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REVIEW



Reading comprehension treatment in aphasia: a systematic review

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ABSTRACT

Background: Reading difficulties often present as a consequence of aphasia. The specific nature of reading deficits varies widely in manifestation, and the cause of these deficits may be the result of a phonological, lexical semantic, or cognitive impairment. Several treatments have been developed to address a range of impairments underlying reading difficulty.

Aims: The purpose of this review is to describe the current research on reading comprehension treatments for persons with aphasia, assess the quality of the research, and summarize treatment outcomes.

Methods & Procedures: A systematic review of the literature was conducted based on a set of a priori questions, inclusion/exclusion criteria, and pre-determined search parameters. Results were summarized according to treatment type, methodologic rigor, and outcomes.

Outcomes & Results: Fifteen studies meeting criteria were identified. A variety of reading comprehension treatments was implemented including: oral reading, strategy-based, cognitive treatment, and hierarchical reading treatments. Quality ratings were highly variable, ranging from 3 to 9 (on a 12-point scale). Overall, 14 of the 18 individuals for whom individual data were provided demonstrated some degree of improvement (oral reading 4/5 participants, strategy based 4/6, and cognitive treatment 6/7). Gains were also evident for hierarchical reading treatment administered to participant groups via computer; however, the degree to which improvement reached statistical significance varied among studies.

Conclusions: Reading comprehension treatments have the potential to improve reading comprehension ability in persons with aphasia; however, outcomes were variable within and among treatment methods. We suggest focusing future research on factors such as participant candidacy and treatment intensity using increased methodological rigor.

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Reading difficulties often present as a consequence of aphasia. Persons with aphasia (PWA) who experience reading deficits may also experience a reduced quality of life (Lee, Lee, Choi, & Pyun, 2015). They may be unable to fully participate in routine, leisure, and vocational activities because reading is required for daily activities (e.g., understanding written instructions, menus, and bank statements), success in the work environment (Penn & Jones, 2000), and participation in social communication activities (Howe, Worrall, & Hickson, 2008; Nätterlund, 2010). The specific nature of reading deficits in aphasia varies widely both in manifestation and in underlying impairment. Deficits may appear in oral reading and/or in comprehension of printed material, and at the single word and/or text level. The underlying cause of a reading deficit may be the result of a phonological, lexical, semantic, and/or cognitive impairment.

Considering the variable nature of reading disorders, it is critical that treatment selected for a PWA with a reading disorder matches the manifestation and underlying impairment. For example, reading deficits stemming from an underlying impairment in phonology disrupt the grapheme to phoneme correspondence and therefore the ability to sound out words (Beeson, Rising, Kim, & Rapcsak, 2010). It follows then that treatment for this reading disorder, phonological alexia, targets single-word reading (Whitworth, Webster, & Howard, 2013) to improve oral reading by training phonological awareness and decoding (e.g., Brookshire, Conway, Pompon, Oelke, & Kendall, 2014; Friedman & Lott, 2002; Kendall, Conway, Rosenbek, & Gonzalez Rothi, 2003). In contrast, if the reading disorder manifests at the level of comprehension, treatment typically proceeds at the text level with varying contributors to the underlying impairment to consider. For example, consider that at the text level cognitive skills operate in parallel with linguistic skills thus allowing the reader to construct the meaning of what is read (Perfetti, 2000). The reader must continuously attend to the text to quickly decode the printed information and access semantic and grammatical knowledge. Using this knowledge, the reader applies inference skills to extract meaning from text (Long & Chong, 2001) and establish referential coherence by linking successive elements. Inference requires the reader to use world knowledge to establish context (Fincher-Kiefer, 2001; Perfetti, 2000; Rinck & Bower, 2000) and to develop prediction about upcoming content. Working memory is a key mediator in reading comprehension ability (Meteyard, Bruce, & Edmundson et al., 2015) because it actively maintains inferential, contextual, and predictive information, and also because it is important in allocating attention and controlling identification of relevant information at any one moment in time (McVay & Kane, 2012). Finally, application of meta-cognitive strategies allows the reader to monitor comprehension and address instances of miscomprehension (Kletzien, 1991; Mokhtari & Reichard, 2002; Oakhill, Hartt, & Samols, 2005; Schreiber, 2005). In recognition of the skills in support of text comprehension, several studies have reported treatment for PWA who have reading disorders at the text level (e.g., Lynch, Damico, Damico, Tetnowski, & Tetnowski, 2009; Mayer & Murray, 2002; Webster et al., 2013).

Treatment foci for reading disorders are numerous, targeting the level of material (single word or text), the behavioral response (oral reading or comprehension of written material), or the underlying impairment (e.g., grapheme-phoneme conversion or inference). The focus of the current systematic review is treatment for the behavioral response of reading comprehension. Watter, Copely, and Finch (2016) completed a systematic review of a broad range of treatment approaches that directly or indirectly

targeted text-level reading comprehension treatments for individuals with reading difficulties resulting from acquired brain injury (ABI) (e.g., stroke, traumatic brain injury). The authors identified 23 articles that addressed reading comprehension treatment, and categorized these treatments into six different approaches: hierarchical reading; oral reading treatments; strategy-based interventions; cognitive treatments; mixed interventions; and compensatory/facilitative interventions. Watter et al. (2016) reported that in 18 of the 23 studies they reviewed, at least one participant in each study made improvement on a reading comprehension outcome measure. Crucial to understanding the value of treatment for reading comprehension in PWA are two points made by Watter et al. First, they noted the variation in methodological quality of the studies in their review, leading to muted conclusions about treatment effectiveness. Second, they acknowledged that combining studies of participants with various types of ABI precluded the ability to draw conclusions about treatment effectiveness for a specific treatment approach or individual participant group. Bearing in mind these caveats, the focus of the current review was narrowed to include only PWA.

The current systematic review, conducted by the Evidence-Based Clinical Research Committee of the Academy of Neurologic Communication Disorders and Sciences, examined reading comprehension treatment studies in individuals with aphasia as a result of a stroke. By restricting participant inclusion criterion to aphasia following stroke, and the clinical question to examine only the behavioral response of reading comprehension, we provide a clear foundation for understanding the effects of treatment for disorders of reading comprehension in this population. To this end, the objectives of this project were to (a) identify treatment studies for reading disorders in which the participants had aphasia due to stroke and in which reading comprehension was the primary outcome variable; (b) provide a description of the reading comprehension interventions; (c) assess the quality of each study; and; (d) summarize the treatment outcomes, including generalization and maintenance, for each intervention approach relative to participant characteristics and the study quality.

