Efficacy of Using a Modified Rave-O Approach for Adults with Aphasia and Acquired Dyslexia

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EFFICACY OF USING A MODIFIED RAVE-O APPROACH FOR ADULTS WITH APHASIA AND ACQUIRED DYSLEXIA

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Abstract

of

EFFICACY OF USING A MODIFIED RAVE-O APPROACH FOR ADULTS WITH APHASIA AND ACQUIRED DYSLEXIA

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Despite the similarities between RAVE-O and effective aphasia treatments, a RAVE-O approach has not been investigated as an aphasia treatment in its own right, nor has its efficacy for treating acquired dyslexia been explored. The purpose of this study was to investigate the efficacy of using a modified RAVE-O approach, which was designed to support literacy for early elementary school students, with an adult stroke patient.

The participant in this study was a 53-year-old woman with aphasia due to stroke, who was a client at the Maryjane Rees Language, Speech and Hearing Center at the California State University of Sacramento. Her reading accuracy was consistent with a diagnosis of acquired phonological dyslexia, and her expressive language was consistent with non-fluent aphasia. This study used a case-study design in which the participant’s performance was monitored individually for improvement. The participant’s literacy goals were addressed using a modified RAVE-O kit and corresponding weekly homework was assigned; she was trained to read ten words from each of five word families, and was taught alternate meanings of five multiple meaning words.
Results of this study are inconclusive regarding use of a modified RAVE-O approach to treat acquired dyslexia and aphasia post-stroke. However, results suggest general reading and language improvements of the participant as demonstrated by increased comfort and speed while reading, awareness of incorrectly and correctly read words, and understanding of the concept of multiple-meaning words.

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Date
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Chapter 1

INTRODUCTION

*Retrieval, Automaticity, Vocabulary-Elaboration, Orthography* (RAVE-O) is a reading program designed to improve reading fluency and automaticity in primary-school aged children (The Center for Reading and Language Research, 2005; Wolf, Miller & Donnelly, 2000). It incorporates phonological awareness, orthography and semantics to improve reading and oral language. Aphasia therapies often treat symptoms of word finding (Fisher, Wilshire, & Ponsford, 2009) and semantic difficulties (Thompson & Lee, 2009), or reading and writing disorders (Centers for Disease Control and Prevention; National Stroke Association, 2009), but do not traditionally combine them. This study investigated the efficacy of using a modified RAVE-O approach as a comprehensive treatment for aphasia and acquired dyslexia secondary to stroke.

Stroke

Aphasia and acquired dyslexia often occur as the results of a stroke (American Stroke Association, 2009; National Stroke Association, 2009; Small, Flores & Noll, 1998). A stroke occurs when blood flow to the brain is disrupted by a blocked blood vessel (i.e., an ischemic stroke) or bleeding in the brain (i.e., hemorrhagic strokes) (Centers for Disease Control and Prevention, 2007; National Stroke Association). Such an event causes brain damage by killing neurons deprived of blood flow (National Stroke Association). Abilities controlled by these brain cells are lost or damaged as a result (American Stroke Association; National Stroke Association).
Ischemic strokes are caused by blood vessel obstructions that limit the blood supply to the brain (American Stroke Association, 2009). The two types of ischemic stroke are *embolic* and *thrombotic* (National Stroke Association, 2009). An embolic stroke occurs as a result of a blood clot in another part of the body. A common place for clots to form is in the heart as a result of an irregular heartbeat, also known as atrial fibrillation (American Stroke Association). A piece of the clot breaks free and travels through the circulatory system until it becomes lodged in a small blood vessel in the brain, where it blocks further blood flow (American Stroke Association; National Stroke Association). A thrombotic stroke occurs when a blood vessel in the brain becomes blocked over time by a build up of plaque and blood clots (American Stroke Association; Centers for Disease Control and Prevention, 2007; National Stroke Association).

Hemorrhagic strokes are caused by intracranial bleeding from ruptured blood vessels (American Stroke Association, 2009). Hemorrhagic strokes can be caused by high blood pressure, which causes arterial walls to become thin, brittle, and inelastic (Centers for Disease Control and Prevention, 2007), aneurysms (American Stroke Association; Centers for Disease Control and Prevention; National Stroke Association, 2009), and arteriovenous malformation (AVM) (American Stroke Association). “An aneurysm is a weak or thin spot on a blood vessel wall” (National Stroke Association) which is present at birth or develops over time. “An AVM is a cluster of abnormally formed blood vessels” which can rupture (American Stroke Association). Hemorrhagic strokes are either subarachnoid or intracerebral (American Stroke Association; National Stroke Association). Subarachnoid hemorrhage is bleeding between the meninges which are thin
layers of tissue surrounding the brain (Centers for Disease Control and Prevention), while intracerebral hemorrhage is bleeding within the brain tissue (Centers for Disease Control and Prevention; National Stroke Association).

A transient ischemic attack (TIA), which is sometimes called a mini-stroke, causes symptoms similar to a stroke but which resolve within 24 hours of onset (American Stroke Association, 2009; Centers for Disease Control and Prevention, 2007; National Stroke Association, 2009). A TIA does not typically cause lasting damage, but can be a precursor to a more serious stroke.

Stroke is “a leading cause of serious long term disability” (Centers for Disease Control and Prevention, 2007). The types and severity of the deficits caused by a stroke depend primarily on the location and extent of the damage (American Stroke Association, 2009; National Stroke Association, 2009).

A stroke in the right cerebral hemisphere commonly causes paralysis (complete loss of motor control) or paresis (weakness) on the left side of the body (American Stroke Association, 2009; National Stroke Association, 2009), vision problems (American Stroke Association), left-sided neglect which causes a person to ignore items in the left visual field (National Stroke Association), difficulty with spatial perception, impulsive behavior and memory loss (American Stroke Association; National Stroke Association).

