Abstract

The AHCPR Post-Stroke Rehabilitation Clinical Practice Guidelines defines aphasia as "the loss of ability to communicate orally, through signs, or in writing, or the inability to understand such communications; the loss of language usage ability." It has been reported that aphasia is one of the most common consequences of stroke in both the acute and chronic phases. Acutely, it is estimated that from 21 - 38% of stroke patients are aphasic. The presence of aphasia has been associated with decreased response to rehabilitation intervention and increased risk for mortality. In the present review, definitions, natural history and impact of aphasia are discussed. Therapy-based interventions are reviewed including group programs, training conversation partners, computer-based instruction, filmed language instruction constraint-induced therapy, repetitive transcranial magnetic stimulation, and direct current stimulation as well as deficit specific rehabilitation. Pharmacotherapy for aphasia is addressed and reviews of the impact, risk factors, clinical consequences and treatment of apraxia post-stroke are also provided.
Key Points

- Language therapy may not be more efficacious when compared to no treatment or a non-aphasia therapy program.
- Limited evidence suggests that moderate intensity language therapy may not be more effective in treating aphasia when compared to less intensive therapy; however, the benefit of high intensity language therapy in those that can tolerate it is not yet known.
- Volunteers can provide an effective adjunct to speech-language pathologists’ treatment. Participation in group therapy may result in communicative and linguistic improvements.
- Community-based language therapy programs provide a setting for improved language functions taking into account limitations and constraints of the “real-world”.
- Training communication partners may result in improved participation in conversation and improved conversational skills of persons with aphasia and their communication partners.
- Educational seminars for aphasic individuals and their families/caregivers may improve not only knowledge, but may also be beneficial in terms of social participation and family adjustment.
- Computer-based aphasia therapy results in improved language skills and may improve functional communication.
- Remote assessment of language following stroke may be as effective as face-to-face assessment of stroke outcomes among individuals with aphasia.
- Remotely administered language therapy may be an effective alternative to face-to-face therapy.
- Supplementary-filmed programmed language instruction has not been sufficiently studied to draw any meaningful conclusions.
- Melodic intonation therapy may be beneficial for treatment of aphasia, however limited evidence suggests it may be no better than standard language therapy.
- Evidence for the effectiveness of constraint-induced aphasia therapy on language function and everyday communication in individuals with chronic aphasia suggests that it may be as effective as conventional aphasia therapy.
- Treatment with repetitive transcranial magnetic stimulation may have positive effects on naming performance in individuals with chronic post-stroke aphasia.
- Site and polarity specific tDCS may improve naming ability in chronic aphasia.
- Further research is needed to determine the effectiveness of unilateral forced nostril breathing on post-stroke aphasia.
- Task-specific semantic therapy and task-specific phonological therapy may improve semantic and phonological language activities respectively in aphasia; however, it is unclear which is more beneficial.
- Cognitive linguistic therapy with both semantic and phonological elements may improve semantic fluency. More studies are needed to determine the efficacy of picture-naming therapy in combination with gesture therapy on lexical retrieval abilities in patients with aphasia.
• Language therapy may be associated with improved language function for individuals with global aphasia.

• Additional research regarding the effectiveness of alexia-specific therapy is required.

• Piracetam when delivered alone or combined with language therapy may be helpful for aphasia recovery.

• The effectiveness of levodopa as an adjunct to speech and language therapy may be limited.

• Bromocriptine may be helpful for aphasia recovery post-stroke, however, further research is required.

• Dextroamphetamine appears to improve aphasia recovery when combined with language therapy.

• Bifemelane may improve comprehension and naming; however, more research is needed to determine its effectiveness at facilitating aphasia recovery.

• Dextran-40 treatment may result in better outcomes for aphasia recovery compared to no treatment; however, more research is needed to determine its effectiveness on other language deficits.

• More research is needed to determine the effectiveness of Moclobemide on aphasia recovery.

• Treatment with donepezil HCl has not been studied sufficiently and there is inconclusive evidence with respect to its effectiveness on global language function.

• Memantine offered in combination with constraint-induced language therapy may improve language and communication; however further research is still warranted.

• Treatment with Galantamine may result in improved linguistic function; however, it has not been studied sufficiently in aphasia recovery to draw any meaningful conclusions.

• Strategic or compensatory training appears to be effective in the treatment of apraxia post-stroke.

• Gesture training is an effective intervention for the treatment of ideomotor apraxia post stroke.
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14. Aphasia and Apraxia

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14.1 Defining Aphasia

The AHCPR Post-Stroke Rehabilitation Clinical Practice Guidelines defines aphasia as “the loss of ability to communicate orally, through signs, or in writing, or the inability to understand such communications” (Klein 1995). Darley (1982) noted that aphasia is generally described as an impairment of language as a result of focal brain damage to the language dominant cerebral hemisphere. This serves to distinguish aphasia from the language and cognitive-communication problems associated with non-language dominant hemisphere damage, dementia and traumatic brain injury (Orange & Kertesz 1998). Ninety-three percent of the population is right-handed, with the left hemisphere being dominant for language in 99% of right-handed individuals (Delaney & Potter 1993). In left-handed individuals, 70% have language control in the left hemisphere, 15% in the right hemisphere, and 15% in both hemispheres (O’Brien & Pallet 1978). Language function is almost exclusively the domain of the left hemisphere; for 96.9% of the population language control is localized primarily in the left hemisphere.

### Table 14.1.1 Boston Classification System - Characteristic Features of Aphasia

<table>
<thead>
<tr>
<th>Type</th>
<th>Fluency</th>
<th>Comprehension</th>
<th>Repetition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broca's</td>
<td>Nonfluent</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Transcortical motor</td>
<td>Nonfluent</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Global</td>
<td>Nonfluent</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Wernicke’s</td>
<td>Fluent</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Transcortical sensory</td>
<td>Fluent</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>Anomic</td>
<td>Fluent</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Conduction</td>
<td>Fluent</td>
<td>Good</td>
<td>Poor</td>
</tr>
</tbody>
</table>

The concept of aphasia as simply a disorder of language fails to do the entity justice. Kertesz (1979) clinically described aphasia as a “…neurologically central disturbance of language characterized by paraphasias, word finding difficulty, and variably impaired comprehension, associated with disturbance or reading and writing, at times with dysarthria, non-verbal constructional and problem-solving difficulty and impairment of gesture”. The Boston classification system is used frequently by researchers and clinicians to classify type of aphasias (Table 14.1.1). Type of aphasia is determined, primarily, by lesion location (Godefroy et al. 2002).

14.2 Natural History and Impact of Aphasia

It has been reported that aphasia is one of the most common consequences of stroke in both the acute and chronic phases. Acutely, it is estimated that from 21 – 38% of stroke patients are aphasic (Berthier 2005). A recent report based on data from the Ontario Stroke Audit (Ontario, Canada) estimated that 35% of individuals with stroke have symptoms of aphasia at the time of discharge from inpatient care (Dickey et al. 2010).

Global aphasia is the most common type in the acute period affecting as many as 25-32% of aphasic patients, while other classic aphasias described within the Boston system of classification are seen less frequently (Godefroy et al. 2002; Laska et al. 2001; Pedersen et al. 2004). The frequency of unclassified or mixed aphasias that cannot be assigned to a classic category is more difficult to determine. Godefroy et al. (2002) reported approximately 25% of patients as having non-classified aphasias, comprised mostly of
disorders similar to anomic aphasia in addition to some other impairments. In that study, the presence of non-classified aphasia was significantly associated with a history of previous stroke. Initial stroke severity and lesion volume have been associated with initial severity of aphasia (Ferro et al. 1999; Laska et al. 2001; Pedersen et al. 2004).

Significant risk factors associated with development of aphasia include older age and greater severity of stroke and of disability (Bersano et al. 2009; Croquelois & Bogousslavsky 2011; Dickey et al. 2010; Engelter et al. 2006; Gialanella & Prometti 2009; Kyrozis et al. 2009). In a population-based study of aphasia following first-ever ischemic stroke, Engelter et al. (2006) reported that risk for aphasia increased significantly with age, such that each advancing year was associated with 1-7% greater risk. While 15% of individuals under the age of 65 experienced aphasia, in the group of patients 85 years of age and older, 43% were aphasic. In a study of 1,541 consecutive stroke cases, Croquelois et al. (2011) also found cardioembolic origin and superficial middle cerebral artery stoke to be significant risk factors for the development of aphasia.

For many, aphasia improves during the first year following the stroke event. A review by Ferro et al. (1999) reported that approximately 40% of acutely aphasic patients experience complete or almost complete recovery by one year post stroke. Similarly, Maas et al. (2012) found that 86% of stroke patients presenting with aphasia symptoms in an emergency setting experienced partial improvement within six months, 74% of whom had completely resolved.

Within the literature, most longitudinal studies have identified that the greatest amount of spontaneous recovery occurs in the first 3 months following stroke. After this, the rate of recovery slows and little additional spontaneous recovery can be expected after the first 12 months (Ferro et al. 1999). Pedersen et al. (2004) reported that during these first 12 months, aphasia of all types (even global aphasia) tended to evolve to a less severe form. While 61% of aphasic patients in the Copenhagen Aphasia Study still experienced aphasia at one year post stroke, it was usually of a milder form.

