test on verb memory. Participants also performed a semantic judgment task, in addition to the phoneme judgment test.

3.1. Performance on BNT and ANT

Group 1 consisted of those who had received training in PCA, and Group 2 in SFA. Participants in Group 1 scored a median of 37 (maximum of 57) on the BNT and a median of 32 (maximum of 57) on the ANT (maximum being 40). Participants in Group 2 averaged 43 on the BNT and 34 on the ANT.

3.2. Performance on phonemic judgment and semantic judgment task

On the phonemic judgment task, Group 1 participants scored 75%, but on the semantic judgment task, they scored 82%. In Group 1, members scored 81% on the phonemic judgment and 85% on the semantic judgment. Except for the pre-post analysis detailed below, no statistical measures were applied to the participants as the number of participants was less under each sub group.

We conducted the Semantic Judgment Task and the Phonemic Judgment Task before enrolling the participants to therapy and also post therapeutically. For participants exhibiting issues with phonemic judgment in the baseline assessment, PCA was used. Participants learnt to infer

phonemic relationships and overcame the phoneme retrieval disadvantage, as evidenced by their elevated performance on the Post-Training Assessment of Phonemic Judgment. Scores improved to 81%, however, indicating that more sessions are required to eradicate the phoneme retrieval shortfall. Similarly, participants in Group 2 scored below 50% on the semantic judgment test before training, but their post-training scores increased to 85%, showing that they were able to overcome the barrier in lexical semantic activation to a higher extent.

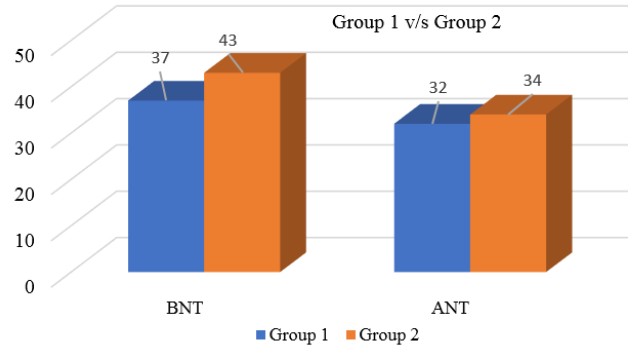

Fig. 1: Comparison of performance of group 1 and group 2 on Naming Tests

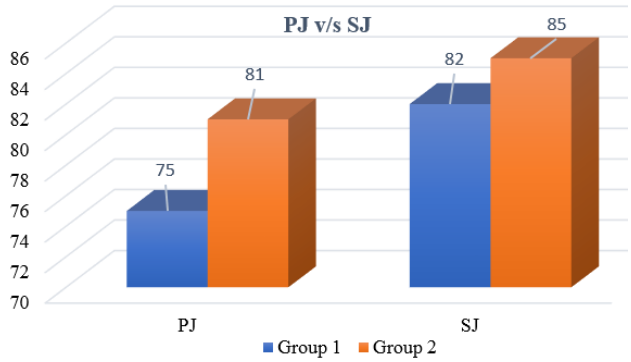

Fig. 2: Comparison of performance of group 1 and group 2 on Judgment task.

4. Discussion

The purpose of this study was to evaluate the relative efficacy of PCA and SFA in treating anomic aphasia based on the outcomes of a phonemic and a semantic judgment tasks, administered pre-therapy [15] (Nettleton, & Lesser, 1991). The phonemic and semantic judgment task pinpointed the points of lexical semantic disintegration [10] (van Hees, Angwin, McMahon, & Copland, 2013).

A lexical-semantic gap is considered a single phenomenon in a clinical setting. A lexical semantic breakdown can be caused by difficulties with either concept or semantic processing or with retrieving phonemes. In order to be most effective, therapy methods need to be applied at the precise sites where lexical semantic collapse has occurred. In the present investigation, a phoneme and semantic judgment task was used for first evaluation [10,16–18] (Van Hees, Angwin, McMahon, & Copland, 2013; Fotiadou, Northcott, Chatzidaki, & Hilari, 2014; Northcott, Moss, Harrison, & Hilari, 2016; Wisenburn & Mahoney, 2009). Participants were split into two categories based on their levels of performance. The first group performed poorly on phoneme judgment task while the second group performed poorly on semantic judgment. The group which under performed on phoneme judgment task underwent therapy using Phonological Component Analysis (PCA) while the group performing poorly on semantic judgment underwent training using Semantic Feature Analysis (SFA).