The primary language centers of the brain are housed in the left hemisphere, so a left-hemisphere stroke in or near one of these regions often causes speech and language problems such as dysarthria (Centers for Disease Control and Prevention, 2007) and aphasia (American Stroke Association, 2009; National Stroke Association, 2009).
hemisphere stroke can also cause paralysis or paresis of the right side of the body, slow, cautious behavior (American Stroke Association), and memory loss (American Stroke Association; National Stroke Association) including difficulty learning new information, difficulty conceptualizing, and shortened retention spans (National Stroke Association).

Emotional upset is common after a stroke. “Depression is nearly universal among people who have had a stroke” (National Stroke Association, 2009). Stroke patients may also experience emotional lability, which is difficulty controlling or inability to control emotional responses such as laughing or crying.

Many stroke patients experience physical pain, which can have a number of causes (Centers for Disease Control and Prevention, 2007; National Stroke Association, 2009). Pain can be caused by stiff joints, damage to the sensory regions of the brain (Centers for Disease Control and Prevention), the weight of a paralyzed limb (National Stroke Association), ill-fitting or restrictive adaptive devices such as braces or slings, and lying or sitting still for extended periods of time.

A major medical concern following a stroke is the risk of an additional stroke (Centers for Disease Control and Prevention, 2007). Each stroke increases the risk of an additional stroke. Impaired balance and depth perception following a stroke increases the likelihood of a fall, which can result in head trauma, which can further result in a hemorrhagic stroke especially if the patient has begun taking blood thinners to decrease clotting risks. Decreased physical activity following a stroke increases the likelihood of deep vein thrombosis, which can result in an ischemic stroke.
Aphasia

Aphasia, a deficit common to left-hemisphere stroke patients, is an impairment of using and comprehending language (Jokel et al., 2009; National Stroke Association, 2009). Word-finding difficulty is one of the most common deficits related to aphasia, and aphasia patients may experience a variety of symptoms associated with word-finding deficits (Fisher, Wilshire, & Ponsford, 2009). Persons with aphasia may also experience deficits in auditory comprehension (National Stroke Association), grammar and sentence structure (Thompson & Lee, 2009), reading and writing (Centers for Disease Control and Prevention, 2007; National Stroke Association), using numbers, and doing calculations. While much of an aphasic person’s language abilities are disordered, automatic speech is often preserved to the extent that aphasic patients communicate with automatic expressions when their ability to produce novel phrases is severely deficient (Sidtis, Canterucci & Katnelson, 2009).

The term aphasia encompasses several language disorders, which generally fall into the categories of non-fluent and fluent aphasia (Brookshire, 2007). Non-fluent aphasia, which includes Broca’s, Transcortical Motor, Mixed Transcortical, and Global aphasia subtypes, is characterized by agrammatic, halting, slow speech, sometimes with impaired prosody. Fluent aphasia, which includes Wernicke’s, Transcortical Sensory, Conduction, and Anomic aphasia subtypes, is characterized by free flowing speech, which is often lacking communicative meaningfulness.

The causes of specific characteristics of aphasia are being investigated by a number of researchers. Thompson and Lee (2009) found that production of certain types
of words and parts of speech are more impaired than others in patients with agrammatic aphasia. They found that noun production was less impaired than verb production, and that verbs with complex argument structures were particularly impaired. They determined that “sentence production deficits derive from faulty sentence building operations that become more difficult as the complexity of the material encoded by the verbs increases…Sentence production is, thus, more impaired when the selected verbs entail greater argument structure complexity” (Thompson & Lee, 2009, p. 366).

Avent et al. (2009) found evidence of disrupted phonemic analysis and semantic categorization. They found that limitations of these abilities decreased the aphasic persons’ abilities to produce words in specific semantic categories and to alternate between categories.

Fisher, Wilshire, and Ponsford (2009) described the effects of word-finding impairments based on a two-stage model consisting of lexical selection and phonological encoding. Impairment at the stage of lexical selection resulted in selecting words semantically related to the target word. Impairment at the stage of phonological encoding allowed for selection of the intended target word, but incorrect selection of phonemes to produce the word.

Sidtis, Canterucci and Katsnelson (2009) investigated the relationship between the aphasic person’s use of automatic/formulaic and novel expressions. They determined that these two types speech are controlled by different neural processes by observing greater left-sided mouth openings during automatic tasks, such as smiling in babies, and greater right-sided mouth openings during voluntary tasks such as babbling in babies. Processes
in the right hemisphere may play a significant role in formulating automatic expressions; because we know that other language processes are primarily controlled in the left hemisphere, this idea helps to explain why patients with left hemisphere damage retain formulaic speech.

The risk for developing aphasia after stroke is not only related to location and severity of the lesion. Kyrozis et al. (2009) noted many factors contributing to the development of post-stroke aphasia including left hemisphere stroke location, cardioembolic embolic stroke type, heart disease, female gender, diabetes, older age, and atrial fibrillation. Of these contributing factors, heart disease, female gender, and diabetes were found to be independent predictors of aphasia.

Acquired Dyslexia

In addition to aphasia, left-hemisphere stroke can result in one of several forms of acquired dyslexia, known as central reading syndromes (Small, Flores & Noll, 1998). These include surface dyslexia, phonological dyslexia, and deep dyslexia.

Patients with surface dyslexia read by relying on spelling rules (Small, Flores & Noll, 1998). Surface dyslexia is associated with intact ability to read regularly spelled words and non-words that comply with standard rules of spelling, but impaired ability to read irregularly spelled words (Brambati et al., 2009; Crisp & Lambon Ralph, 2006; Kendall, McNeil & Small, 1998). Brambati et al., and Crisp and Lambon Ralph find that surface dyslexia results from a deficit of the semantic system. Several studies have used a case-series design to demonstrate that accurate reading of irregularly spelled words
relates directly to semantic ability (Crisp & Lambon Ralph), which implies that individuals with impaired semantic skills cannot rely on meaning and context to help them read irregularly spelled words.