Similarly, Bakheit et al. (2007) demonstrated that patients with all types of aphasia experienced significant improvement in the first 6 months post-stroke when treated with conventional speech and language therapy as part of a comprehensive rehabilitation program. Improvements were greatest in the first 4 weeks, and then slowed to a lesser though still significant rate. Further, individuals diagnosed with Broca’s aphasia demonstrated the greatest gains despite greater initial impairment. In general, patients with Broca’s aphasia made greater gains in terms of scores on the Western Aphasia Battery (WAB) than patients with global aphasia, who in turn demonstrated greater improvement than those with Wernicke’s, anomic or conduction aphasia. However, it should be noted that patients with anomic and conduction aphasia demonstrated better WAB scores at baseline and so did not require as much improvement in order to return to normal speech and language abilities as patients with Broca’s or Wernicke’s aphasias. Bakheit et al. (2007) also cite previous literature that suggests severe and non-fluent aphasia progresses through phases of moderate aphasia such as conduction to less severe aphasia such as anomic aphasia before a full recovery.

Furthermore, in a study of 147 patients, El Hachioui et al. (2013) observed that linguistic component scores in phonology were found to be predictive of functional verbal outcome at 1 year following a stroke. However, Pedersen et al. (2004) reported no significant differences in recovery on the various parts of the Western Aphasia Battery and found that gains ranged from 54% for comprehension to 78% for naming. An additional study by El Hachioui et al. (2011) suggested that it may be beneficial to test performance
levels for the various facets of language separately, rather than rely on overall assessments in order to examine recovery patterns.

The most powerful predictor of recovery may be the initial severity of aphasia such that greater severity is associated with poorer recovery (Berthier 2005; Laska et al. 2001; Lazar et al. 2010; Pedersen et al. 2004; Ferro et al. 1999). Lazar et al. (2010) reported that more than 80% of recovery could be predicted based on initial severity of aphasia. In addition, the authors suggested that the relationship between recovery and initial impairment is proportional. Based on 21 stroke patients with mild to moderate aphasia and composite scores from 3 subtests of the Western Aphasia Battery (comprehension, repetition and naming), the authors demonstrated that patients improved by 73% of maximum potential recovery (defined as maximum potential language score minus their initial WAB score) during the first 90 days post stroke. The authors suggested that this may be attributable to mechanisms of spontaneous recovery common to all domains of function.

The influence of other factors on the degree of recovery is less clear. While some studies report recovery to be significantly better for younger patients (Ferro et al. 1999; Laska et al. 2001) others report that age does not predict recovery (Payabvash et al. 2010; Pedersen et al. 2004). Similarly, while there are reported gender differences in type and severity of aphasia, sex does not predict recovery (Laska et al. 2001; Payabvash et al. 2010; Pedersen et al. 2004). Studies examining handedness and education also provide conflicting results (Berthier 2005; Ferro et al. 1999).

In examining the prediction of language recovery, Payabvash et al. (2010) derived a model based on analysis of admission CT perfusion scans to predict early language improvement in individuals with acute stroke. Using multiple logistic regression, the authors identified 4 factors that could predict improvement on the NIHSS aphasia item with 90% sensitivity (91% specificity): aphasia score on admission NIHSS, presence/absence of proximal cerebral artery occlusion on admission CT, relative cerebral blood flow of the sublobar insular ribbon (lower third) and relative cerebral blood flow of angular gyrus (BA39). The authors present an 8-point scoring system (Table 14.2.1) to predict language improvement based on these 4 factors (Payabvash et al. 2010).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Absence/Presence, Value</th>
<th>Score (points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphasia score on admission NIHSS</td>
<td>Absent/Present, Value</td>
<td>1-3</td>
</tr>
<tr>
<td>Proximal cerebral artery occlusion on admission CT Angiography</td>
<td>Present</td>
<td>0</td>
</tr>
<tr>
<td>Relative cerebral blood flow (rCBF) of the sublobar insular ribbon (Lower third)</td>
<td>&gt;1.5</td>
<td>-2</td>
</tr>
<tr>
<td></td>
<td>0.66-1.5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.34-0.66</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&lt;0.34</td>
<td>2</td>
</tr>
<tr>
<td>rCBF of angular gyrus GM (BA 39)</td>
<td>&gt;0.66</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&lt;0.66</td>
<td>1</td>
</tr>
</tbody>
</table>

**Mortality.** The presence of post-stroke aphasia has been associated with higher rates of mortality over both the short and long-term. Laska et al. (2001) demonstrated that mortality among aphasic patients was 11% in the acute period compared to 3% among non-aphasic patients. While this early comparison
did not reach statistical significance, it was significant at 18 months (p=0.02). However, more recently, Guyomard et al. (2009) examined in-hospital mortality for individuals with aphasia and reported significant increases in risk associated with speech disorders, even when controlling for age, sex, premorbid Rankin score, previous disabling stroke and stroke type (OR = 2.2, 95% CI 1.8-2.7).

Similarly, Bersano et al. (2009) reported significantly greater rates (11% vs. 4%; p<0.0001) of in-hospital mortality for individuals with aphasia vs. those without. At 2-year follow-up, 34% of individuals with aphasia had died vs. 19% of non-aphasic individuals. Individuals with aphasia did have more severe strokes, greater motor impairments and were more likely to have experienced a haemorrhagic stroke. However, presence of aphasia was associated with significantly greater odds for mortality overall (OR=2.09; 95% CI 1.90-2.32) when controlling for age, sex, atrial fibrillation, cerebral haemorrhage and severity of motor impairment (Bersano et al. 2009).

In the Copenhagen Aphasia Study, Pedersen et al. (2004) reported mortality in aphasic patients to be 27% one year following stroke. In that study, there was a tendency for mortality at one year to be associated with the severity of aphasia at the time of the acute admission.

**Rehabilitation Gains.** In a study of 240 stroke patients, Paolucci et al. (2005) reported that, while all patients experienced significant gains over the course of rehabilitation, patients with aphasia and comprehension deficits had poorer outcomes in terms of activities of daily living, mobility and urinary continence at discharge than patients with no aphasia or patients with aphasia but no comprehension deficits. The most powerful predictor of effectiveness of rehabilitation as assessed on the Barthel Index and Rivermead Mobility Index was performance on a semantic-associated word comprehension task. For patients with aphasia and comprehension deficits, the risk of poor response to rehabilitation was approximately 5 times greater than for patients with aphasia and no comprehension deficits or patients with no aphasia (Paolucci et al. 2005). Additionally, in a study of 156 patients, Gialanella (2011) demonstrated that comprehension deficits were predictive of total Functional Independence Measure (FIM) score at discharge from inpatient rehabilitation.

Presence of aphasia may result in extended lengths of stay in rehabilitation, with less demonstrated gain over time. Gialanella and Prometti (2009) demonstrated that in a group of 252 stroke patients admitted for inpatient rehabilitation, those with aphasia (n=126) tended to have longer lengths of stay (p=0.056), smaller gains in function (assessed on the motor Functional Independence Measure score; p=0.017) and poorer rehabilitation gains per day (p<0.0001) than individuals with no aphasia (n=126).

Although the presence of aphasia has also been reported to have an adverse effect on mood, functional and social outcomes as well as overall quality of life (Davidson et al. 2008; Ferro et al. 1999; Wade et al. 1986). Williamson et al. (2011) demonstrated no significant association between aphasia severity and overall quality of life in a group of 24 subjects with chronic stroke.

**Discharge Destination.** Individuals with post stroke aphasia may be less likely to return home following stroke. Dickey et al. (2010) reported that (in Ontario, Canada) twice as many patients with aphasia are discharged directly to long-term care from acute care than individuals without aphasia (14% vs. 7%). However, relatively more individuals with aphasia are discharged to inpatient rehabilitation facilities (34% vs. 24%). In addition to having greater dysfunction at admission to and discharge from inpatient rehabilitation as well poorer rates of recovery compared to non-aphasic patients, Gialanella and Prometti (2009) reported that significantly more individuals with aphasia were discharged to nursing homes (p=0.002). Similarly, Bersano et al. (2009) demonstrated that, at 2 years post stroke, relatively fewer
individuals with aphasia still lived at home compared to patients with no aphasia (87% vs. 91%, OR=1.39 [1.17-1.65]). Auditory comprehension, reading comprehension, and tactile naming deficits were more common in individuals discharged somewhere other than home when compared with those discharged home (63.6% vs. 42.9; 70.7% vs. 54.0%; 62.9% vs. 43.6% respectively) (Gonzalez-Fernandez 2013).

14.3 Therapies for Aphasia

Reviewing and critiquing therapies for aphasia was challenging because of the extensive number of heterogeneous studies, many of which relied on small samples and were poorly designed or of overall low quality.

14.3.1 Language Therapy Reviews

Robey (1994) performed a meta-analysis of 21 studies of aphasia treatments that revealed several important findings. The significant findings of this meta-analysis were summarised by Orange and Kertesz (1998) into four points: “(1) the performance of individuals who receive language therapy in the acute stage of recovery is nearly twice as large as the effect of spontaneous recovery alone; (2) language therapy initiated after spontaneous recovery has a positive, albeit small, effect on language performance; (3) a medium to large effect is present in comparisons of treated versus untreated individuals when therapy is begun in the acute phase and (4) a small to medium effect is present in treated versus untreated groups when therapy is begun in the chronic stage of recovery (i.e. 6 – 12 months post onset)”. Robey (1998) conducted a second meta-analysis of 55 articles to investigate the general effectiveness of aphasia treatments across stages of recovery and to assess the different experimental and clinical dimensions of aphasia treatment. Again, Robey found that the average effect for treated recovery was nearly twice that for untreated recovery when treatment was begun in the acute phase. When treatment was initiated in the acute phase, the average effect size, although smaller, was 1.68 times greater than that of spontaneous recovery alone. When treatment was delayed until the chronic phase, the average effect size for treated patients was smaller, but still exceeded that of non-treated patients. In addition, the meta-analysis revealed that the more intensive the therapy, the greater the improvement. Robey suggested that two hours of treatment per week should be the minimum length of time for patients who can tolerate receiving intensive therapy. Finally, it was noted that large gains were made by individuals with severe aphasia treated by speech-language pathologists (Robey 1998).