Method

Search strategy

A literature search was conducted using Medline, PsychArticles, PsychInfo, and CINAHL databases to identify studies contained in electronic databases up to 2016 that reported treatment for disorders of reading comprehension in PWA (see [Figure 1](#)). Using combinations of keywords to identify the target population (aphasia, dysphasia) AND disability (alexia, dyslexia, reading, reading comprehension, functional reading) AND therapy (therapy, treatment, intervention, training, remediation), the search produced 1494 articles. Adding three population and publication delimiters (adult, English, and peer reviewed publications) reduced the number of articles to 1286, and eliminating duplicate articles further reduced the number to 273. Titles of these 273 articles were examined to eliminate those reporting results for participants with disorders other than aphasia (NOT progressive, NOT dementia, NOT tumor, NOT traumatic brain injury), reducing the number of relevant articles to 133. The abstract of each of these papers was independently reviewed by two authors to determine the purpose of the study,

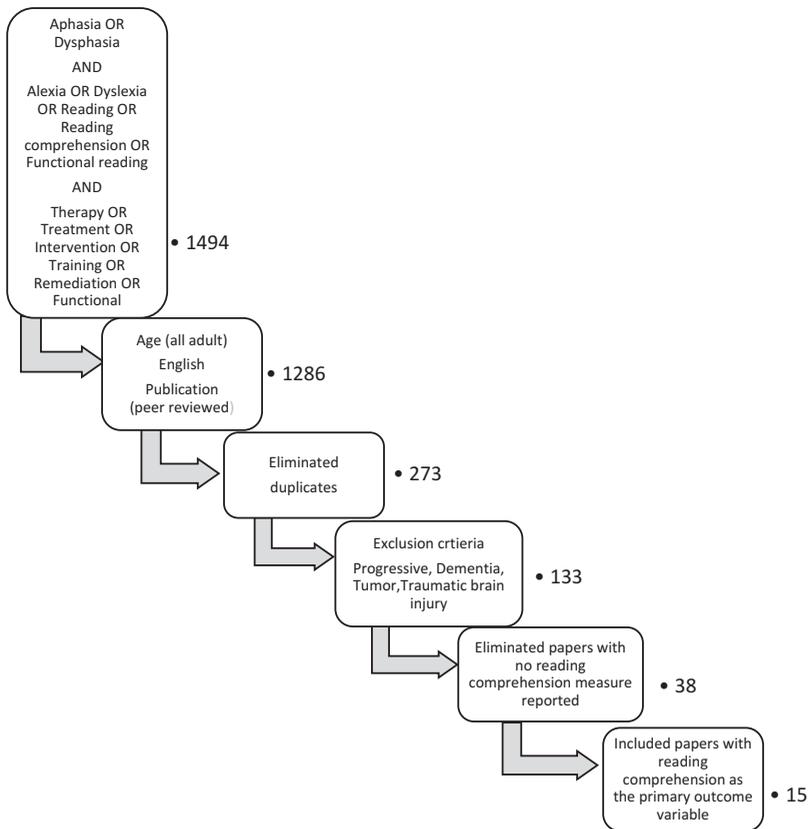


Figure 1. Search process and resulting number of studies.

participant inclusion and exclusion criteria, and the presence of a reading comprehension outcome measure; this produced 38 articles. Finally, each of these 38 articles was independently reviewed by two of the authors to determine if the article explicitly stated that the treatment protocol was designed to treat disorders of reading comprehension in PWA; articles were eliminated if treatment for reading comprehension disorders was not explicitly stated. As a result of this search process, 15 articles were included in this review.

Each of these 15 articles was then examined to determine the stated purpose of the treatment and the specific treatment activities and procedures. Four categories of treatment procedure emerged: oral reading treatment, strategy-based reading treatment, cognitive-based reading treatment, and hierarchical reading treatment.

Review of methodological quality

Ten of the 15 articles included in this review used a single-case research design and the methodological quality of these papers was evaluated using the Single-Case Experimental Design+ scale (SCED+) (Cherney, Simmons-Mackie, Raymer, Armstrong, & Holland, 2013). The SCED+ contains 13 items, 11 of which appeared in the original SCED scale (Tate et al., 2008). The two additional items in the SCED+ scale are treatment

fidelity (i.e., the accuracy of adherence to the treatment protocol) and treatment replicability (i.e., the clear description of treatment procedures so that clinicians or researchers can accurately reproduce the treatment) (Cherney et al., 2013). Of the 13 items in the SCED+, 12 are used to derive the quality score of an article; the item *reporting clinical history* was not included in the quality score in adherence with the SCED+ directions.

Each of the 10 papers using a single-case design was independently reviewed by two of the authors using the SCED+ scale. Initial interrater reliability for quality score was 90%; discrepancies were discussed by the two reviewers until agreement on the quality score was achieved.

Five of the 15 papers were randomized controlled trials (RCTs) or group studies. The methodological quality of these studies was evaluated using the Physiotherapy Evidence Database+ scale (PEDro+) (Cherney et al., 2013). The PEDro+ is a combination of the 11 items of the Physiotherapy Evidence Database scale (PEDro; <http://www.pedro.org.au/>) (Herbert, Moseley, & Sherrington, 1998–1999), plus treatment fidelity and treatment replicability, similar to the addition to SCED+ (Cherney et al., 2013). Of the 13 items in the PEDro + scale, 12 are used to derive the quality score of an article; the item *eligibility specified* was not included in the quality score in adherence with the PEDro+ directions.

Each of the five papers reporting group data was independently reviewed by two of the authors using the PEDro+ scale. Initial interrater reliability for quality score was 92%; discrepancies were discussed by the two reviewers until agreement on quality score was achieved.

Results

The following sections report the methodological quality scores of the 15 studies included in this review, describe the participants who received treatment for reading comprehension, and present detailed discussion of individual studies grouped according to treatment category.

Methodological quality

Single-case studies

The SCED+ scores for the 10 single-case design articles ranged from 3 to 9 with a mean of 5.9 out of 12 possible points. Table 1 shows ratings for each item in each study. Looking across the 10 studies included in this review, the SCED+ scale items most often appearing in the reviewed studies included: *Target behaviors defined*, (10), *Generalization* (9), *Treatment procedure clearly described* (8), and *Raw data included* (8). The remaining SCED+ items were identified less often: *Behavior sampled during treatment* (6), *Design phases identified* (6), *Statistical analyses reported* (4), *Baseline sufficient* (3), *Treatment fidelity reported* (2), *Inter-rater reliability reported* (2), *Replicated across participants* (1), and *Independence of assessors* (0).