Patients with phonological dyslexia use whole-word reading instead of using spelling-sound relationships (Small, Flores & Noll, 1998). Phonological dyslexia results from a deficit of the phonological system while the semantic system remains intact (Brambati et al., 2009), and is therefore associated with the ability to read real-words, both regularly and irregularly spelled, but the inability to read non-words (Brambati et al.; Crisp & Lambon Ralph, 2006; Kendall, McNeil & Small, 1998; Small, Flores & Noll; Vliet, Miozzo & Stern, 2004). “Because nonwords depend more on orthography-phonology mapping, have less stable phonological representations, and do not benefit from the collateral support of semantics, conditions that alter the representation of phonological information are expected to have sizable effects on nonword reading” (Vliet, Miozzo & Stern, 2004, p. 583). Therefore, an individual with phonological dyslexia reads by recognizing previously memorized words, and benefits from the semantic context of sentences and paragraphs.

Deep dyslexia is similar to phonological dyslexia because it involves a discrepancy between the abilities to read real- and non-words (Kendall, McNeil & Small, 1998). However, deep dyslexia differs from phonological dyslexia because in addition to deficits in the phonological system, it also involves deficits of the semantic system (Crisp & Lambon Ralph, 2006; Small, Flores & Noll). The symptom of semantic errors distinguishes deep dyslexia from phonological dyslexia (Kendall, McNeil & Small).
While the exact anatomical causes of the central dyslexias are not yet known (Small, Flores & Noll, 1998), some correlations between lesions to general anatomical locations and symptoms of acquired reading deficits have been found. Brambati et al., (2009) assert that exception- and pseudo-word reading result from different language mechanisms as well as processes in different regions within the brain. They associated surface dyslexia with damage to the antero-lateral temporal cortex. Accurate exception-word reading specifically corresponded with an intact left antero-lateral temporal cortex and the anterior portion of the inferior frontal gyrus. The anterior fusiform gyrus is active during exception word reading and semantic tasks, making it an integral structure when translating orthography to phonology. Pseudo-word reading consistently corresponded with the left inferior parietal lobule, posterior inferior frontal gyrus, and posterior portion of the left fusiform gyrus, and was inconsistently linked to the left temporoparietal region.

General Rehabilitation Post-Stroke

If a stroke occurs, several treatments and rehabilitation options exist. Acute treatments, which attempt to stop a stroke in progress and thereby reduce its affects (Centers for Disease Control and Prevention, 2007) are most effective within the first few hours after the onset of symptoms (American Stroke Association, 2009). Acute treatments include (a) dissolving, removing or breaking up blockages, or (b) stopping bleeding (American Stroke Association; Centers for Disease Control and Prevention).
The acute treatments for an ischemic stroke are designed to remove the blockage interfering with cranial blood flow (American Stroke Association, 2009). A common acute treatment for ischemic strokes is intravenous administration of tissue plasminogen activator (tPA), a clot-dissolving agent that can greatly decrease the damage and subsequent disability caused by the stroke (National Stroke Association, 2009). If tPA is ineffective or cannot be used, Merci® Retriever, which removes blood clots, and the Penumbra System, which revascularizes blood vessels are two additional treatment options designed to restore blood flow to the brain. The acute treatments for a hemorrhagic stroke involve surgical procedures such as placing metal clips in the ruptured blood vessels to interrupt the bleed or physically removing the AVM (American Stroke Association).

Treatment and rehabilitation help stroke patients respond to the effects of their strokes. Treatment can help reduce the risk of an additional stroke (Centers for Disease Control and Prevention, 2007). Physical, occupational and speech therapy, sometimes in conjunction with psychological or psychiatric treatment help patients regain skills that are lost as a result of the stroke.

While some stroke-induced disabilities are long lasting requiring prolonged treatment, some immediate symptoms will resolve within the first 30 days after the stroke (American Heart Association, 2010). This is because initial swelling decreases naturally, allowing neurons that were disrupted by swelling but not killed by the stroke to resume functioning (National Stroke Association, 2009). In some cases, brain functions reorganize themselves naturally as intact regions of the brain take over the functions of
damaged regions. For skills that do not return naturally, therapy is available with the goal of rehabilitating the patient to the greatest level of independence possible. Rehabilitation options post-stroke commonly include (a) physical therapy, which helps restore gross motor skills such as walking, (b) occupational therapy, which helps restore fine motor skills necessary to carry out many activities of daily living such as dressing, and (c) speech/language therapy, which helps restore communication abilities such talking, reading, and writing.

Aphasia Rehabilitation

When addressing aphasia, the primary rehabilitation goal is to improve communication by regaining some language skills and by learning some new means of communication (National Stroke Association, 2009). Aphasia studies often investigate how to improve communication and word retrieval while achieving maximum generalization and long-term maintenance.

A cognitive neuropsychological approach tailors a treatment program based on individual assessment and an understanding of each client’s specific needs (Fisher, Wilshire, & Ponsford, 2009). In order to select appropriate therapy activities, the speech/language pathologist (SLP) must first understand the nature of the client’s impairment, including the client’s degree and type of impairment” (Croot et al., 2009). For example, the SLP should consider the type of cognitive impairment when deciding to use a syntactic or decreased cueing approach. Sentence length and complexity, or amount of cueing depends on the client’s degree of impairment. In addition to considering level
and degree of impairment, the SLP may structure therapy based on the hypothesized underlying cause of the condition.