Both the Robey meta-analyses (Robey 1994; Robey & Schultz 1998) examined aphasia therapy as it pertained to all aphasic patients and not just stroke-based patients with aphasia. Furthermore, both meta-analyses excluded drug treatment therapies. Finally, neither Robey meta-analyses assessed the quality of methodology of the trials reviewed.

A Cochrane Systematic Review by Greener et al. (1999) identified 12 trials investigating speech and language therapy for aphasia following stroke that were rated as suitable for review. However, they noted that most trials were old, and often had poor quality or used methodology that could not be evaluated unambiguously. Overall, the trials lacked sufficient detail for Greener et al. (1999, 2001) to carry out complete descriptions and analyses. Consequently, they were unable to determine whether formal language therapy was more effective than informal support. Kelly et al. (2010) provided an updated Cochrane review including results from a total of 30 trials comparing i) speech and language therapy (SLT) with no SLT, ii) SLT with social support and communication stimulation and iii) two different approaches
to SLT (see Table 14.3.1.1). Few significant differences were noted in SLT vs. no SLT comparisons; however, the authors note that there is a consistent direction of results in favour of speech and language therapy, overall. There was some evidence that the provision of social support and stimulation was associated with improved receptive and expressive language skills, although this result was based primarily upon findings of a single study. In examining specific approaches, the authors found that intensive SLT was associated with improved written and receptive language and in overall measures of severity when compared to conventional SLT. Volunteer-facilitated therapy appeared to produce outcomes similar to conventional SLT and, in one study, produced superior results on measures of spoken repetition. Apart from these two notable exceptions (intensity and volunteer-facilitated therapy), the authors state that there was insufficient evidence to support the effectiveness of one approach over the other.

Table 14.3.1.1 Cochrane Review of Effectiveness of Speech and Language Therapy for Post-Stroke Aphasia (Kelly et al. 2010)

<table>
<thead>
<tr>
<th>Study</th>
<th>Types of Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakheit et al. 2007</td>
<td>Intensive vs. conventional SLT</td>
</tr>
<tr>
<td>David et al. 1982</td>
<td>Conventional SLT vs. social support &amp; stimulation</td>
</tr>
<tr>
<td>Denes et al. 1996</td>
<td>Intensive vs. conventional SLT</td>
</tr>
<tr>
<td>DiCarlo et al. 1980</td>
<td>SLT+filmed instruction vs. conventional SLT</td>
</tr>
<tr>
<td>Doesborg et al. 2004a</td>
<td>Semantic treatment vs. phonological treatment</td>
</tr>
<tr>
<td>Doesborg et al. 2004b</td>
<td>Computer-based SLT vs. no SLT</td>
</tr>
<tr>
<td>Drummond et al. 1981</td>
<td>Gesture cuing vs conventional SLT</td>
</tr>
<tr>
<td>Elman et al. 1999</td>
<td>Conventional SLT vs. social support &amp; stimulation</td>
</tr>
<tr>
<td>Hinckley et al. 2001</td>
<td>Functional SLT vs. conventional SLT</td>
</tr>
<tr>
<td>Jufeng et al. 2005 (Chinese)</td>
<td>Group SLT vs. conventional SLT vs. no SLT</td>
</tr>
<tr>
<td>Katz et al. 1997</td>
<td>Computer-mediated SLT vs. computer-based placebo vs. no SLT or computer-based stimulation</td>
</tr>
<tr>
<td>Leal et al. 1993 (abstract)</td>
<td>Conventional vs. volunteer-facilitated SL</td>
</tr>
<tr>
<td>Lincoln et al. 1982</td>
<td>Crossover trial of conventional SLT, operant training SLT and social support and stimulation</td>
</tr>
<tr>
<td>Lincoln et al. 1984a</td>
<td>Conventional SLT vs. no SLT</td>
</tr>
<tr>
<td>Lincoln et al. 1984b</td>
<td>Operant training + conventional SLT vs. attention placebo + conventional SLT</td>
</tr>
<tr>
<td>Lyon et al. 1997</td>
<td>Functional SLT vs. no SLT</td>
</tr>
<tr>
<td>MacKay et al. 1988</td>
<td>Volunteer-facilitated SLT vs. no SLT</td>
</tr>
<tr>
<td>Meikle et al. 1979</td>
<td>Volunteer-facilitated SLT vs. conventional SLT</td>
</tr>
<tr>
<td>Meinzer et al. 2007</td>
<td>Constraint-induced SLT vs. volunteer-facilitated constraint-induced SLT</td>
</tr>
<tr>
<td>ORLA 2006 (poster)</td>
<td>Intensive vs. conventional SLT</td>
</tr>
<tr>
<td>Prins et al. 1989</td>
<td>STACDAP SLT vs. conventional SLT</td>
</tr>
<tr>
<td>Pulvermuller et al. 2001</td>
<td>Constraint-induced SLT vs. conventional SLT</td>
</tr>
<tr>
<td>Rochon et al. 2005</td>
<td>Sentence mapping SLT vs. social support and stimulation</td>
</tr>
<tr>
<td>Shewan et al. 1984</td>
<td>Language-oriented SLT vs. conventional SLT vs. social stimulation and support</td>
</tr>
<tr>
<td>Smania et al. 2006</td>
<td>Conventional SLT vs. no SLT (limb apraxia therapy only)</td>
</tr>
<tr>
<td>Smith et al. 1981</td>
<td>Intensive SLT vs. no SLT vs. conventional SLT</td>
</tr>
<tr>
<td>Van Steenbrugge et al. 1981</td>
<td>Task-specific SLT vs. conventional SLT</td>
</tr>
<tr>
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<td>Task-specific SLT vs. conventional SLT</td>
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<td>Van Steenbrugge et al. 1981</td>
<td>Task-specific SLT vs. conventional SLT</td>
</tr>
<tr>
<td>Wertz et al. 1981</td>
<td>Group SLT vs. conventional SLT</td>
</tr>
<tr>
<td>Wertz et al. 1986</td>
<td>Conventional SLT vs. no SLT vs. volunteer-facilitated SL</td>
</tr>
<tr>
<td>Wu et al. 2004 (Chinese)</td>
<td>Conventional SLT vs. no SLT</td>
</tr>
</tbody>
</table>

www.ebrsr.com
In considering the results of their review, the authors point out several important limitations. Included studies were all small and of the 30 studies only 2 performed a power calculation to determine appropriate sample size. Outcome assessment was heterogeneous and data reporting inadequate and/or incomplete, thereby limiting the number of studies that could be included in the meta-analyses. The authors report a substantial use of unpublished data.

### 14.3.2 Individual Studies of Language Therapy for Aphasia after Stroke

In addition to studies not published in English, the present review excludes abstracts, posters and conference proceedings several of which were used in the Cochrane review (Leal et al. 1993). The study by Smith et al. (1981) contains no data regarding speech and language therapy outcomes and was, therefore, also excluded as was the study by MacKay et al. (1988) which reported no results. We have also chosen to separate evaluation of specific therapies such as group therapy, gestural cuing, constraint-induced language therapy, or computer-based language therapy from the assessment of the more general “language therapy”. Individual studies examining the effectiveness of speech and language therapy in general, are summarised in Table 14.3.2.1.

#### Table 14.3.2.1 Summary of the Effects of Language Therapy on Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s) Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laska et al. (2011)</strong> RCT (7) N=99</td>
<td>E: Speech-language therapy C: No therapy</td>
<td>Amsterdam-Nijmegen Everyday Language Test (-)</td>
</tr>
<tr>
<td><strong>Bowen et. al. (2012)</strong> RCT (7) N=170</td>
<td>E: Enhanced communication therapy C: No therapy</td>
<td>Therapy Outcome Measure: Activity subscale (-)</td>
</tr>
<tr>
<td><strong>Godecke et. al. (2012)</strong> RCT (7) N=59</td>
<td>E: Daily aphasia therapy C: Usual care</td>
<td>Aphasia Quotient (+); 6mo follow-up (-)</td>
</tr>
<tr>
<td><strong>Lincoln et al. (1984)</strong> RCT (6) N=211</td>
<td>E: Hospital or home language therapy C: No therapy</td>
<td>Porch Index of Communicative Ability (-)</td>
</tr>
<tr>
<td><strong>Hartman (1987)</strong> RCT (6) N=60</td>
<td>E: Language therapy C: Emotional support program</td>
<td>Porch Index of Communicative Ability (-)</td>
</tr>
<tr>
<td><strong>Shewan &amp; Kertesz (1984)</strong> RCT (5) N=100</td>
<td>E1: Language-oriented therapy E2: Stimulation-facilitation therapy E3: Unstructured stimulation-facilitation therapy C: No therapy</td>
<td>Aphasia Quotient: E vs. C (+); E1 vs. C (+); E2 vs. C (+); E3 vs. C (-); E vs. E (-)</td>
</tr>
<tr>
<td><strong>Prins et al. (1989)</strong> RCT (5) N=32</td>
<td>E1: Systematic stimulation therapy for auditory comprehension disorders E2: Conventional stimulation therapy C: No therapy</td>
<td>Sentence Construction: E1 vs. E2 (+); E1 vs. C (-); E2 vs. C (+)</td>
</tr>
</tbody>
</table>

[www.ebrsr.com](http://www.ebrsr.com)
• Spontaneous speech (-)

Lincoln et al. (1982)
RCT (4)
N=24
E: Cross-over of speech therapy and an operant training procedure
C: Cross-over of speech therapy and a non-specific treatment
• Porch Index of Communicative Ability (-)
• Raven’s Coloured Progressive Matrices: Speech therapy vs. non-specific treatment (+)
• Speech Questionnaire (-)

Poeck et al. (1989)
PCT
N=160
E: Intensive language treatment
C: No language treatment
• Aachen Aphasia Test: Token Test: Early onset (+), Late onset (-); Repetition: Early onset (+), Late onset (-); Written Language (-); Naming (-); Comprehension (-); Profile level: Early onset (+), Late onset (-)

Takizawa et al. (2015)
Cross-over Case Series
N=6
E2: Single word therapy
E2: Sentence verb therapy
• Verb acquisition (-)

- Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

Discussion

Studies summarised in the present review compare various forms of speech and language or other aphasia therapies (e.g. intensive or adjunctive) for their effectiveness on post-stroke aphasia. Collectively, the studies suggest there is no clear difference in outcomes between the different comparators.