RCTs and group studies

The PEDro+ scores for the five studies using a group research design ranged from 6 to 8, with a mean of 7.6 out of 12. Table 2 shows ratings for each item in each study. Comparing the five studies included in this review, the PEDro+ scale items most frequently identified were *Groups similar on key values* (5), *Outcomes reported for more*

Table 1. SCED+ ratings for single-case studies.

Article	Treatment	Clinical history (not rated)	Target behaviors defined	Design phases identified	Baseline sufficient	Behavior		Raw data included	Inter-rater reliability reported	Independence of assessors	Statistical analyses reported	Replicated across participants	Generalization	Treatment	SCED+ score (12 possible)
						sampled during treatment	samplers							procedure clearly described	
Cherney, 2004	ORLA/MMOR	Yes	Yes	No	No	No	No	No	No	No	No	No	Yes	Yes	3
Cocks et al., 2013	Strategy	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	Yes	5
Coelho, 2005	Cognitive	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	No	Yes	Yes	8
Gold & Freeman, 1984	Strategy	No	Yes	Yes	No	No	No	No	No	No	No	No	Yes	Yes	4
Kim & Russo, 2010	MMOR	Yes	Yes	No	No	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	6
Lee & Sohlberg, 2013	Cognitive	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	No	Yes	9
Lynch et al., 2009	Strategy	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No	No	No	No	3
Mayer & Murray, 2002	Cognitive/MMOR	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	7
Sinotte & Coelho, 2007	Cognitive	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	No	7
Webster et al., 2013	ORLA/Strategy	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes	No	Yes	Yes	7
Number of papers reporting SCED+ item			10	6	3	6	8	2	2	0	4	1	9	2	8

ORLA = oral reading for language in aphasia; MMOR = modified multiple oral rereading; Strategy = strategy-based treatments; Cognitive = cognitive-based treatments

Table 2. PEDro+ quality rating scale for randomized controlled trials and group studies.

Article	Treatment	Eligibility specified (not rated)		Allocation to groups random		Groups similar on key values		Participant blinding	Therapist blinding	Assessor blinding	Outcomes reported for more than 85% of participants		Intention to treat	Between group statistical comparison	Outcome measure statistics	Treatment fidelity	Treatment procedure clearly described	Total Score (out of 12) (total possible = 12)
		Yes	No	Yes	No	Yes	No				Yes	No						
Cherney et al., 1986	ORLA	Yes	No	No	No	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes	6
Cherney, 2010a	ORLA	Yes	Yes	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8
Cherney, 2010b	ORLA	Yes	Yes	No	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	8
Katz & Wertz, 1992	Hierarchical	Yes	Yes	No	No	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Katz & Wertz, 1997	Hierarchical	Yes	Yes	No	No	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8
Number of papers reporting PEDro + item		5	4	0	0	5	0	0	2	2	5	5	5	5	5	2	5	

ORLA = oral reading for language in aphasia; Hierarchical = hierarchical treatments

than 85% of participants (5), *Intention to treat* (5), *Between group statistical comparison* (5), *Outcome measure statistics* (5), *Treatment procedure clearly described* (5), and *Allocation to groups random* (4). The remaining PEDro+ items were identified less often: *Assessor blinding* (2), *Treatment fidelity* (2), as well as *Concealed allocation*, *Participant blinding*, and *Therapist blinding* which were not reported in any article.

Participants

A total of 176 participants received treatment (136 male, 40 female) in the 15 studies included in this review. However, it is unclear whether some of the participants in the (Cherney, 2010a, 2010b) studies were the same, and, likewise, some of the participants in the Katz and Wertz (1992, 1997) studies were likely identical. Participants' ages ranged from 20 to 84 years and education levels ranged from 8 to greater than 18 years. Time post-stroke ranged from less than 3 months to 22 years. Severity of aphasia was most frequently determined by the Aphasia Quotient (AQ) of the Western Aphasia Battery (WAB) (Kertesz, 1982) or the Western Aphasia Battery-Revised (WAB-R) (Kertesz, 2006), and participants' AQs ranged from approximately 9.7 to 97 out of 100. Reports of single-case studies included 18 participants, and 158 participants were part of group studies.

Interventions and outcomes

Oral reading treatments

Two oral reading treatments appeared in the 15 reviewed studies: Oral Reading for Language in Aphasia (ORLA) and modified multiple oral rereading (MMOR). Both approaches involve the participant orally reading text-level material, either in unison with the clinician or independently. Although the goal of each treatment is to improve oral reading, improved reading comprehension is also a primary aim. Each will be described individually.

ORLA was designed to improve the fluency of reading by automatizing the decoding process, thus allowing the reader to increase focus on comprehending meaning. It uses a multimodal stimulation approach intended to facilitate whole-word recognition. Sentence and paragraph stimuli are used because the material is typically more meaningful than single words, natural intonations can be modeled, and a variety of grammatical structures can be practiced.

ORLA is administered in six steps: (a) the clinician reads the text aloud while pointing to each word; (b) the clinician reads aloud, pointing to each word and encourages the participant to point to the words; (c) the clinician and participant read aloud together while pointing to each word – this step is repeated several times; (d) the clinician states a word the participant must identify in each sentence; (e) the clinician points to a word in each line the participant must identify; and (f) the participant reads the whole text in unison with the clinician. ORLA has four levels of difficulty based on length (3 to 100 words) and reading level (first grade to sixth grade).

Four of the 15 treatment studies reviewed implemented ORLA as described earlier (Cherney, 2004, 2010b; Cherney, Merbitz, & Grip, 1986; Webster et al., 2013). A fifth study delivered ORLA via computer (Cherney, 2010a). Across these five studies, a total of 62 participants received ORLA treatment. WAB AQ was used to rate severity of aphasia in

three studies. One participant had a WAB AQ of 62.8 (Cherney, 2004), and participants in the group studies (Cherney, 2010a, 2010b) had a mean WAB AQ ranging from 13.73 to 76.84. Two studies reported severity using a subjective measure. The mean time post-stroke ranged from less than 3 months to 253 months. Treatment session durations were 30–60 min for 2–5 days per week. The total duration of the treatment programs was variable per participant, but in general ranged from 6 to 22 weeks.