The SLP may choose to use an *impairment-directed* or an *activity/participation-directed* approach (Croot et al., 2009). Impairment-directed interventions aim to rehabilitate deficits of ability, such word retrieval, syntactic structures, motor-speech, etc. Activity/participation-directed interventions are designed to improve a person’s ability or desire to participate in life situations, and may include the ability to communicate basic wants and needs, and to participate in social activities. The decision to use one of these approaches is made by the SLP in conjunction with the client and the client’s caregivers, considering the client’s functional needs and the gains the client is expected to retain once therapy has ceased. Croot et al. noted that clients who received impairment-directed therapy improved significantly on treated items, but not on untreated items; however, similar studies with more experimental control showed some evidence of generalization. Croot et al. also found that gains made by clients who received impairment-directed therapy were not maintained over a period of two months to one year.

If the client’s deficit is hypothesized to be semantically based, the SLP may choose a semantic treatment approach. Because left-hemisphere strokes often damage structures responsible for semantic representations, semantic treatments are appropriate to a wide variety of aphasia patients (Edmonds, Nadeau, & Kiran, 2009). Edmonds et al. noted that using a semantic approach may see greater generalization than naming therapy, because of shared semantic features between trained and untrained items.
Two specific semantic treatments are (a) encouraging semantic participation from the intact right hemisphere (Edmonds, Nadeau, & Kiran, 2009) and (b) explicitly teaching the semantic features of parts of speech, such as verbs (Conroy, Sage, & Lambon Ralph, 2009; Edmonds, Nadeau, & Kiran; Jokel et al., 2009). While the right hemisphere may hold some semantic knowledge, training is required in order for the right hemisphere to take over the majority of semantic representation (Edmonds, Nadeau, & Kiran).

Cognitive psychology and generative semantics theories propose that the verb identifies relationships between concepts and is therefore the representational core of simple sentence structure (Edmonds, Nadeau, & Kiran, 2009). Accessing the semantic information inherent to a particular verb should allow the client to access other verbs with similar semantic information (e.g., *jump* and *hop*). Conroy, Sage, and Lambon Ralph (2009) compared verbs to nouns and explained that verbs tend to be more difficult therapy targets than nouns for aphasic clients because verbs create greater cognitive and linguistic demands than nouns. While the verb-related studies preceding theirs did not produce significant generalization, Conroy, Sage, and Lambon Ralph and Jokel et al. reported positive results when using gestures to facilitate verb productions.

Patients with non-fluent aphasia may benefit from a syntactic approach to improve their sentence structure and to increase the length and complexity of their utterances. McCall et al. (2009) reviewed several studies aiming to improve aphasic sentence production by addressing specific syntactic structures. Their research indicated
that while studies showed improvement and generalization at the single sentence level, they rarely improved multi-sentence productions.

Jokel et al. (2009) investigated the efficacy of using word lists to improve word-finding abilities. Graham and colleagues as cited by Jokel et al. followed the use of word lists by a man with semantic dementia who kept written lists in notebooks to aid his practice retrieving words categorically. They found that this client’s word retrieval improved more for practiced words than for those not practiced.

*Contextual priming* is a technique that “strengthen[s] links between representations or increases resting levels of activations of representations themselves” (Croot et al., 2009, p. 139). It gives frequent repetition of sets of stimulus items in the form of pictures and written words that are either unrelated, phonologically related, semantically related, or both phonologically and semantically related (Fisher, Wilshire, & Ponsford, 2009). After using contextual priming, word-finding gains in all conditions were maintained 1.5-5 months after treatment was ceased. These gains also generalized to untrained items.

*Errorless learning* provides the client with as many cues as necessary to provide practice without producing errors. Errorless learning only reinforces correct associations (Croot et al., 2009). As the client’s naming abilities improve, the cueing is decreased as appropriate to maintain errorless production. Decreasing cueing provides an individualized therapy program that increases in difficulty as the client improves. Another form of errorless therapy is *spaced retrieval*, which attempts to improve naming skills by requiring productions over progressively greater lengths of time. While the
theory of errorless learning sounds promising, results are inconclusive as some studies indicate that decreased cueing alone does not produce long-term improvement in naming abilities (Conroy, Sage, & Lambon Ralph, 2009; Croot et al.) while others indicate that it does (Conroy, Sage, & Lambon Ralph). Research does not reveal a difference between spaced retrieval training and simple repetition, which requires the same number of productions as spaced retrieval, but does not increase time intervals between productions (Croot et al.). Conroy, Sage, and Lambon Ralph found that both errorless and errorful learning were equally effective. Errorful learning allows clients to make errors. Research finds errorful learning without feedback to be equivalent to no treatment, and errorful learning with feedback to be equivalent to errorless learning. Whether errorless or errorful therapy is more effective, clients who received both forms of therapy initially preferred errorless therapy with decreased cueing (Conroy, Sage, & Lambon Ralph, 2009). As therapy progressed, patients with more severe naming impairments continue to prefer errorless therapy while those with mild-moderate impairments began to find it tedious and intrusive as their skills improved. Participants with mild-moderate impairments reported that over time the errorful therapy provided some challenge while still allowing them to progress.

Life participation refers to a client’s ability or willingness to socialize and participate in life-enriching activities (Avent et al., 2009). Improved life participation is being recognized as an important indicator of effective aphasia therapy, but clinicians and researchers do not generally agree upon how to measure and improve life participation. One method of improving life participation is known as reciprocal scaffolding treatment.
(RST). RST involves communication about a particular topic between an *expert* who has knowledge of a topic and *novices* who are taught by the expert. Avent et al. used RST to improve the life participation of one client by putting him in the conversational role of expert. This exercise also improved his verbal fluency and use of drawing and writing for communication.

Several studies have shown that personal meaningfulness plays an important role in an aphasic person’s ability to retrieve defining information about learned words (Jokel et al., 2009). In order to ensure maintenance after therapy, it is necessary that trained items be highly functional to insure that they are personally meaningful to the client (Croot et al., 2009).