Five RCTs, including one multi-center RCT conducted by Bowen et al. (2012) compared the effectiveness of speech-language therapy to no treatment, and all reported no significant differences between groups. Only Poeck et al. (1989) reported statistically significant between-group differences on the Token Test and Profile level subtests of the Aachen Aphasia Test within the early onset stroke subgroup, in a PCT.

One RCT made comparisons between aphasia therapy and non-aphasia therapy programs and another multicenter trial, Godecke et al. (2012) compared aphasia therapy consisting of mainly semantic-feature analysis to usual inpatient services administered in the acute phase following stroke. The authors found statistically significant improvements following aphasia therapy on the Aphasia Quotient and Functional Communication Profile measures, however these results were not maintained at the six month follow-up.

Four RCTs and one case series made comparisons between different types of aphasia therapy interventions. Two studies (Lincoln et al. 1982; Takizawa et al. 2015) used a cross-over design and found statistically significant improvements associated with each treatment phase but no significant differences between interventions. Similar results were observed in Hartman et al. (1987) which compared standard language therapy to an emotional support program and found no significant differences between groups on the Porch Index of Communicative Ability. Prins et al. (1989) compared systematic and conventional stimulation therapies and no treatment and found significant differences only in sentence construction between conditions. Shewan and Kertesz (1984) made comparisons between language oriented therapy, structured and unstructured stimulation-facilitation therapy and no therapy and found significant differences only between treatment and no treatment conditions. The lack of difference in outcomes between different types of aphasia therapy has suggested to be in part due to limitations in study design such as small sample sizes and spontaneous recovery within groups.

Study results should be interpreted with caution due to possible sources of bias in aphasia treatment studies. These include lack of a priori sample size calculations, the mixing of aetiologies, inappropriate use
of non-standardized measures, inappropriate measures, weak design, lack of clarity regarding aphasia types or levels of severity, undocumented type of language therapy and frequency of therapy, among other deficiencies.

Conclusions Regarding Language Therapy on Aphasia

There is level 1a and level 2 evidence that language therapy may not improve communicative ability, performance on comprehensive language assessments, comprehension or oral expression when compared to no treatment.

There is limited and conflicting level 1a and level 2 evidence for the effect of language therapy on communicative ability when compared to a non-aphasia therapy program.

There is level 2 and level 4 evidence that comparisons between similar types of aphasia therapy may not result in differences for the improvement of communicative ability, comprehension, language and cognitive impairment, non-verbal reasoning, verb acquisition and performance on comprehensive language assessments.

**Language therapy may not be more efficacious when compared to no treatment or a non-aphasia therapy program.**

14.3.2.1 Intensity of Speech and Language Therapy
The most effective means of treating aphasia post stroke has yet to be determined, and studies investigating the efficacy of speech and language therapy for patients suffering aphasia post stroke have yielded conflicting results. One possible explanation for the observed heterogeneity of findings across studies is a difference in intensity of therapy. The recent Cochrane update (Kelly et al. 2010) reported that intensive therapy was associated with improved outcome when compared to conventional treatment; however, more participants withdrew from intensive therapy conditions than conventional. Studies examining the role of intensity in effectiveness are summarised in Table 14.3.2.1.1.

Table 14.3.2.1.1 Summary of the Effects of Intensity of Speech and Language Therapy on Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bakheit et al. (2007) RCT (8) N=97</td>
<td>E: Intensive speech therapy (total 35.6hr) C1: Standard speech therapy (total 19.3hr) C2: National Health Service standard therapy (total 6.9hr)</td>
<td></td>
<td>Western Aphasia Battery: 4wk: (-); 8wk: E vs. C1 (-), E vs. C2 (-), C1 vs. C2 (+); 12wk: E vs. C1 (-), E vs. C2 (-), C1 vs. C2 (+)</td>
<td></td>
</tr>
<tr>
<td>Martins et al. (2013) RCT (7) N_{int}=30 N_{non}=14</td>
<td>E: Intensive speech therapy C: Standard speech therapy</td>
<td></td>
<td>Functional Communication Profile (-) Aphasia Quotient (-)</td>
<td></td>
</tr>
<tr>
<td>Denes et al. (1996) RCT (6) N=17</td>
<td>E: Intensive speech therapy C: Standard speech therapy</td>
<td></td>
<td>Aachen Aphasia Test: Written language (+); Token Test (-); Comprehension (-); Profile (-)</td>
<td></td>
</tr>
</tbody>
</table>
Discussion

Overall, the present review has included three RCTs examining the effectiveness of intensive speech-language therapy compared to non-intensive speech-language therapy. We have noted that the failure to identify a consistent benefit associated with speech and language therapy might have been due to the low intensity of speech-language therapy applied in the negative studies while higher intensities of therapy appeared to be present in positive studies.

An examination of intensity of treatment and mean change scores undertaken by Bhogal et al. (2003) showed significant positive treatment effects for a mean of 8.8 hours of therapy per week for 11.2 weeks versus negative studies that provided approximately two hours per week for 22.9 weeks. On average, positive studies provided a total of 98.4 hours of therapy while negative studies provided a total of 43.6 hours of therapy. Hours of therapy provided in a week and total number of hours of therapy were significantly correlated with greater improvement on both the Porch Index of Communicative Ability (PICA) and the Token Test while total length of therapy (i.e. time) was inversely correlated with mean change in PICA scores. Bhogal et al. (2003) concluded that intense therapy over a short amount of time could improve outcomes of speech and language therapy for stroke patients with aphasia.

In contrast, Bakheit et al. (2007) were unable to demonstrate an association between intensity and improvement on the Western Aphasia Battery (WAB). They compared language therapies that were offered for a mean total of 35.6, 19.3 or 6.9 hours and found statistically significant differences only between participants receiving 19.3 and 6.9 hours of therapy. However, the authors suggest that the amount of therapy received by patients in the intensive therapy condition may not have reached the threshold necessary to significantly enhance recovery. Additionally, the authors report that the majority of patients receiving the intensive treatment were unable to tolerate it. Patients were either too ill or refused therapy and had lower WAB scores compared with patients who received less intensive, standard therapy.

The most recent RCT conducted by Martins et al. (2013) also reported no significant difference in outcomes between groups that received either intensive aphasia therapy or regular therapy as assessed
by the Aphasia Quotient and Functional Communication Profile. Two other studies (Denes et al. 1996; J. Hinckley & Carr 2005) that compared intensive and standard aphasia therapies reported statistically significant effects of intensive therapy on the Aachen Aphasia Test, Psycholinguistic Assessment of Language Processing in Aphasia and the Communicative Abilities in Daily Living measures. However, statistically significant between-group differences were not observed for the majority of outcome measures in either of these studies. Likewise, Des Roches et al. (2015) found significant between-group differences only for syllable identification, picture naming, category identification and word spelling outcomes in a PCT that matched two groups on the duration and intensity of clinical sessions. However, additional home practice sessions were only offered to the experimental group.

**Conclusions Regarding Intensity of Speech and Language Therapy**

*There is level 1a that intensive language therapy may not improve performance on comprehensive language assessments, cognitive and language tasks or communicative ability when compared to standard language therapy; however, level 2 evidence is conflicting.*

*There is level 1b evidence that 19.3hrs of speech therapy program may improve performance on comprehensive language assessments compared to standard therapy (6.9hrs).*

*Moderate intensity language therapy may not be more effective in treating aphasia when compared to less intensive therapy; however, the benefit of high intensity language therapy in those that can tolerate it is not yet known*

14.3.2.2 Volunteer-Facilitated Speech and Language Therapy

Kelley et al. (2010) reported that speech therapy delivered by volunteers produced outcomes similar to those produced by therapy delivered by trained speech-language professionals. Individual studies examining the use of volunteer-facilitated therapy are summarised in Table 14.3.2.2.1.