ORLA outcomes. Data related to participants, treatment schedule, and results for oral reading treatments can be found in Appendix 1 (see Supplementary Appendix 1 online). ORLA treatment resulted in improvement on some measures of reading comprehension for a group of 10 participants with moderate-severe aphasia (Cherney et al., 1986), a group of 6 participants with severe aphasia (Cherney, 2010b), an individual with moderate aphasia (Cherney, 2004), and an individual with mild aphasia (Webster et al., 2013). Improved reading comprehension was noted on the Reading Comprehension Battery for Aphasia, 2nd edition (RCBA-2; LaPointe & Horner, 1998) (Cherney, 2004; Webster et al., 2013), the WAB reading subtest (Cherney, 2004, 2010b), the Gates-MacGinitie Reading Test (GMRT; MacGinitie, 1978) (Cherney et al., 1986), and the Boston Diagnostic Aphasia Examination (BDAA; Goodglass & Kaplan, 1972) (Cherney et al., 1986).

Multiple oral rereading (MOR) (Moyer, 1979) and its derivatives, MMOR), comprise the second type of oral reading treatment for reading comprehension disorders. The goal of MOR (Moyer, 1979) is to increase oral reading rate and accuracy, not specifically reading comprehension. Moyer hypothesized that familiarization with the text would promote top-down, contextual processing rather than bottom-up, letter-by-letter processing. In addition to improving reading rate, using top-down processing during reading should lead to improved text comprehension and generalization of reading to untrained texts (Tuomainen & Laine, 1991).

When participating in MOR, PWA are required to repeatedly read texts until accuracy and rate criterion are met. As necessary, the clinician provides cues to assist the PWA to achieve criteria. New passages are introduced as the criteria are met. MOR and ORLA are similar in that they both require repeated oral reading to facilitate whole-word recognition. While ORLA incorporates choral reading (clinician and PWA) of 10–100 word passages (Cherney et al., 1986), MOR stresses independent reading of lengthier paragraphs or short stories (Moyer, 1979). MOR has been modified in several ways (MMOR), some of which aim to treat reading comprehension.

Kim and Russo (2010) devised an MMOR technique which directly aimed to treat reading comprehension by asking a series of comprehension questions after multiple times practicing the targeted reading aloud. Accuracy of production rather than speed was used as the criterion to move to a new passage. Stimuli were multiple paragraph, non-fiction stories of interest to the participant. A list of words on which the participant frequently erred was developed for additional home practice and a tape recording of stories was provided to assist the participant with home practice. As an extra motivational tool, a written news story was given to the participant at the end of each session to practice reading at home. Comprehension questions about the story were posed during the subsequent treatment session.

Cherney's (2004) use of MMOR required collaboration with family members of the PWA. Treatment allowed independent, systematic practice at home with oversight from

the clinician. A family member chose an item from the newspaper, and the participant practiced it at home while being recorded. Each week, the clinician reviewed the tape and the family member selected a new item. Mayer and Murray (2002) developed another MMOR approach, which included a component that directly addressed comprehension. The participant was instructed to read a paragraph aloud as quickly as possible then answer five comprehension questions addressing the main idea, details, and inferential material. This procedure was repeated until a rate of 150 words per minute (later reduced to 100 words per minute to reflect the participant's oral motor deficit) and 100% comprehension was reached. As criteria were met, the clinician introduced passages that systematically increased in complexity based on grade levels.

MMOR outcomes. MMOR treatment was successful for two of the three participants in the three studies. Specifically, Cherney's (2004) participant with mild anomic aphasia demonstrated improvement in reading rate and reading comprehension on the GMRT after practicing oral reading at home 30 min each day for 16 weeks. Mayer and Murray's (2002) participant with moderate fluent aphasia showed improvement on the *Gray Oral Reading Test-3* (GORT-3; Wiederholt & Bryant, 1992), as well as on modified passages from the *Graduate Record Examination* following 11, one-hour treatment sessions. However, Kim and Russo's (2010) participant with moderate Broca's aphasia did not show significant improvement in word- or text-level reading comprehension on the GORT-4 (Wiederholt & Bryant, 2001), or the *Psycholinguistic Assessments of Language Processing in Aphasia* (PALPA; Kay, Lesser, & Coltheart, 1996) following 70, 50-minute sessions over 9 months.

Oral reading generalization and maintenance. Reports of generalization of treatment gains following ORLA or MMOR to other texts or settings, or maintenance of learned behavior were mixed. Four of the five studies using ORLA reported generalization for PWA on overall language measures such as the BDAE and *Token Test* (DeRenzi & Faglioni, 1978; Cherney et al., 1986) or the WAB AQ (Cherney, 2004, 2010a, 2010b). Through self-report of the participant, Webster et al. (2013) reported no generalization. Maintenance of reading comprehension behavior as measured by results on the RCBA-2 and the *Discourse Comprehension Test* (DCT; Brookshire & Nicholas, 1993) was reported only by Webster et al., and occurred only for the RCBA-2.

The three studies that used MMOR reported generalization as measured by improved reading rate for their participants (Cherney, 2004; Kim & Russo, 2010; Mayer & Murray, 2002). Additionally, Mayer and Murray (2002) reported generalization as improved auditory-verbal scores on working memory tests. Mayer and Murray's participant maintained behavior for working memory and reading rate, but not for reading comprehension. Neither Cherney (2004) nor Kim and Russo (2010) reported maintenance measures.

Oral reading quality ratings. The two single-case design studies that used ORLA had SCED+ scores of 3 (Cherney, 2004) and 7 (Webster et al., 2013) from a maximum of 12. Three group studies using ORLA and rated on the PEDro+ scale had quality scores of 6 (Cherney et al., 1986) or 8 (Cherney, 2010a, 2010b) from a maximum of 12. Three single-case design studies used MMOR in conjunction with another treatment and had SCED+ scores of 3 (Cherney, 2004), 6 (Kim & Russo, 2010) and 7 (Mayer & Murray, 2002). No group studies using MMOR were identified.

Summary of oral reading treatments. ORLA and MMOR are two treatment techniques that aim to improve reading comprehension by targeting oral reading. Although typically not to a significant level, four of the five studies using ORLA supported its viability as a method to improve reading comprehension for some individuals with aphasia, most often for individuals with moderate-to-severe aphasia. Both single-case studies reported gains on at least one reading comprehension outcome measure and two of three group studies showed that participants made gains in comprehension following ORLA. Likewise, two of the three studies using MMOR also reported participants' improved reading comprehension.

Two points warrant consideration when interpreting these results. First, the quality scores of these studies vary widely and may not be entirely reflective of experimental rigor. For example, some studies may have been conducted under controlled conditions but were published before SCED, SCED+, PEDro and PEDro+ scales guided study evaluation. As a result, information such as assessor blinding or treatment fidelity may not have been included in the article even if they occurred. Second, participants in these studies ranged in aphasia severity. These treatments were not designed for specific levels of aphasia severity; however, they were adapted to meet individual PWA needs.