Using computer-based programs for part or all of aphasia treatment is increasing in popularity (Jokel et al., 2009). Jokel et al. used *MossTalk Words®,* a computer program using pictures and word lists to treat clients with word retrieval deficits. Each participant in their study was given three lists of 20 pictures to name from the *MossTalk* list, each containing pictures the participant could easily name, and pictures the client could not name during testing. They used a hierarchical cueing schedule of written initial letter, and written whole words, and Cued Naming, using the most minimal cueing necessary for each word. Participants were trained on one list until they reached a maximum of 12 treatment sessions or 80% accuracy across two probes. Participants received three sessions per week of either entirely clinician-led treatment or partially self-guided treatment. All clients treated with *MossTalk Words®* improved and they found
evidence of generalization one month after treatment. However, it was noted that greater maintenance post therapy was associated with greater intensity of therapy.

McCall et al. (2009) used *SentenceShaper®*, another computer program that supports speakers’ productions while they are being formulated, to improve aphasic sentence structure. They found that using a computer program to aid target production improved their client’s sentence production. *SentenceShaper®* helped teach McCall et al.’s client to plan sentences in small segments.

RAVE-O

*Retrieval, Automaticity, Vocabulary-Elaboration, Orthography* (RAVE-O) is a reading program associated with researchers at Tufts University’s Center for Reading and Language Research (The Center for Reading Language Research, 2005). It was designed to improve specific and global reading skills in the primary school grades (Wolf, Miller & Donnelly, 2000). RAVE-O uses a comprehensive approach to improving reading fluency by incorporating phonological awareness and orthographic and semantic knowledge (The Center for Reading and Language Research; Wolf, Miller & Donnelly). RAVE-O was designed to work in conjunction with an explicit phonemic awareness program, noting the importance of phonological awareness skills when comprehending written language. The two primary focuses of RAVE-O are (a) fluency in reading outcomes such as word identification, word attack, and comprehension and (b) automaticity in the underlying skills necessary to read fluently, such as orthographic,
phonological, semantic, and lexical retrieval (Wolf, Miller & Donnelly). Wolf, Miller and Donnelly (p. 377) define fluency as “the acquisition of smooth rates of processing speed in reading outcomes” and automaticity as “a continuum in which processes are considered automatic when they are fast, obligatory, and autonomous and require only limited use of cognitive resources.” Improved fluency and automaticity contributes to improved overall reading comprehension.

RAVE-O uses multiple modalities and a metacognitive approach to aid long-term memory and enhance reading fluency and automaticity (Wolf, Miller & Donnelly, 2000). Multiple modalities are addressed with core words, image cards, color-coded orthographic pattern cards, and word webs. A metacognitive approach teaches readers to become word detectives and ask four specific questions to identify unknown words in writing, and to aid word finding production in oral language.

The RAVE-O program includes explicit phonological awareness training, beginning with individual phonemes and moving quickly to common letter patterns including those phonemes (Wolf, Miller & Donnelly, 2000). Consonant blends and digraphs, onset-rimes, and common affixes are introduced gradually. Phonological awareness sets the foundation for later literacy skills.

A set of approximately five core words is presented weekly with image cards depicting the various meanings associated with each core word (The Center for Reading and Language Research, 2005; Wolf, Miller & Donnelly, 2000). Each of the weekly core words serves as a springboard for learning multiple features of linguistic information (The Center for Reading and Language Research). The words are specifically chosen for
their “(a) systematically introduced phonemes…(b) connected orthographic patterns (e.g.,
rimes, consonant blends) that employ these phonemes, and (c) multiple meanings and
rich associations attached to each meaning” (Wolf, Miller & Donnelly, 2000, p. 378).
Learning these words provides a foundation for future decoding by teaching students to
recognize sublexical units in words and by developing their semantic flexibility (The
Center for Reading and Language Research). By introducing frequent exposure to the
most common sets of phoneme patterns rather than individual phonemes, RAVE-O
improves rapid word identification more efficiently than teaching students to decode
letter-by-letter (Wolf, Miller & Donnelly). Rapid word identification gives readers time
to process multiple meanings of words, giving them access to the richness of written
language. Teaching multiple meaning words increases the students’ general knowledge
and understanding of the words, allowing for more rapid word identification and reading
comprehension (The Center for Reading and Language Research; Wolf, Miller &
Donnelly). Multiple meanings of core words are taught with their idiomatic uses and in
jokes to increase students’ flexibility with language to combat the inflexibility toward
words of many impaired readers (Wolf, Miller & Donnelly). With each set of core words,
students create word webs to build further connections between the meanings of each
word.

To continue strengthening the foundation of phonological awareness while also
building reading fluency, the multiple meaning words are also taught with spelling cards
that separate onset from rime (The Center for Reading and Language Research, 2005;
Wolf, Miller & Donnelly, 2000). Students use these cards to construct their core words as
well as additional words with the same rime (The Center for Reading and Language Research). These onset-rime cards offer numerous activities and games to provide practice with common orthographic patterns and their associated sublexical units. Because the onsets and rimes can be manipulated independently, these cards also help develop flexibility with morphological units. As students develop mastery with the core words, a set of computer games called Speed Wizards is introduced to increase rapid recognition of orthographic patterns and sublexical units constructing simple, compound, and nonwords (The Center for Reading and Language Research; Wolf, Miller & Donnelly).

A series of *minute stories* was developed to emphasize the multiple meanings of each week’s set of core words (The Center for Reading and Language Research, 2005; Wolf, Miller & Donnelly, 2000). The minute stories provide contextual reading opportunities for students to practice their developing orthographic and semantic skills (Wolf, Miller & Donnelly). Writing activities accompany the minute stories to offer yet another modality of learning to the students’ literacy development. These activities are introduced according to the students’ skills and abilities and focus on reading comprehension, vocabulary use, and self-expression.