Poor performers on the phoneme judgment task were also subjected to the naming tasks, and post-training PCA was employed to help them improve. Improved phonological network strength and enhanced phoneme retrieval from the lexicon of phonological input are both results of principal component analysis (PCA). At the same time, the SFA helps to activate lemma nodes and strengthen the semantic network as a whole. It was observed that when the sites of lexical semantic breakdown are pinpointed [14] (Drew, & Thompson, 1999) and the appropriate rehabilitation methods are implemented, participants' outcomes improve [11] (Davis, & Pring, 1991). The results of this study cast doubt on previous research that suggested phonological and semantically based tasks would help people with each impairment. It emphasizes the importance of pinpointing the precise locations where lexical semantic breakdown is occurring so that appropriate therapeutic measures can be taken.

The lexical semantic gap can be bridged informally by the use of phonetic cues and semantic cues SFA-trained people outperformed PCA-trained participants on both the ANT and BNT, contradicting the results of the aforementioned study [6] (Hird & Kirsner, 2010). The authors argue that pinpointing the precise points of language breakdown is essential before deciding on a rehabilitation approach [11] (Davis, & Pring, 1991). Both groups apparently self-cued phonemic and semantic cues to overcome the lexical semantic breakdown, as evidenced by their improved performance on name tests.

The best course of treatment for people with aphasia has always been up for discussion. It is a prevalent belief that therapeutic procedures operate best when the breakdown sites or largely unaffected language processes are located. These concerns are unquestionably influenced by elements including response mode flexibility, anomia severity, and loci of failure in the naming process. Therapy strategies that take into account these elements can inspire achievement

Table 1: Details of the participants

S.No.	Age/ Gender	Post stroke duration	Initial Diagnosis	Number of sessions	Diagnosis at the time of conduct of present study
1	43/Male	7 months	Broca's aphasia	26	Anomic Aphasia
2	37/Male	8.5 months	Broca's aphasia	25	Anomic Aphasia
3	43/Male	6 months	Broca's aphasia	22	Anomic Aphasia
4	44/Male	8 months	Broca's aphasia	32	Anomic Aphasia
5	48/Male	8 months	Broca's aphasia	15	Anomic Aphasia
8	43/Male	12 months	Global Aphasia	38	Anomic Aphasia
9	39/Male	6 months	Conduction Aphasia	19	Anomic Aphasia
10	47/Male	8 months	Conduction Aphasia	27	Anomic Aphasia

and be clinically beneficial. After locating the sites of the lexical breakdown, the goal of our study was to examine the effectiveness of the available therapy options [14] (Drew, & Thompson, 1999). Our research demonstrates unequivocally that clinicians would have an easier time selecting a course of treatment if the locus of linguistic collapse were precisely recognized. In order to effectively offer treatment solutions in a timely manner for improving communication in aphasics, we would want to emphasize that the diagnostic process should also rule out the loci of breakdown in the naming process.

5. Conclusion

This study was conducted to compare PCA and SFA in the treatment of anomic aphasia by assessing their efficacy using phonemic and semantic judgment tests. Based on how well they did in phonetic and semantic grouping, participants were divided into distinct subgroups. Study participants with poor scores on the phonemic judgment exam were placed in Group 1. Participants who performed poorly on the study's semantic judgment test make up the second group. Phonological component analysis was made available to Group 1 participants, whereas Group 2 participants were taught how to conduct semantic feature analysis to hone their abilities. The principal component analysis (PCA) and the structural feature analysis (SFA) are basic tools for overcoming lexical semantic breakdown. In contrast to previous research, individuals in the current study had their phonemic and semantic judgment assessed at the outset. Training with principal component analysis (PCA) improved the performance of people who had previously performed poorly on phonemic judgment, and training with structural factor analysis (SFA) improved the performance of people who had previously performed poorly on semantic judgment, highlighting the importance of conducting a baseline assessment before implementing either PCA or SFA for training. Greater success could be achieved by pinpointing the specific loci where lexical break down occurred.

6. Conflict of Interest

None.

7. Source of Funding

None.

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