Strategy-based treatments

Four studies used a variety of strategies to facilitate reading comprehension (Cocks, Pritchard, Cornish, Johnson, & Cruice, 2013; Gold & Freeman, 1984; Lynch et al., 2009; Webster et al., 2013). These strategies focused on factors known to influence text comprehension in good readers, and covered a broad range of cognitive and linguistic processing. For example, simple strategies to facilitate focused attention included using an index card to hide text above and below the target text (Cocks et al., 2013) and reading/re-reading three sentence chunks (Webster et al., 2013) (e.g., attentive reading and constrained summarization [ARCS], (Rogalski & Edmonds, 2008)). Strategies requiring an increased level of cognitive processing included identification and summarization of main points) (Cocks et al., 2013; Gold & Freeman, 1984; Webster, 2013) (e.g., ARCS, proposition identification and constrained summarization [PICS]). Metacognitive strategies, the most cognitively demanding, included prediction and foreshadowing (Cocks et al., Pritchard, Cornish, Johnson, & Cruice, 2013; Lynch et al., 2009). A common element among the strategy-based treatments was use of text-level stories of interest to the participants.

Cocks, Pritchard, Cornish, Johnson, and Cruice (2013) developed personalized strategies for their participant that could be used on any reading task. Specific strategies were: (a) moving a card to hide text above and below the target text, (b) stopping at the end of each paragraph and verbally summarizing the main points, (c) highlighting the main characters' names and key words, (d) writing important plot developments in the margin of the book, (e) creating "mind-maps" to track who, where, and what happened in the text, and (f) writing summaries at the end of each chapter.

Lynch, Damico, Damico, Tetnowski, and Tetnowski (2009) implemented two primary strategies to facilitate comprehension of meaning: reading and writing aloud, and shared reading. The use of reading and writing aloud was intended to result in one modality facilitating the other modality. Texts were systematically introduced, beginning with content familiar to the participant and progressing to less familiar material. The clinician read the text aloud to the participant to

demonstrate effective use of strategies and to expose the participant to various patterns of language. The clinician then wrote text and verbalized what was written while the participant observed. During shared reading, the participant and clinician simultaneously read text aloud, with the participant gradually assuming greater responsibility for reading. The clinician used additional techniques and cues to mediate comprehension such as modeling, foreshadowing and employing meta-literacy comments (highlighting a problem the participant had while reading and explaining how it may be addressed).

Webster et al. (2013) examined three different strategy treatments. The first treatment was ARCS (Rogalski & Edmonds, 2008) in which the participant read a page of text aloud, read it again silently in two-three sentence chunks (attentive reading), then provided a short summary of the text while adhering to specific constraints (no opinions, no pronouns, and no nonspecific words). The second treatment was PICS in which the participant read the text as often as needed to identify key points, then wrote key words and summarized the information. The third treatment involved three contextual strategies: (a) read an article and identify the main topic based on prior knowledge; (b) develop titles and draw diagrams and pictures, and (c) underline the most relevant or salient information. At the end of each session, the participant responded to a series of yes/no and multiple-choice questions.

Gold and Freeman (1984) provided treatment using strategies of active problem solving, vocabulary and concept development, guided discussion, and summarization.

Strategy-based treatment outcomes. Data reporting participant characteristics, treatment schedule, and results for strategy-based treatments can be found in Appendix 2 (see Supplementary Appendix 2 online). Three of six participants receiving strategy-based treatment demonstrated some degree of improvement in reading comprehension (Cocks et al., 2013; Lynch et al., 2009; Webster et al., 2013). A fourth participant showed improvement, but the change was not significant (Webster et al., 2013). However, this participant subjectively reported improvement.

Cocks et al. (2013) showed improvement on the GORT-4 for their participant with mild anomic aphasia following 11 one-hour treatment sessions over a 13-week period. In addition, the participant reported increased confidence in her reading ability. Lynch et al. (2009) showed improved accuracy on comprehension questions drawn from novel passages for their participant with Broca's aphasia following 58 one-hour treatment sessions over 8 months. Webster et al. (2013) reported ARCS treatment resulted in significant gains on the DCT main idea questions for their one participant following 12, 45–60 min sessions over 6 weeks. No significant change was evident on detail questions. This participant also reported improved confidence in reading in general. Some improvement, though not statistically significant, was evident on the RCBA-2 and DCT for one participant following 8, 60 min sessions over 4 weeks of PICS treatment (Webster et al., 2013). This participant also reported improved confidence in reading. Minimal changes were evident following eight, 60-minute treatment sessions over 2 weeks, a 3-week break, then 2 more weeks for the participant who received the 3-strategy therapy (Webster et al., 2013). Gold and Freeman (1984) reported no change on the Woodcock Reading Mastery Test (WRMT) (Woodcock, 1973) for their participant with Broca's aphasia after 24, 1.5 h sessions over 12 weeks, nor was there any change in reading confidence.

Strategy-based treatment generalization and maintenance. Each of the four studies using strategy-based treatment reported some measure of generalization. Cocks et al. (2013) compared their participant's subjective reports and noted improved reading confidence and a change in positive emotion about re-engaging with reading. Webster et al. (2013) used the *Comprehensive Aphasia Test Disability Questionnaire* (Swinburn, Porter, & Howard, 2004) and informal interviews to identify increased confidence and ease of reading. Gold and Freeman (1984) reported generalization effects as measured by several tests of auditory comprehension and the peabody picture vocabulary test (Dunn & Dunn, 2007), and Lynch et al. (2009) showed generalization of treatment effects to improved reading rate.

Maintenance of reading comprehension scores was reported at 6 weeks post-treatment by Cocks et al. (2013) and 2–4 weeks post-treatment by Webster et al. (2013).

Strategy-based treatment quality ratings. Ratings on the SCED+ scale ranged from 3 to 7 for the four strategy-based treatment studies. Two studies were given low-quality ratings of 3 (Lynch et al., 2009) or 4 (Gold & Freeman, 1984). Cocks et al. (2013) had a quality rating of 5 and Webster et al. (2013) had a quality rating of 7.

Summary of strategy-based treatments. Strategy-based treatments designed to improve reading comprehension varied in composition and quality rating. Four of the six participants who received a strategy-based intervention showed some improvements in accuracy of reading comprehension, but the extent to which the changes reached statistical significance varied. Individuals who have a mild aphasia or mild reading comprehension impairments seem to be the most appropriate candidates for this treatment approach. However, these results must be viewed cautiously considering the low and variable SCED+ ratings.