**Table 14.3.2.2.1 Summary of Volunteer-Facilitated Speech and Language Therapy on Aphasia Post-Stroke**

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wertz et al.</strong> (1986)</td>
<td>RCT (6)</td>
<td>N=121</td>
<td>E1: Clinical treatment then no treatment E2: Treatment administered by a volunteer at home then no treatment E3: Deferred clinical treatment</td>
<td>• Porch Index of Communicative Ability (-)</td>
</tr>
<tr>
<td><strong>David et al.</strong> (1982)</td>
<td>RCT (5)</td>
<td>N=155</td>
<td>E: Speech-language pathologist therapy C: Volunteer therapy</td>
<td>• Functional Communication Profile (-)</td>
</tr>
</tbody>
</table>
**Discussion**

All studies summarised here demonstrated no significant differences in outcomes between individuals receiving treatment provided by a volunteer and those who received conventional therapy provided by a professional speech-language pathologist. David et al. (1982) conducted a multicenter RCT with 155 participants and reported that individuals receiving therapist directed treatment demonstrated almost identical recovery to individuals receiving volunteer directed treatment. The authors proposed that the improvement they observed with speech and language therapy was the result of many factors such as interest, support and stimulation more so than who administered the therapy. Similar results were found in a study conducted by Marshall et al. (1989) which observed no significant differences between volunteer and speech-language pathologist treatment on any measure. The authors argue that the absence of difference between volunteer and therapist treated groups may be due to the substantial amount of training speech-language pathologists administer to the volunteers. However, when volunteers were provided with no guidance or instruction in speech therapy techniques as in David et al. (1982), no significant differences were observed between volunteer and therapist treated groups. Therefore, the use of volunteers could be an effective supplement to available speech-language resources; one which could help to increase intensity of therapy where appropriate.

**Conclusions Regarding Volunteer-Facilitated Speech and Language Therapy**

There is level 1b and level 2 evidence that volunteers can provide speech and language therapy and achieve similar outcomes in terms of comprehension and communicative ability when compared to speech-language pathologists.

There is level 1b and level 2 evidence that immediate language therapy may not improve reading comprehension, auditory comprehension or non-verbal reasoning when compared to deferred therapy; however, the evidence for communicative ability is conflicting.

Volunteers can provide an effective adjunct to speech-language pathologists’ treatment.

### 14.3.3 Group Therapy for Aphasia Post-Stroke

Group therapy for aphasic patients is a potential means to maximize limited language therapy resources and encourage social interactions. Individual studies examining the effectiveness of group language therapy are summarised in Table 14.3.3.1.

**Table 14.3.3.1 Summary of Efficacy of Group Language Therapy on Aphasia Post-Stroke**

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wertz et al. (1981)</td>
<td>RCT (6) N=67</td>
<td>E: Group therapy</td>
<td>Porch Index of Communicative Ability: Overall: 15wk (-), 26wk (+); 37wk (+), 45wk (-); Graphic: 15wk (+),</td>
</tr>
</tbody>
</table>
26wk (+), 37wk (+), 45wk (+); Verbal: 15wk (+), 26wk (+), 37wk (-), 45wk (-); Gestural: (-)
- Token Test (-)
- Word Fluency (-)
- Coloured Progressive Matrices (-)
- Conversational Rating (-)
- Informant’s Rating (-)

**Discussion**

Of the seven studies summarised in Table 14.3.3.1, only three were RCTs. The remainder were small, single-group prospective studies. However, the results of these uncontrolled studies appeared generally positive, reporting significant improvements in communication activities over time. Similar results were found in the three RCTs examining the effectiveness of group treatment. In a cross-over RCT conducted by Hoover et al. (2014), the effect of group treatment was compared with both individual treatment and combined group and individual treatment. Although statistically significant within-group improvements were observed, no significant differences were found between treatment conditions. The authors proposed that the absence of a between-group difference may have resulted from cross-training where elements practiced in individual therapy could also be used in the more dynamic group therapy. In contrast, Wertz et al. (1981) observed significant differences in the Porch Index of Communicative Ability (PICA) in favour of individual treatment when compared to group treatment. However, these differences were limited to specific time points and specific subtests on the PICA and were not present for any other language outcome measure assessed. In a comparison of immediate group therapy and four month deferred group therapy conducted by Elman & Berstein-Ellis (1999), participants were found to improve their communication ability and language impairment only after group therapy and not during the deferment period. This suggests that group language therapy may be an effective method of rehabilitation for individuals with aphasia.

**Conclusions Regarding Group Language Therapy**

*There is level 1a evidence that group treatment may improve communicative ability but not conversational ability, non-verbal reasoning, verbal expression, auditory comprehension or fluency as compared to individual treatment.***

*There is level 1b evidence that group treatment, individual treatment and combined group and individual treatment may not produce different results in terms of word retrieval.***

*There is limited level 2 evidence that immediate group therapy may improve language impairment when compared to deferred group therapy; however, evidence for the effect on communicative ability is conflicting.***

**Participation in group therapy may result in communicative and linguistic improvements.**
14.3.4 Community-Based Treatment Programs

As noted by Aftonomos et al. (1999), most conclusions regarding the efficacy of aphasia therapy are derived mainly in academic research; however, it is in the community that patients with aphasia are identified, reached and treated (Aftonomos et al. 1999). Thus, aphasia therapy depends on “its ability to promote and improve functional outcomes in real-world settings of constraints and limitations”. Individual studies examining community-based treatment are summarised in Table 14.3.4.1.

Table 14.3.4.1 Summary of Community-Based Aphasia Programs

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
<th>Results</th>
</tr>
</thead>
</table>
E2: Recreational activities program followed by the Speaking Out intervention | • ASHA Functional Assessment of Communication Skills: E1 (-); E2 (+)  
• Western Aphasia Battery (-)  
• Communication Effectiveness Index (-)  
• Functional Communication Therapy Planner (-)  

- Indicates no statistically significant differences between treatment groups  
+ Indicates statistically significant differences between treatment groups

Discussion

While there seems to be a generally positive effect associated with community-based aphasia intervention, there is little to recommend community-based interventions over other interventions. A RCT conducted by Worrall and Yiu (2000) compared the effectiveness of a community-based Speaking Out program to a recreational activity program in a cross-over design. The authors found significant improvements after both phases of the trial but observed differences between interventions only on the ASHA Functional Assessment of Communicational Skills measure in participants who received the Speaking Out program first, and on the Short Form Health Survey in participants who received the recreational program first. When comparing these interventions within each treatment phase, differences were only observed on the Short Form Health Survey in the second phase. The authors suggest that the absence of differences on other measures may be due to a high variability within aphasic groups based on factors such as aphasia severity and aphasia type. However, in Aftonomos et al.’s (1999) study on community-based programs, the authors observed no differences in improvement when controlling for impairment severity, diagnostic type and different functional levels. Further studies should evaluate the effectiveness of community-based aphasia programs when compared to different aphasia interventions, especially in a RCT design.

Conclusions Regarding Community-Based Aphasia Programs

There is conflicting level 1b evidence in reference to the effectiveness of a community-based language program on communicative ability when compared to a recreational activities program; however, evidence suggests that the community-based program may not improve performance on comprehensive language assessments.
Community-based language therapy programs provide a setting for improved language functions taking into account limitations and constraints of the “real-world”.

14.3.5 Training Conversation/Communication Partners

Conversation is important in social participation and plays a key role in many social functions such as establishing and maintaining relationships, sharing ideas and opinions or making plans. According to Kagan et al. (2001), it is also the means by which individuals reveal their inner competencies. Individuals living with aphasia have lost, to varying degrees, the tools of conversation. This loss impacts the ability of the individual to participate in social roles and obscures the individual’s inner competencies (Kagan et al. 2001; Rayner & Marshall 2003).

Interventions focused on the restoration of conversation are not restricted to alleviating impairment of language but also attempt to remove barriers to social participation in the settings within which the individual with aphasia lives and interacts with others (Lyon et al. 1997). Training conversation or communication partners within the aphasic individual’s social setting is one way to promote opportunities for restored access to conversation (Marshall 1998; Rayner & Marshall 2003). Individual studies examining the training of communication partners are summarised in Table 14.3.5.1.

Table 14.3.5.1 Summary of Training Conversation/Communication Partners

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kagan et al. (2001)</td>
<td>RCT (6)</td>
<td>N=40</td>
<td>E: Conversation partners trained to acknowledge and reveal competence of aphasia participants C: Conversation partners exposed to an informative aphasia video presentation</td>
<td>• Measure of Skill in Providing Supported Conversation for Adults with Aphasia (+) • Measure of Participation in Conversation for Adults with Aphasia (+)</td>
</tr>
</tbody>
</table>

- Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

Discussion

A RCT conducted by Kagan et al. (2001) compared training conversation partners as part of the Supported Conversations for Adults with Aphasia (SCA) program with exposing conversation partners to an informative aphasia video presentation. The authors found that by training conversation partners to acknowledge and reveal competence of the person with aphasia (PWA), participation of the PWA in conversation as well as the support provided by the conversation partner significantly increased when compared to the video presentation treatment.

Although most studies show a general positive effect with training conversation partners, it is important to consider the limitations of these studies. In a literature review of conversation therapy for aphasia conducted by Simmons-Mackie et al. (2014), the authors noted a large inconsistency in the outcome measures used to assess gains in conversational ability. In addition, factors such as small sample sizes and variability of the relationship between conversation partners and the PWAs can affect the strength of conclusions. Future studies should assess the effectiveness of conversational therapy with larger samples and using standardized outcome measures.

Conclusions regarding Training Conversation/Communication Partners
There is level 1b evidence that training conversation partners to acknowledge and reveal competence of individuals with aphasia may enhance the conversational skill of both parties when compared to delivering an informative video presentation to conversation partners.

Training communication partners may result in improved participation in conversation and improved conversational skills of persons with aphasia and their communication partners.

14.3.6 Patient and Caregiver Education
Community-based therapy, partner training and group therapy have both been examined as possible intervention approaches in long-term or chronic aphasia. The role of education for both the patient and family has also been examined as a means to improve communication in the home and social participation (See Table 14.3.6.1).