Additional activities and games help teach and reinforce literacy skills. *Word Wall Bricks* are large cards printed with the core words intended to be used for displaying word-webs on classroom walls (The Center for Reading and Language Research, 2005). *Dice* are printed with rime patterns, onsets, and prefixes/suffixes; they are thrown as typical dice, and students read the combinations that result. *Sound Sliders* are folders with
rime patterns and onsets printed separately so the students can match them to construct real and non-words to practice reading.

RAVE-O as Stroke Treatment

While RAVE-O was designed for children with reading deficits, its focus addresses symptoms that are also features of the acquired dyslexias associated with aphasia. These include the impaired semantic representations (The Center for Reading and Language Research, 2005; Wolf, Miller & Donnelly, 2000) associated with surface- and deep dyslexia (Brambati et al., 2009; Crisp & Lambon Ralph, 2006), and the impaired phonological system and spelling-to-sound correspondences (The Center for Reading and Language Research; Wolf, Miller & Donnelly) associated with phonological- and deep dyslexia (Brambati et al.; Small, Flores & Noll, 1998).

Elements of effective aphasia treatments are noted within the RAVE-O methodology. These include teaching semantic features of words (The Center for Reading and Language Research, 2005; Wolf, Miller & Donnelly, 2000), using computer-based activities, and creating a high level of meaningfulness for core words and phoneme combinations by discussing previous knowledge of core words and by contextualizing learning with minute stories including core words and practiced phoneme sequences. RAVE-O also improves upon the previously discussed concept of using word lists by combining semantic teaching with core-word flash cards, and by using separated onset-rime cards to allow development of flexibility with reading and word recognition. Additionally, RAVE-O can contribute to improved life participation because “being
literate confirms an individual’s social identity as a ‘full participant in the community’” (Silliman & Wilkinson, as cited by Goldsworthy, 2003, p. 23).

Despite the similarities between RAVE-O and effective aphasia treatments, RAVE-O methodology has not been investigated as an aphasia treatment in its own right, nor has its efficacy for treating acquired dyslexia been explored. The purpose of this study was to investigate whether a modified RAVE-O approach could be used as a post-stroke treatment for adults with acquired dyslexia associated with aphasia.
Chapter 2

METHODS

Participant

The participant in this study was a 53-year-old woman with aphasia secondary to stroke, who was a client at the Maryjane Rees Language, Speech and Hearing Center at the California State University of Sacramento. The participant was considered eligible to participate in this study because she had experienced a stroke within the 12 months prior to the study, had shown a deficit in literacy skills secondary to her stroke, had voluntarily sought therapy to remediate language and reading deficits, and had had no language or reading deficits prior to her stroke.

Six weeks prior to this study, the participant experienced a left hemisphere stroke, which left her with a sudden inability to read. A CT scan revealed evidence of both an ischemic and a hemorrhagic stroke.

According to results of the Reading Comprehension Battery for Aphasia (RCBA), the participant’s reading comprehension was severely impaired, especially beyond the sentence level. Results are summarized in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Subtest</th>
<th>% Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Reading</td>
<td>50</td>
</tr>
<tr>
<td>Sentence—Picture</td>
<td>80</td>
</tr>
<tr>
<td>Paragraph—Picture</td>
<td>40</td>
</tr>
<tr>
<td>Paragraph—Factual and Inferential Comprehension</td>
<td>Could Not Complete</td>
</tr>
</tbody>
</table>
The “Functional Reading” subtest required the participant to read words commonly found in the environment (e.g., “Men” and “Women” restroom-door signs and calendars). “Sentence—Picture” and “Paragraph—Picture” required her to comprehend written sentences and paragraphs, respectively, with the help of visual supports, while “Paragraph—Factual and Inferential Comprehension” required her to comprehend written paragraphs without the help of visual supports. The participant could not complete the “Paragraph—Factual and Inferential Comprehension” because her reading comprehension greatly decreased with the increased length and removal of visual aids. Throughout the testing administration, her response latency was consistently greater than 30 seconds.

The participant’s reading accuracy was consistent with a diagnosis of acquired phonological dyslexia, characterized by greater difficulty reading complex, uncommon, and non-words than simple, common words, as well as an inability to make sound-symbol associations. Her expressive language was consistent with non-fluent aphasia, characterized by occasional paraphasias, short utterances, slow rate of speech, and mild-moderate word finding difficulty.

Materials

The participant signed an informed-consent form agreeing to participate in this study. Prior to therapy, the participant was formally assessed by the researcher using the RCBA, which was designed to assess the literacy skills of adult stroke clients. She was also informally assessed by the researcher using flashcards and word lists.
The researcher created a storybook containing the following elements: 1-2 sentences per page; photographs; and a combination of single- and multi-syllabic words, simple and complex words, and single- and multiple-meaning words. A modified RAVE-O kit, which was created by the researcher to correspond with the storybook, was used throughout the study. The modified RAVE-O kit included ten flash cards for each of five common word families (-ash, -ip, -ack, -op, -ad), five multiple-meaning words including idiomatic meanings (mad, chip, sign, feet, shop) with picture representations of each meaning, word webs utilizing wh- questions to associate multiple-meaning words with their various definitions, and a journal. All word families and multiple-meaning words were found in the storybook.

Each therapy session was recorded with a digital voice recorder for the researcher’s later review. These recordings were destroyed at the completion of the study according to the participant’s instructions.

Procedures

The participant was tested, treated and monitored by the researcher, who was a supervised graduate student at the Center. This study used a case study design in which the participant’s performance was monitored individually for improvement. Therapy was conducted in an individual setting between the participant and the researcher for the duration of the study and was scheduled to take place twice weekly for 50-minute sessions during the 12-week semester of Fall 2009. Due to participant illness and campus furloughs, the participant completed 15 out of 24 possible sessions.
After analyzing the results from the above testing, three of the participant’s clinic therapy goals were determined to be appropriate for participation in this study: (1) improved reading comprehension and expressive and receptive language, (2) improved speed and accuracy of reading words from five word families, and (3) demonstrated knowledge of multiple meaning words. The participant’s progress toward meeting these goals was recorded during each session, and probes to determine generalization were administered halfway through the study and at the completion of the study.