Cognitive treatments

Individuals with mild aphasia have demonstrated inconsistent reading comprehension problems, and it has been suggested that nonlinguistic cognitive impairments may contribute to this reading profile (McNeil, Odell, & Tseng, 1991; Murray, Holland, & Beeson, 1997a, 1997b). PWA have demonstrated impairments in attention (Murray et al., 1997a, 1997b) as well as working memory (Caspari, Parkinson, LaPointe, & Katz, 1998; Wright & Shisler, 2005), and these deficits may explain inconsistencies in performance on different reading tasks (McNeil et al., 1991). Thus, treatment of these underlying cognitive deficits may be an effective intervention for individuals with mild aphasia (Mayer & Murray, 2002).

Four studies with a total of seven participants with mild aphasia and attention deficits participated in treatments designed to address attention or working memory problems to facilitate reading comprehension. The treatment approaches are summarized later.

Coelho (2005) and Sinotte and Coelho (2007) used attention process training-II (APT-II) (Sohlberg, Johnson, Paule, Raskin, & Mateer, 1994) for their participants who both described that reading at the text level was effortful and frustrating, that they had inconsistent comprehension of text, and that they had difficulty concentrating for long periods of time. APT-II presents audio recordings of sustained, alternating, selective, and divided

attention tasks, arranged in a hierarchical order of difficulty, placing increased demands on complex attentional control and working memory.

Lee and Solhberg (2013) used an updated version of APT-II, APT-III (Sohlberg & Mateer, 2010). The exercises in APT-III are organized by different attention domains: sustained attention, working memory, and resource allocation. Additionally, because PWA may exhibit problems with self-monitoring, determining task difficulty, and allocating appropriate resources to complex tasks (LaPointe & Erickson, 1991; Murray et al., 1997a, 1997b; Tseng, McNeil, & Milenkovic, 1993), a metacognitive component was added which included eliciting participants' effort and motivation ratings, and providing detailed performance data to participants to facilitate self-monitoring.

Mayer and Murray (2002) designed an indirect cognitive treatment, called sequenced exercises for working memory, which addressed attention and working memory. During this treatment, the participant was initially presented with a set of carefully constructed written sentences, some grammatical and some not. Each sentence in the set ended with a word from the same semantic category. The complexity of the treatment protocol was systematically increased by increasing the number of words in the sentences and the number of sentences in a set. Grammatically correct and incorrect sentences were randomized across sets. The participant was asked to read the sentence and then judge the grammaticality of each sentence as it was presented and to name one semantic category appropriate to the last words of each set.

Cognitive treatment outcomes. Data related to participants, treatment schedule, and results for cognitive treatments can be found in Appendix 3 (see Supplementary Appendix 3 online). All 7 participants receiving cognitive treatment showed improvement on at least one reading outcome measure, though the degree of statistical significance varied. Coelho (2005) reported a medium effect of treatment on reading comprehension of treatment probes, as well as improvement on the RCBA-2 and the GORT-4 for his participant following twice weekly sessions over 8 weeks. Two of the four participants in Lee and Sohlberg's (2013) study showed small but appreciable changes in reading comprehension on the primary outcome measure (i.e., maze reading probes), two participants showed improvement on the GORT-4, and two improved on the RCBA-2 following 32 sessions over 8 weeks. Mayer and Murray (2002) revealed gains on the GORT-3 (levels 8–12) for their participant after 11, 60 min sessions. Sinotte and Coelho (2007) reported their participant demonstrated improvement on reading comprehension treatment probes after 16 sessions provided over 5 weeks; however, the change was not statistically significant.

Cognitive treatment generalization and maintenance. All of the studies implementing a cognitive-based treatment reported behavioral generalization. Coelho (2005) and Sinotte and Coelho (2007) both reported improvement on the WAB AQ. Coelho (2005) also reported generalization on the GORT-4, accuracy and fluency measures. Three studies (Coelho, 2005; Lee & Sohlberg, 2013; Sinotte & Coelho, 2007) reported generalization measured as changes in cognition as demonstrated by gains on the *Test of Everyday Attention* (TEA) (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994). Finally, Mayer and Murray (2002) noted generalized improvement on an informal working memory task.

Three studies (Coelho, 2005; Lee & Sohlberg, 2013; Sinotte & Coelho, 2007) reported that gains on their primary reading comprehension tasks were maintained at least one-month post-treatment. *Cognitive treatment quality ratings*. SCED+ ratings for all cognitive-based studies were clustered: 7 (Mayer & Murray, 2002; Sinotte & Coelho, 2007), 8 (Coelho, 2005), and 9 (Lee & Sohlberg, 2013).

Summary of cognitive treatments. Treatment approaches that addressed reading comprehension via focusing on underlying attention or working memory problems resulted in improved reading comprehension for four of seven participants with mild aphasia. Two points are important to note in understanding these studies. First, despite the variability in treatment tasks and participants, all studies achieved strong SCED+ ratings, suggesting rigor in the studies and inspiring confidence in reported outcomes. Second, these treatments appear best suited to individuals with mild aphasia who have some level of text reading ability.

Hierarchical treatment

Schuell's stimulation approach (1974) formed the basis for a hierarchical treatment approach for reading designed by Katz and Wertz (1992, 1997). The aim of the treatment was to provide a large number and variety of stimuli to maximize the number of responses the participant made while simultaneously maintaining a high degree of reading accuracy. To achieve this goal, Katz and Wertz developed computer reading treatment (CRT), a computer-based reading comprehension treatment delivered through programmed stimulation. CRT contained 29 activities, each with 8 levels for a total of 232 hierarchically organized tasks (i.e., single words, sentences, and complex reading tasks). Participants advanced to the next level in the hierarchy after achieving a pre-determined criterion.

Hierarchical computer reading treatment outcomes. Data related to participants, treatment schedule, and results for hierarchical computer reading treatment can be found in Appendix 4 (see Supplementary Appendix 4 online). Hierarchical CRT resulted in significant positive changes on the *Porch Index of Communicative Ability* (PICA; Porch, 1973) reading subscale for a group of 13 PWA (Katz & Wertz, 1992). Improvement on the PICA reading subscale was also evident for a group of 21 PWA; however, the gains were not significant (Katz & Wertz, 1997). Of note, the degree of improvement for participants receiving hierarchical CRT was greater than changes for a general computer stimulation group and a no treatment group (Katz & Wertz, 1992, 1997).