Table 14.3.6.1 Summary of Caregiver/Patient Education Programs

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s) Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draper et al. (2007) RCT (4) N=39</td>
<td>E: Group-based education C: Wait list</td>
<td>• General Health Questionnaire: NR</td>
<td></td>
</tr>
<tr>
<td>Hinckley &amp; Packard (2001) PCT N=36</td>
<td>E: Educational program participants C: Non-participants</td>
<td>• Aphasia knowledge difference (+) • Frenchay Activities Index (-) • Family Assessment Device (-) • Community Integration Questionnaire (-)</td>
<td></td>
</tr>
</tbody>
</table>

- Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups
NR No between group results reported

Discussion
Overall, caregiver and patient education programs resulted in positive outcomes, as reported by the three studies included in this section. Draper et al. (2007) reported that participation in a group-based education and support program was associated with statistically significant outcomes for caregiver distress, though these improvements were temporary. No significant findings were reported for other outcomes including use and perceived effectiveness of functional communication strategies. However, the study acknowledged a number of limitations including problems in recruitment, insufficient power and no reported between-group comparisons. A PCT evaluating the effectiveness of education programs for aphasia was conducted by Hinckley and Packard (2001) which compared participation in a two-day educational program to a non-participant group. The authors reported statistically significant within-group improvements on measures for knowledge, family adjustment and level of functional activities for participants, however there were no significant improvements observed within the non-participant group. These results suggest that educational programs may improve knowledge of living with aphasia but may not be generalizable beyond this patient population for outcomes related to community integration, activity level or family functioning.

Conclusions Regarding Caregiver/Patient Education Programs
There is limited level 2 evidence that a caregiver and patient education program may improve knowledge of aphasia but not activity level, community integration or family functioning when compared to no treatment.

Educational seminars for aphasic individuals and their families/caregivers may improve not only knowledge, but may also be beneficial in terms of social participation and family adjustment.

14.3.7 Computer-Based Treatment in Aphasia
Computer-based aphasia therapy is appealing in that it provides a means for massed practice, thereby increasing intensity of therapy (Wallesch & Johannsen, 2004), while minimizing use of therapist time and resources (Katz & Wertz 1997). However, the effectiveness of computer-based therapies has not been thoroughly investigated. A review of reports of computerised treatments for aphasia (Wertz & Katz, 2004) identified eight phase 1 studies, three series of phase 2 studies and a single phase 3 study using the model for clinical outcome research developed by Robey and Schultz (1998) (Table 14.3.7.1).

Table 14.3.7.1 Studies included in Wertz and Katz 2004

<table>
<thead>
<tr>
<th>Study</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seron et al. 1980</td>
<td>1</td>
</tr>
<tr>
<td>Mills 1982</td>
<td>1</td>
</tr>
<tr>
<td>Katz &amp; Nagy 1982</td>
<td>1</td>
</tr>
<tr>
<td>Katz &amp; Nagy 1983</td>
<td>1</td>
</tr>
<tr>
<td>Scott &amp; Byng 1989</td>
<td>1</td>
</tr>
<tr>
<td>Deloche et al. 1993</td>
<td>1</td>
</tr>
<tr>
<td>Crerar &amp; Ellis 1995</td>
<td>1</td>
</tr>
<tr>
<td>Crerar et al. 1996</td>
<td>1</td>
</tr>
<tr>
<td>Katz et al. (1984, 1985, 1989)</td>
<td>2</td>
</tr>
<tr>
<td>Loverso et al. (1988, 1992, 1985)</td>
<td>2</td>
</tr>
<tr>
<td>Steele, Weinrich et al. (1987, 1989); Weinrich et al. (1993, 1989); Aftonomos et al. 1997.</td>
<td>2</td>
</tr>
<tr>
<td>Katz &amp; Wertz 1997</td>
<td>3</td>
</tr>
</tbody>
</table>

Phase 1 and 2 studies are concerned with the development and refinement of hypotheses and are appropriate for small, single group or single subject/case series designs while phase 3 studies examine the efficacy of treatment under controlled conditions (Wertz & Katz, 2004). Results of phase 1 and 2 studies were mixed. Computer-based therapy appeared to have a positive effect in some of the studies; however all of the studies examined in the review provide evidence based on single small group or case study designs. There was a single study identified as a phase 3 study, which evaluated the effects of computer-based therapy in a randomised controlled trial. The results of this single RCT favoured the efficacy of computerised treatment. Studies identified for inclusion in the present review are summarised in Table 14.3.7.2.

Table 14.3.7.2 Summary of Computer-Based Treatments in Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year Study Design (PEDro Score) Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmer et. al. (2012) RCT (8) N=34</td>
<td>E: Computer-based language therapy C: Daily language therapy</td>
<td>• Object and Action Naming Battery: 5mo follow-up (+); 8mo follow-up (-)</td>
</tr>
</tbody>
</table>
Cherney et al. (2010)
RCT (6)
N=25
E: Aphasia therapy delivered by a computer
C: Aphasia therapy delivered by speech-language pathologist
- Western Aphasia Battery (-)

Katz & Wertz (1997)
RCT (5)
N=55
E1: Computer reading treatment
E2: Computer stimulation treatment
C: No treatment
- Western Aphasia Battery: Repetition: E1 vs. E2 (+), E1 vs. C (+), E2 vs. C (+); Aphasia Quotient: E1 vs. E2 (+); E1 vs. C (+), E2 vs. C (-)
- Porch Index of Communicative Ability: Overall: E1 vs. E2 (+), E1 vs. C (+), E2 vs. C (-); Verbal: E1 vs. E2 (+), E1 vs. C (+), E2 vs. C (+); Pantomime: E1 vs. E2 (-), E1 vs. C (+), E2 vs. C (+)

Fridriksson et al. (2009)
Cross-over PCT
N=10
E1: Audio-visual naming training
C: Audio only naming training
- Naming nouns task (+)
- Philadelphia Naming Test (-)

- Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

Discussion
All four of these also reported positive results, although only the computer-based reading comprehension intervention (Katz & Wertz 1997) was able to demonstrate any generalization of effect. In a comparison of computer-based aphasia therapy and aphasia therapy delivered by a speech-language pathologist, Cherney et al. (2010) found no significant differences between groups on any measure, although significant improvement was observed within both groups. In contrast, cueing treatment provided by use of the Multicue program did not appear to have an effect on every day, verbal communication (Doesborgh et al. 2004).

Palmer et al. (2012) investigated the feasibility of self-managed computer treatment for individuals with chronic aphasia following stroke. Over 75% of individuals were offered the therapy using a trained volunteer as a support (as per protocol). Volunteer support was unavailable for the remaining treatment group participants. Of those who received volunteer support, 66.7% completed the study intervention with the recommended frequency, while 25% of individuals who had no available support were able to complete the program as recommended. Furthermore, a mean of 75% of computer therapy time completed was independent practice indicating the ability of participants to use the program autonomously. This demonstrates that the use of a self-managed computer treatment program with volunteer support is a feasible way of providing intervention for people with aphasia after stroke.

While all of the authors reported a generally positive effect, none established which element of the therapeutic intervention might be responsible for the demonstrated improvements (Wallesch & Johannsen, 2004). Whether improvements are attributable to the use of the computer, the opportunity to augment therapy intensity through additional practice opportunities or other concurrent activities is not known. This is particularly true of studies such as Aftonomos et al. (1999) in which patients took part in a comprehensive community-based program that used the Lingraphica computer system. Further study, especially at the level of RCT, is indicated.

Conclusions Regarding Computer-Based Treatments

There is level 1a evidence that computer-based aphasia therapy may improve word retrieval ability in the short-term but not language function or word retrieval ability in the long-term when compared to standard language therapy.
There is limited level 2 evidence that computer-based aphasia therapy may improve communicative ability and language function when compared to no treatment.

There is level 2 evidence that a reading comprehension focused computer-based treatment may improve communicative ability and language skills assessed at the impairment level when compared to a cognitive rehabilitation focused computer-based treatment.

There is conflicting and limited level 2 evidence in reference to the effect of audio-visual naming training on word retrieval ability when compared to audio only naming training.

**Computer-based aphasia therapy results in improved language skills and may improve functional communication.**

### 14.3.8 Telerehabilitation and Speech and Language Therapy

Although increased intensity of speech-language therapy (SLT) has been associated with improved outcome, delivery of such services may be complicated by issues of increased demand, available resources and equitable access to services. While “in-person” services are the gold standard of care, other options for service delivery should be considered. One such option is telerehabilitation or telecare, in which services are provided at a distance even though the definition for ‘telerehabilitation’ varies across studies assessing the efficacy of speech and language therapies remotely. Online platforms such as video-conferencing or interactive computer-based programs may be used to assess, deliver interventions and monitor function in a timely fashion (Theodoros et al. 2008). Other telecommunication methods (e.g. telephone calls) are often considered telerehabilitation and used to connect the patient to the health care professional to conduct assessments remotely; however, these methods do not provide live face-to-face communication.

Two previous reviews have identified a number of studies examining the use of telerehabilitation for the provision of communication services in a variety of populations including stroke (Hill & Theodoros 2002; Reynolds et al. 2009). The majority of studies included in both of these reviews present positive findings with regard to the use of telehealth. However, in both reviews, the authors note that the research suffers from a number of significant shortcomings that need to be addressed. Studies tend to be very small of single group or case series design. Twenty-two of the 28 studies identified for inclusion by Reynolds et al. (2009) were classified as preliminary studies only (i.e. pilot studies, case studies, conference presentations). Studies tend to lack important information necessary for replication (e.g. information about characteristics of participants and about the technology and procedures employed). Outcome assessment was varied and measures used were not necessarily accompanied by appropriate reliability and validity information.