The participant’s literacy goals were addressed using the modified RAVE-O kit for a minimum of 15 minutes during each therapy session and corresponding weekly homework was assigned. Due to time constraints, modified RAVE-O activities were limited to word families and multiple-meaning core words.

At the start of the study, the storybook was introduced, along with one multiple-meaning word and two word families. A new multiple-meaning word was introduced when the participant could correctly use each meaning of previously taught words in a sentence and answer wh- questions from her word-web with 90% accuracy. New word families were introduced when the participant could read ten words from previously taught word families with 90% accuracy, and could recognize and accurately read 90% of previous taught words in two seconds.

Each session began with the participant reading her storybook with help as needed from the researcher. During the reading, any multiple-meaning words the participant had been taught were discussed, and any word families the participant had been taught were pointed out. The participant was asked comprehension questions at different points
during each reading to monitor her comprehension of the story. After the reading, the participant practiced reading word-family flash cards, first sorted by family, and then with all families mixed at random. Last, the participant used her multiple-meaning words in sentences and used her word webs to answer wh- questions about each word.

The participant’s journal was designed to record word families, multiple-meaning words, and wordwebs. As new word families were introduced, she wrote ten words containing the new word family to practice reading at home. As new multiple-meaning words were introduced, the participant wrote the meanings in the style of a dictionary, as well as a sentence appropriately using each meaning. The last section of the journal was reserved for writing word webs for multiple-meaning words, but she elected to use manipulative cards to represent her word webs instead of writing them in her journal.

The participant was given homework after every session: (a) practice reading her word lists for each word family at home with the help of a family member every day, and (b) write at least one sentence for each meaning of each multiple-meaning word each week. Throughout the duration of the study, the participant’s progress toward her goals was recorded by the researcher.
Chapter 3

RESULTS

Pre-treatment data was collected and compared to the participant’s reading accuracy with words containing trained word families on probes during and after treatment. At the time of the pre-treatment testing, the participant’s response latency averaged four seconds per word that contained the selected word families. She also reported that she did not recognize words as she read them and was unaware of whether she was reading accurately. At the time of the pre-treatment testing, the participant was tested reading ten words each from the “ack,” “ad,” “ash,” “op,” and “ip” families. Her accuracy reading single-syllable words categorized by word family before training was 90% for the “ack,” “ad,” “ash,” and “op” families and 100% for the “ip” family. Her overall accuracy was 92%.

Mid- and post-treatment probes consisted of lists of untrained words containing the addressed word families. Twenty-six words contained the “ad” family, of which eight were one-syllable words, eighteen were two-or-more-syllable words, eight ended in the “ad” family, and eighteen contained the “ad” family somewhere in the middle of the word. Twenty-five words contained the “ip” family, of which twelve were one-syllable words, thirteen were two-or-more-syllable words, twelve contained the “ip” family at the end of the word, and thirteen contained the “ip” family somewhere in the middle of the word. Twenty-four words contained the “ash” family, of which ten were one-syllable words, fourteen were two-or-more-syllable words, ten contained the “ash” family at the end of the word, and fourteen contained the “ash” family somewhere in the middle of the
word. The post-treatment probe also included words containing the “op” family, which were not probed mid-treatment because no words from this family had yet been trained. Twenty-six words during the post-treatment probe contained the “op” family, of which five were one-syllable words, twenty-one were two-or-more-syllable words, five contained the “op” family at the end of the word, and twenty-one contained the “op” family somewhere in the middle of the word.

A mid-treatment probe revealed a decrease in the participant’s response time and an improvement in her self-monitoring. At the time of the mid-treatment probe, her response latency averaged one second per word, and when she read a word incorrectly, she either self-corrected or asked for assistance. Table 2 summarizes the participant’s reading accuracy of untrained one- and two-or-more-syllable words from trained word families.

A post-treatment probe did not show additional improvement in the participant’s response time or self-monitoring beyond that noted in the mid-treatment probe. Her response latency continued to average one second per word, and she preferred to ask for assistance rather than self-correct for incorrectly read words. Table 3 summarizes the participant’s reading accuracy of untrained one- and two-or-more-syllable words containing all trained word families. Table 4 compares the participant’s overall reading accuracy during the mid-treatment probe, and her overall accuracy reading only those same word families during the post-treatment probe. Overall accuracy was calculated by adding the correct productions of single syllable words for each word-family and dividing
them by the total number of single syllable words; this process was repeated for the two- or-more-syllable words.

Table 2
Mid-Treatment Percent-Accuracy Reading Untrained Words

<table>
<thead>
<tr>
<th>Word Families</th>
<th>Correct on First Try</th>
<th>Self Corrected</th>
<th>With Assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Syllable 2+ Syllables</td>
<td>1 Syllable 2+ Syllables</td>
<td>1 Syllable 2+ Syllables</td>
</tr>
<tr>
<td>“ack”</td>
<td>60 21</td>
<td>30 29</td>
<td>10 50</td>
</tr>
<tr>
<td>“ad”</td>
<td>88 61</td>
<td>12 11</td>
<td>0 28</td>
</tr>
<tr>
<td>“ip”</td>
<td>69 39</td>
<td>15 38</td>
<td>15 23</td>
</tr>
<tr>
<td>Overall Accuracy</td>
<td>72 40</td>
<td>19 26</td>
<td>9 34</td>
</tr>
</tbody>
</table>