Hierarchical treatment generalization and maintenance. Katz and Wertz (1992, 1997) reported that participants in the CRT group in both studies showed generalization from the treatment tasks to improvements in their overall PICA scores. Neither study reported behavior maintenance data.

Hierarchical treatment quality ratings. PEDro+ scores were strong for both hierarchical treatment studies (Katz & Wertz, 1992, 1997), with each study achieving a score of 8.

Summary of hierarchical treatment. The Katz and Wertz studies demonstrated that reading treatment progressing from simple to more complex reading tasks can improve reading ability and generalize to other language abilities. Additionally, their work illustrates that computer delivered reading therapy can generalize to pen and paper reading tasks as well as other non-reading language tasks.

Participant perceived outcomes

Six of the 15 studies reviewed in this systematic review reported subjective ratings of participants' perceptions of change following reading comprehension treatment. Cocks et al. (2013) reported that their participant demonstrated increased confidence and pleasure from reading following strategy-based treatment. Two of Webster et al.'s (2013) participants also reported increased confidence in reading. Cherney's (2004) participant stated that his understanding of each new reading item improved, that he understood more of the passage the first time he read it, and that he achieved a faster reading rate much sooner than anticipated following MMOR treatment. Lynch et al.'s (2009) participant reported resuming her volunteer role in the community as a result of reduced reading effort, less distractibility, and her ability to increase concentration for longer periods of time. Reading was reportedly more pleasurable for Coelho's (2005) participant. One of Lee and Solhberg's (2013) participants commented that she intentionally read more slowly and paid more attention to what she was reading following APT-3 treatment. Finally, Sinotte and Coelho's (2007) participant reported he found reading to be less of a chore and more productive and enjoyable.

Discussion

The primary aim of this systematic review was to describe treatment studies which were designed to address reading comprehension impairments in PWA and which specified reading comprehension as the primary outcome variable. We also sought to evaluate study quality and to report treatment outcomes. Interpretation of the results of this investigation and the outcomes of individual studies must be considered alongside the quality of the studies. Quality ratings of the group studies were generally higher than single-case design studies, which may have been due to factors such as lack of easy availability of an evaluation tool as guidance for authors writing single-case studies or failure to report elements of treatment such as treatment fidelity and assessor blinding. Several studies reporting single-case design outcomes were case reports, or reported changes on pre- post-treatment testing, rather than using more rigorous evaluation methods such as including pretreatment baseline data and calculating effect size, resulting in lower-quality ratings.

The lack of experimental control across studies limits the degree to which study results may be generalized, and it goes without saying that future work must include more rigorous experimental control and evaluation. Two points are worth considering at this juncture, however. First, outcomes from the group of studies examining ORLA and hierarchical treatment are more likely to reflect the effect of treatment because they had higher quality ratings, indicating more rigorous control. Second, many of the techniques reported in the studies we reviewed produced positive change for individual

participants and may indeed be appropriate for a PWA despite the absence of a high study quality rating. Careful matching of a treatment technique with participant factors that may contribute to success is critical to achieving the best possible outcome in clinical treatment. For example, in selecting a treatment technique, the clinician might consider the reading habits, desires, and current reading ability of the PWA; the likely underlying impairment; or the availability of family or caregiver support. The scientific rigor of studies may be increased by including more participant characteristics and matching these characteristics to characteristics of specific PWA will inspire confidence in applying the treatment.

Treatments and outcomes

Reading comprehension was addressed through a variety of methods, each of which could be placed into one of four categories: oral reading treatment, strategy-based treatment, cognitive-based treatment, and hierarchical treatment. Each approach had some success in improving reading comprehension; however, results were inconsistent. Overall, 14 of the 18 participants for whom *individual data* were reported showed some degree of improvement in reading comprehension as a result of the treatment procedure: 4 of the 5 participants who received oral reading treatment; 4 of the 6 participants who received strategy-based treatment; and 6 of the 7 individuals who participated in cognitive-based treatment. The number of sessions required to obtain these results varied from 11 to 58.

Five studies reported group data following treatment to improve reading comprehension (Cherney, 2010a, 2010b; Cherney et al., 1986; Katz & Wertz, 1992, 1997). Cherney and colleagues included 60 participants in group studies using ORLA. Of those participants, the 10 individuals with moderate-severe aphasia from Cherney et al. (1986) and the six participants with severe aphasia from Cherney (2010b) evidenced improvement; no other participants regardless of ORLA version (clinician or computer) or aphasia severity (mild or moderate) made notable improvement in reading comprehension. Collectively, Katz and Wertz (1992, 1997) included 98 participants in a RCT computer-based, hierarchical reading treatment. The 13 participants in their 1992 computer group showed significant change, whereas none of the 21 participants in their 1997 computer group showed significant improvement in reading comprehension ability. The 64 participants assigned to the computer simulation or control groups across both studies, also did not show reading improvement.

Taken together, results from the reported single-case and group studies suggest that for individuals with severe aphasia, as measured by the WAB AQ, ORLA is the treatment that has the greatest likelihood of inducing positive behavior change in reading comprehension. None of the other reading treatments reviewed appear to reliably induce change in reading comprehension for severe aphasia.

Several reasons may account for the inability to make a definitive statement about the effectiveness of the reading treatments for improving reading comprehension. While the review included 15 studies, many of the factors on which these studies were evaluated showed substantial variability. For example, ORLA was the technique most frequently used (5 studies) while other techniques were only used in one study (e.g., APT-III). The number of participants for whom each technique was used varied, and often a technique was administered to only one participant (e.g., ARCS). Treatment

delivery factors such as frequency, duration, and dosage varied across studies, as did outcome measures. Application of experimental control and statistical evaluation was limited, particularly in the single-case design studies. Thus, a clear recommendation of treatment that will likely result in improved reading comprehension for an individual with aphasia is not possible. Despite the variability, valuable information about the potential effectiveness of these techniques can be gleaned from detailed examination of each study, however.

It is important to recognize that meaningful change may not always be apparent on standardized tests. An equally important source of change information and success in reading treatment is participants' perceptual reports of factors such as change in self-confidence, improved ease of reading, and heightened enjoyment of reading (Cocks et al., 2013). For example, Webster et al. (2013) reported that two of the three participants receiving strategy-based treatment reported improved confidence in their reading ability, and reading a wider variety of text-level information at home. One of Lee and Sohlberg (2013) participants indicated she no longer had to read aloud to comprehend text and another participant reported using a slowing strategy to enable him to attend to content. One of Cocks et al.'s (2013) participants reported increased confidence and continued use of the strategies that were taught in therapy. Coelho's (2005) participant documented in her reading log that reading was less effortful, that she could concentrate more, and that she had resumed reading novels. These patient-reported outcomes suggest that real and functional changes do occur in daily activities, and that participants attribute these improvements to their reading treatments. A direct application of these research investigations to contemporary clinical practice is to advise clinicians to engage in discussion with the patient about reading goals and expected outcomes, and match them to specific treatment techniques that have shown positive, although perhaps not statistically significant, outcomes.