The majority of studies identified in previous reviews have examined the use of telehealth technologies for evaluation and consultation. Individual studies examining the use of telecare technology for the purposes of language assessment and/or diagnosis are summarized in Table 14.3.8.1.

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoffman et al. (2010)</td>
<td>PCT</td>
<td>E: Telephone administration</td>
<td>Stroke and Aphasia Quality of Life Scale (-)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C: Face-to-face administration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N_{Start}=28</td>
<td>N_{End}=19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agostini et al. (2014)</td>
<td>Cross-over PCT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1: Face-to-face naming treatment</td>
<td>E2: Online tele-naming treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Picture naming treated items (-)</td>
<td>• Picture naming untreated items (-)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Woolf et al. (2016)</td>
<td>Quasi-experimental</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N_{Start}=20</td>
<td>N_{End}=19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1: Remote therapy delivered from a University lab</td>
<td>E2: Remote therapy delivered from a Clinical site</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E3: Face-to-face therapy</td>
<td>E4: An attention control condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Word retrieval outcomes: E1 vs E2 &amp; E3 (+); E2 vs E3 (+)</td>
<td>• Word finding in conversation (-)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Indicates non-statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

**Discussion**

Overall, studies that have used telerehabilitation methods to provide an audible and visual connection for assessing aphasia report that participants are generally satisfied and feel comfortable with the remote assessment. These findings highlight that remote assessment methods may be useful and feasible for administering outcome measures to individuals with stroke. Tests for validity and reliability have also shown a high level of agreement between face-to-face and remote raters which supports that remote assessment may be an effective alternative to face-to-face assessment. One prospective study conducted by Palsbo (2007) reported 92% agreement within 1% between raters for face-to-face assessment and 92-100% agreement with in 1% for remote assessment. However, the exact agreement ranged from 50-67% in the face-to-face assessment condition compared to 8-25% in remote assessment. The authors suggest that this discrepancy may be due to a lack of familiarity with administering the assessment remotely or difficulty with directing the subject through the assessment in one of four therapists in particular.

A quasi-experimental study and an RCT both examined whether there were differences between assessments conducted remotely as compared to face-to-face administration and found conflicting results. In the first study, Hoffman et al. (2010) assessed stroke and aphasia quality of life as well as caregiver distress and found no significant differences between the telephone administration group and the face-to-face therapy group for assessment of outcome measures. In the latter, Woolf et al. (2016) found that both remote therapy groups performed better than the face-to-face therapy group and the attention control group. While the results of these studies differ, the results generally suggest that remote-led assessments may be as effective as assessments conducted in-person, and perhaps this form of rehabilitation for stroke may be helpful. Common limitations of studies using various forms of telecommunication or telerehabilitation to assess aphasia recovery are the use of insufficient sample sizes for ensuring greater statistical power, the use of various outcome measures, and differing on the definition of a telerehabilitation approach. Future studies should compare the effectiveness of remote assessment to face-to-face assessment using a greater number and diversity of study subjects and therapists, consideration of both audible and visual forms of telerehabilitation (i.e. videoconferencing style) and consider follow-up evaluations of patients.

Only in one study was the effectiveness of remote intervention compared to face-to-face intervention. In a cross-over design, Agostini et al. (2014) administered each intervention for eight days with a washout period of three weeks in between treatments. The authors observed significant improvements in picture naming ability following both interventions, although no significant effect of intervention type was found. This suggests that neither the lack of physical interaction between the therapist and the subject nor the technical complexity of the system significantly affected the effectiveness of the intervention. This indicates that remote interventions may be an effective alternative to face-to-face interventions. Further
study regarding the use of telerehabilitation for the provision of speech and language therapy compared to face-to-face therapy is required.

Conclusions Regarding Telehealth and Language Assessment Post Stroke

There is limited level 2 evidence for the use of remote assessment when compared to face-to-face assessment; however, preliminary findings suggest that the interventions are comparable.

There is limited level 2 evidence that the use of teleconferencing for remote speech and language treatment is comparable to face-to-face treatment in individuals with aphasia following stroke.

Remote assessment of language following stroke may be as effective as face-to-face assessment of stroke outcomes among individuals with aphasia.

Remotely administered language therapy may be an effective alternative to face-to-face therapy.

14.3.9 Filmed Language Instruction

The use of a prepared program of filmed language instruction has been assessed in a single RCT and several pre-post studies (Table 14.3.9.1).

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
</table>
| Di Carlo (1980) | RCT (4) | N=14 | E: Speech therapy with systematic filmed program instruction  
C: Traditional speech therapy | • Reading recognition (-)  
• Reading comprehension (-)  
• Figure background (-)  
• Visual learning (-)  
• Visual closure (+)  
• Vocabulary (-) |

* Indicates no statistically significant differences between treatment groups  
+ Indicates statistically significant differences between treatment groups

Discussion

The impact of filmed language instruction on language performance outcomes may be helpful for aphasia recovery post-stroke. Rudnev and Shteinerdt (2013) recently evaluated the efficacy of a speech rehabilitation method in a pre-post study that incorporated patients' own audiovisual samples with biological feedback within a group of patients with differing degrees of aphasia severity. They reported that speech donation (using audiovisual samples of the speech production of first-order relatives) was associated with a 35.8% decrease in the proportion of patients exhibiting literal paraphasia, however, the contrary was observed for the proportion of patients exhibiting rare literal paraphasias, an increase of 24.5%. For those who displayed occasional verbal paraphasias, there was a decrease from 43.4% to 18.9%, but a 26.5% increase in verbal paraphasias during sessions. The author also reported a statistically significant improvement in speech production activity among all patients, which may have been attributed to several elements of the rehabilitation process that involved speech-competent components. However, levels of improvement from the speech rehabilitation varied among individuals with varying degrees of aphasia severity.
Another pre-post study (Sarasso et al. 2014) assessed whether an imitation-based speech therapy was associated with acute plastic changes by comparing sleep slow-wave activity (SWA) changes before and after the programme. The rationale for this study was based on prior research suggesting that SWA is heightened during speech observation and imitation. Sarasso and colleagues did not find any significant differences in any speech-related outcome measures (i.e. the overall Aphasia Quotient, two subtests of the Apraxia Battery for Adults, or the Boston Naming Test) after two nights of sleep, however, the results did show positive associations between the IMITATE protocol and changes in synaptic strength. This finding offers additional support that an imitation-based speech therapy might be able to positively engage both hemispheres and positively affect speech production outcomes. Further research is required to examine how such a topographical analysis may be able to recognize functional recovery among individuals post-stroke or populations with neurological deficits.

Only one RCT evaluated the impact of filmed language instruction on individuals with aphasia (Di Carlo et al. 1980). The intervention group received speech therapy via filmed instructions while the control group received traditional therapy. Results suggest no significant difference between the groups with respect to reading recognition, reading comprehension, and visual learning among other outcomes (see Table 14.3.9.1). Visual disclosure however, was not found to differ between the groups. The results of this study are to be interpreted with caution as the methodology suffered from “poor” quality and the study included only 14 participants.

**Conclusion Regarding Filmed Language Instruction**

*There is level 1b evidence that supplementary-filmed programmed language instruction combined with speech therapy may be as effective as traditional speech therapy for aphasia recovery post-stroke.*

*There is limited level 5 evidence that speech rehabilitation involving biological feedback may be helpful for aphasia recovery; however, the use of video clips alone may not result an improvement. Further research regarding filmed language instruction is required.*

*Supplementary-filmed programmed language instruction has not been sufficiently studied to draw any meaningful conclusions.*

**14.3.10 Music Based Therapies**

Music and music based therapies in the rehabilitation of speech disorders, such as aphasia, have been used for over a century. This form of therapy has not been extensively studied in randomized controlled trials, however, it shows promise as a potentially effective treatment for this condition. Music and speech production are thought to have shared neural pathways (Tomanino 2012). Singing also reduces the rate at which words are articulated and, as such, dependence on the left hemisphere is reduced (Marchina 2010). Similarly, lengthening of syllables provides the ability to distinguish phonemes as well as allows the stringing of words to enhance fluency (Marchina 2010). Furthermore, rhythmic tapping that is often associated with music based therapy may engage the right hemisphere sensorimotor network, providing an impulse for verbal production and encourage auditory-motor coupling (Marchina 2010).

There are a number of music based therapies that may be used when treating aphasia. The most prominent is Melodic Intonation Therapy (MIT). This therapy encompasses the two main components of music based therapy: melodic intonation (singing) and rhythmic tapping while words, and eventually phrases, are repeated (Marchina 2010). Other approaches to this type of therapy involve other musical
elements such as melody, rhythm, dynamics, tempo, and meter (Hurkmans 2012). These components of music may be provided as therapies encompassing the singing of familiar songs, musically assisted speech, dynamically cued singing, rhythmic speech cueing, or oral motor exercises (Tomanino 2012).

Several RCTs evaluating the effect of music-based therapy for aphasia are summarized in Table 14.3.10.1.