Table 3
Post-Treatment Percent-Accuracy Reading Untrained Words

<table>
<thead>
<tr>
<th>Word Families</th>
<th>Correct on First Try</th>
<th>Self Corrected</th>
<th>With Assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 Syllable 2+ Syllables</td>
<td>1 Syllable 2+ Syllables</td>
<td>1 Syllable 2+ Syllables</td>
</tr>
<tr>
<td>“ack”</td>
<td>55 86</td>
<td>18 0</td>
<td>27 14</td>
</tr>
<tr>
<td>“ad”</td>
<td>88 44</td>
<td>0 6</td>
<td>12 50</td>
</tr>
<tr>
<td>“ip”</td>
<td>77 46</td>
<td>8 15</td>
<td>15 39</td>
</tr>
<tr>
<td>“ash”</td>
<td>60 50</td>
<td>0 0</td>
<td>40 50</td>
</tr>
<tr>
<td>“op”</td>
<td>80 57</td>
<td>20 10</td>
<td>0 33</td>
</tr>
<tr>
<td>Overall Accuracy</td>
<td>72 59</td>
<td>9 7</td>
<td>19 34</td>
</tr>
</tbody>
</table>

Table 4
Comparison of Overall Mid- and Post-Treatment Percent Accuracy

<table>
<thead>
<tr>
<th></th>
<th>Correct on First Try</th>
<th>Self Corrected</th>
<th>With Assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-Treatment</td>
<td>72 40</td>
<td>19 26</td>
<td>9 34</td>
</tr>
<tr>
<td>Post-Treatment</td>
<td>72 59</td>
<td>9 7</td>
<td>19 34</td>
</tr>
</tbody>
</table>

Pre-treatment data compared the participant’s knowledge of multiple meaning words after treatment. At the time of pre-treatment testing, she did not understand the concept that words could have more than one meaning. During the course of the study,
the participant was taught two or more meanings of each of five multiple meaning words. Post-treatment testing revealed that the client remembered alternate meanings of the trained words. She did not understand the alternate meanings of untrained multiple meaning words presented to her, but she understood that words could have more than one meaning, and she verbalized that if she did not understand what a person said, it could be because the speaker intended word meanings she did not know.
Chapter 4

CONCLUSIONS

The purpose of this study was to investigate the efficacy of using a modified RAVE-O approach, which was designed to support literacy for early elementary school students, with an adult stroke patient with acquired dyslexia and aphasia secondary to stroke. The participant in this study was a 53-year-old woman who had experienced a left hemisphere stroke, which resulted in symptoms consistent with non-fluent aphasia and acquired phonological dyslexia. She was trained to read ten words from each of five word families, and was taught alternate meanings of five multiple meaning words.

The participant’s reading was tested pre-, mid- and post-treatment to determine whether her ability to read selected word families was generalizing beyond the trained words from each family. During the mid-treatment probe, the participant did not show a significant overall improvement in her independent accuracy reading one-syllable words; however, her accuracy reading one-syllable “ad” family words improved from 90 to 100%. Two syllable words were not probed pre-treatment. While overall accuracy did not improve by the mid-treatment probe, her response latency decreased from an average of four seconds to an average of one second per word, and she began to recognize accurate and inaccurate reading as demonstrated by her ability to self-correct or request assistance for incorrectly read words. During the mid-treatment probe, the participant was not able to read two-syllable words accurately without assistance; however, she was able to identify and read the syllable with the word families she had been taught, which indicated a growing recognition of trained word families.
During the post-treatment probe, the participant’s overall accuracy reading word families in untrained words appeared to decrease; however, at that time, the participant was highly concerned with first-attempt accuracy, and preferred to request assistance rather than to self-correct. If she had attempted to self-correct more words or had not been provided with assistance, her first-attempt and self-corrected accuracy may have been higher. It should also be noted that the participant’s response latency during the post-treatment probe was often less than one second per correctly read word, indicating more rapid sound-symbol association and/or word recognition.

Post-treatment data did not reveal generalization of the client’s ability to understand or predict multiple meanings of untrained words; however, post-treatment she demonstrated a sound understanding of the concept that words often have more than one meaning. She also developed a strategy of asking a speaker to rephrase statements she did not understand. This was noted in statements that contained words with multiple-meanings that she did not know.

This study could have been modified by reducing the amount of time spent with word families during sessions, and increasing the amount of time spent with multiple meaning words. As the participant gained confidence with the word families, she was motivated to practice reading them outside of therapy. Because multiple meaning words were more challenging for her, she was uncomfortable studying them without the researcher’s assistance. By requiring her to practice word families more independently, the researcher would have been allowed a greater amount of time to address multiple meaning words, which may have increased her improvements in that area. This study also
could have been modified by teaching word families in multi-syllabic words in addition to single-syllabic words, which may have helped generalize the participant’s word-family reading skills.

Results of this study are inconclusive regarding the use of a modified RAVE-O approach to treat acquired dyslexia and aphasia post-stroke. The results do indicate some general reading and language improvements of the participant as demonstrated by her increased comfort and speed while reading, her awareness of incorrectly and correctly read words, and her understanding of the concept of multiple-meaning words. Because the participant attended 15 of 24 allotted sessions, it is unknown whether attending a greater number of sessions would have resulted in greater improvement.

Future research in this area may consider including training a caregiver to practice with the participant outside of therapy, which may result in faster, more noticeable improvement. Including a caregiver in the treatment may also increase the chances of the participant continuing to practice independently post-treatment. An ideal participant for further study would be more than six months post-stroke to increase the chances that gains result from therapy and not from spontaneous recovery. Because the three types of acquired dyslexia differ from one another in areas of real- and non-word reading, whole-word and spelling-sound relationship reading, and the presence or absence of semantic errors, future research with a modified RAVE-O approach should consider differing the amounts of time spent with word families and multiple-meaning words to emphasize either decoding or semantic ability as appropriate within the different acquired dyslexia types.
REFERENCES