Treatment candidacy

Candidacy for a treatment, meaning the likelihood that a PWA can withstand the rigors of a particular procedure and derive benefit from that treatment (Segen, 2010), is a judgment collaboratively made by the clinician, client, and family. Despite the lack of unequivocal criteria for candidacy, numerous variables can contribute to the decision of good or poor candidacy for a treatment (Brookshire & McNeil, 2015; Turner & Whitworth, 2006). For example, one might consider neurological factors such as the type and extent of brain injury, patient factors such as stamina and motivation, and treatment protocol factors such as dosage and materials.

A few commonalities emerged in this review, suggesting some patient-related and treatment protocol-related items that may aid candidacy decisions. The degree to which one or more of these factors was instrumental in producing behavioral change is unclear; however, it is reasonable to include them in candidacy decisions. A striking observation is that the participants who demonstrated improvement in the primary outcome measures of reading comprehension were most likely to be those who exhibited mild to moderate reading difficulties and could read at least some text, albeit inefficiently. Alternatively, Cherney (2010b) reported that the only group who showed improved reading comprehension was the group of participants with severe aphasia, suggesting that ORLA, which trains less complex reading material than the other studies

reviewed, may be most appropriate for persons with more severe aphasia. Two other participant-related factors that emerged in common were high motivation to engage in treatment, and no evidence of a motor speech deficit.

Treatment protocol-related factors that may aid candidacy decisions also emerged in this review. One factor is material selection. Several studies reporting participants' improvement in reading comprehension used reading materials that were of high interest to their participants (Cocks et al., 2013; Lynch et al., 2009; Webster et al., 2013) perhaps increasing motivation and engagement throughout treatment. Other studies devised protocols with systematic progression in material or task difficulty in order to facilitate success and maintain engagement (Katz & Wertz, 1992, 1997; Kim & Russo, 2010; Mayer & Murray, 2002). Finally, several studies used strategies that aimed to promote active engagement in the reading process through use of cognitive-based strategies such as foreshadowing, discussion, summaries, and use of metalinguistic and metacognitive reflection (Cocks et al., 2013; Lee & Sohlberg, 2013; Lynch et al., 2009; Webster et al., 2013). Meta-cognitive strategies are an important component of memory and self-regulation, which may support future reading activities (Kennedy & Coelho, 2005).

It is important to highlight that the reading treatments included in this review identified reading comprehension as the primary outcome measure. Other reading treatments exist that focus on oral reading accuracy, as opposed to reading comprehension, and these treatments may also improve reading comprehension; however, these treatments often do not report reading comprehension outcomes and supporting evidence is lacking. Nonetheless, considering oral reading treatments as part of the reading treatment candidacy discussion is reasonable, particularly for PWA who have a severe reading impairment. Examples of these approaches are phonologic-based treatment (e.g., Beeson et al., 2010; Brookshire et al., 2014) and facilitative or compensatory strategies for their reading difficulties (e.g., Dietz, Hux, McKelvey, Beukelman, & Weissling, 2009; Knollman-Porter, Brown, Hux, Wallace, & Uchtman, 2016).

Generalization and maintenance

Generalization is a complex concept, yet is critical to consider when determining efficacy of treatment. Only five of the papers reviewed explicitly referred to generalization in the purpose, method, or discussion sections in their studies (Cherney, 2004; Katz & Wertz, 1997; Kim & Russo, 2010; Lee & Sohlberg, 2013; Mayer & Murray, 2002). However, in evaluating the quality of a study, Tate et al. (2008) defined generalization as the ability "to demonstrate the functional utility of the treatment in extending beyond the target behaviors or therapy environment into other areas of the individual's life" (p. 400). Therefore, in this review, generalization was rated on the SCED+ as present if data were provided to show pre- to post-change on measures of general language or cognitive functioning. Using this broader definition, generalization was reported on overall language measures (Cherney, 2004; Coelho, 2005; Gold & Freeman, 1984; Sinotte & Coelho, 2007), working memory tasks (Mayer & Murray, 2002), attention (Coelho, 2005; Lee & Sohlberg, 2013; Sinotte & Coelho, 2007), every-day functional activities (Webster et al., 2013), and use of meta-cognitive strategies on reading behaviors (Lee & Sohlberg, 2013). Generalization to other language modalities was also reported in group studies (Cherney, 2010a, 2010b; Cherney, et al., 1986; Katz & Wertz, 1992, 1997).

The inconsistent measurement of generalization effects among studies makes it difficult to draw conclusions about treatment efficacy or effectiveness. Creating the atmosphere for generalized behavior change involves systematic planning (Cooper, Heron, & Heward, 2007) and cannot be a passive assumption (Stokes & Baer, 1977). Further, understanding generalization would be aided if studies included measurement of both response and stimulus generalization. Response generalization is evident when improvement in untreated stimuli occurs concurrently with trained stimuli and is generally planned a priori by using a multiple baseline design and regularly probing trained and untrained behaviors (Stokes & Baer, 1977). Stimulus generalization occurs when gains on a trained behavior are observed in a different stimulus environment (Coppens & Patterson, 2018). None of the 15 studies included in this review reported response or stimulus generalization.

Only 6 of the 15 studies examined in this review included measures of maintenance of treatment effects (Cocks et al., 2013; Coelho, 2005; Lee & Sohlberg, 2013; Mayer & Murray, 2002; Sinotte & Coelho, 2007; Webster et al., 2013). Not all of these studies demonstrated a significant treatment effect; however, positive changes that were made by the end of treatment were generally maintained on follow-up testing that occurred between two weeks to a few months after treatment.

Conclusion

It is clear from the review of these 15 papers that substantive differences in participants, treatment protocols, and experimental rigor preclude drawing general conclusions about the effectiveness of a particular treatment for each person with aphasia. That said, this review provides valuable guidance to clinicians by examining the components of treatment techniques for which reading comprehension was an explicit outcome measure, and providing examples of application in determining candidacy for reading treatment. More carefully controlled experiments of treatments specifically targeting reading comprehension will improve our understanding for the aphasia population.

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