### Table 14.3.10.1 Summary of Music Based Therapies for Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>van der Meulen et al. (2014)</td>
<td>Cross-over RCT (6)</td>
<td>E: Intensive melodic intonation therapy</td>
<td>• Aachen Aphasic Test: Repetition (+); Naming (-)</td>
</tr>
<tr>
<td></td>
<td>N&lt;sub&gt;Start&lt;/sub&gt;=25 N&lt;sub&gt;End&lt;/sub&gt;=24</td>
<td>C: Standard language therapy</td>
<td>• Repetition task: Overall score (+); Untrained items (+); Trained items (+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Amsterdam Nijmegen Everyday Language Test (-)</td>
</tr>
<tr>
<td>Conklyn et al. (2012)</td>
<td>RCT (5)</td>
<td>E: Modified melodic intonation therapy</td>
<td>• Western Aphasia Battery: Visit 1: Total score (+); Responsiveness (+); Repetition (-); pre Visit 1 to pre Visit 2: Total score (-); Responsiveness (+); Repetition (-)</td>
</tr>
<tr>
<td></td>
<td>N=50</td>
<td>C: No language therapy</td>
<td></td>
</tr>
<tr>
<td>Lim et al. (2013)</td>
<td>PCT</td>
<td>E: Melodic intonation therapy</td>
<td>• Western Aphasia Battery: Aphasia Quotient (-); Spontaneous speaking (-); Repetition (-); Naming (-); Comprehension (-)</td>
</tr>
<tr>
<td></td>
<td>N&lt;sub&gt;Start&lt;/sub&gt;=21 N&lt;sub&gt;End&lt;/sub&gt;=21</td>
<td>C: Speech-language therapy</td>
<td></td>
</tr>
</tbody>
</table>

- Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

### Discussion

Of the eight studies that used music based therapies for aphasia, seven used melodic intonation therapy (MIT) and one used a choir singing intervention. Overall, a positive effect was associated with music based aphasia therapy and MIT in particular. In a RCT conducted by Conklyn et al. (2012), the authors compared MIT to a no language treatment control. After administering the intervention for only two sessions, they observed significant improvements in favour of the MIT group on the responsiveness subtest of the Western Aphasia Battery and the adjusted total of responsiveness and repetition. Although MIT appears to be an effective treatment, the main contributing components of the intervention have not been clearly determined. In an attempt to isolate these components, two studies made comparisons between MIT, rhythmic intonation therapy without the musical component and standard language therapy (Stahl et al. 2013; Zumbansen et al. 2014). When comparing the treatments, the authors found no clear evidence describing the effectiveness of one treatment over another; however, the low methodological quality of the studies and the low number of participants may have affected the results.

Two of the included studies made comparisons between MIT and standard language therapy. In a cross-over comparison of MIT with standard language therapy, van der Meulen et al. (2014) found significant differences between interventions in repetition ability, but not in the naming subtest of the Aachen Aphasia Test or the Amsterdam Nijmegen Everyday Language Test. Although a greater performance on repetition tasks was found with MIT, this was not replicated in a PCT conducted by Lim et al. (2013). The authors compared MIT with standard language therapy and observed no significant between group differences on any subtest of the Western Aphasia Battery when controlling for stroke severity. These results suggest that MIT may be an effective treatment for aphasia. Further research is required comparing MIT to traditional language therapy.
**Conclusion Regarding Music Based Therapies**

There is level 1b and limited level 2 evidence that melodic intonation therapy may be as effective as standard language therapy for the improvement of word retrieval ability or performance on comprehensive language assessments; however, evidence regarding its effect on repetition is conflicting.

There is limited level 2 evidence suggesting that melodic intonation therapy may improve responsive speech but not repetition when compared to no language treatment.

*Melodic intonation therapy may be beneficial for treatment of aphasia, however limited evidence suggests it may be no better than standard language therapy.*

**14.3.11 Constraint Induced Therapy (CI) for Aphasia**

Forced use paradigms are popular for subsets of stroke patients in an effort to encourage increasing use of non-functional limbs, especially the upper extremity. The use of this paradigm has now been extended to the treatment of aphasia with a form of CI therapy that was developed for treatment of linguistic functioning. Chronic aphasic patients use communication channels that are most accessible to them and which require the least amount of effort such as drawing and gesturing, or use only those communicative utterances they know they can produce with ease. Constraint induced aphasia therapy is based on three principles: (1) use of intensive practice for short time intervals is preferred over long-term, less-frequent training (intensive practice); (2) constraints are used that force the patient to perform action that (s)he normally avoids (constraint induction); (3) that the therapy focuses on actions relevant in everyday life (behavioural relevance).

Individual studies of constraint induced language therapy for aphasia following stroke are summarised in Table 14.3.11.1.

**Table 14.3.11.1 Summary of Constraint Induced Therapy for Aphasia Post-Stroke**

<table>
<thead>
<tr>
<th>Author, Year Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pulvermuller et al. (2001)</strong> RCT (6) N=17</td>
<td>E: Constraint-induced aphasia therapy C: Conventional language therapy</td>
<td>• Aachen Aphasia Test: (+)</td>
</tr>
<tr>
<td><strong>Sickert et al. (2014)</strong> RCT (6) N=100</td>
<td>E: Constraint-induced aphasia therapy C: Standard treatment for communicative deficits</td>
<td>• Aachen Aphasia Test: (-) • Communicative Activity Log (-)</td>
</tr>
<tr>
<td><strong>Meinzer et al. (2007)</strong> RCT (5) N=20</td>
<td>E1: Constraint-induced aphasia therapy administered by experienced therapists E2: Constraint induced aphasia therapy administered by trained laypersons</td>
<td>• Aachen Aphasia Test: (-) • Profile Score (-)</td>
</tr>
<tr>
<td><strong>Meinzer et al. (2005)</strong> PCT N=27</td>
<td>E: Constraint induced therapy “plus” (CIATplus); additional written language component (task sessions) and individualized instructions for communication exercises in the home involving family and friends</td>
<td>• Aachen Aphasia Test: overall (-); • Communicative Effectiveness Index (+)</td>
</tr>
</tbody>
</table>
**Discussion**

Overall, studies of CIAT/CILT appear to yield positive results from pre-to post-intervention. One RCT identified that constraint-induced aphasia therapy was associated with improved functional communication ability compared to conventional therapy while another small RCT, Meinzer et al. (2007) demonstrated that CIAT may be provided in a group setting led by trained laypersons with similar results to professional-led CIAT. However, each of these studies consisted of small patient populations and different comparators against CIAT.

While most authors report statistically significant improvements in language function from baseline to post-intervention, it still remains to be understood which CIAT procedure-related aspects improvements are attributed to, or which of these influence a greater magnitude of change (i.e. one or both of constraint or shaping intensity, or other factors) (Meinzer et al. 2005; Sickert et al. 2014). An important observation from these studies is that despite differences in aphasia type, individuals with aphasia tend to show an overall receptiveness to treatment from any of intensive CIAT, conventional aphasia therapy or other treatments such as PACE or M-MAT. Follow-up analyses from studies have also indicated that these improvements may be continued past the study treatment period (Maher et al. 2006; Meinzer et al. 2005; Sickert et al. 2014).

One systematic review identified five studies that examined the effect of intensity of treatment, four studies that evaluated the effect of constraint-induced language therapy on language impairment and communication activity and one study that investigated both (Cherney et al. 2008). The authors of this review stated that chronic aphasia participants showed a general improvement in overall aphasia battery assessments and specific subtests for auditory comprehension, word retrieval, repetition and lexical decision (Cherney et al. 2008). Further, the review pointed out that existing CILT studies have examined its effectiveness in chronic aphasic populations and none have investigated its efficacy in an acute aphasia population (Cherney et al. 2008).

A recent review identified 5 primary studies examining the effectiveness of constraint-induced therapy applied to the rehabilitation of aphasia (Balardin & Miotto 2009). The authors noted that while the results suggest improvements associated with constraint-induced therapy, available evidence is insufficient. To date, only 3 randomised controlled trials have been conducted, and two examined the effectiveness of CIAT vs. standard therapy. Recommendations in favour of CIAT should be treated as guidelines for future research (Balardin & Miotto 2009).

**Conclusions Regarding Constraint-Induced Therapy for Aphasia**

*There is conflicting and limited level 1a evidence for the effectiveness of constraint-induced aphasia therapy (CIAT) on language performance, as compared to conventional treatment or placebo.*
There is limited level 2 evidence that CIAT administered by experienced therapists may be as effective as CIAT administered by trained lay persons for aphasia recovery.

There is limited level 2 evidence that CIAT may be as effective as the PACE treatment for the improvement of confrontational word retrieval in individuals with aphasia or other language disturbances caused by stroke.

Evidence for the effectiveness of constraint-induced aphasia therapy on language function and everyday communication in individuals with chronic aphasia suggests that it may be as effective as conventional aphasia therapy.

14.3.12 Repetitive Transcranial Magnetic Stimulation (rTMS)

Transcranial magnetic stimulation is a non-invasive procedure that uses a rapidly fluctuating magnetic field to “create electrical currents in discrete areas of the brain” (Martin et al. 2004). Multiple stimuli can be used to increase or decrease the excitability of the affected cortex, temporarily.

In stroke patients with nonfluent aphasia, functional MRI studies have revealed unusually high levels of right-sided cortical activation during language tasks (Martin et al. 2004; Naeser et al. 2004; Naeser et al. 2005; Rosen et al. 2000). While the potential importance of activation of the right frontal cortex in language recovery cannot be dismissed (Rosen et al. 2000), it has also been suggested that this unusually high level of activation is not necessarily associated with improved language performance, but rather may be a maladaptive strategy that hinders aphasia recovery in non-fluent patients (Martin et al. 2004; Naeser et al. 2004; Naeser et al. 2005; Rosen et al. 2000). Recent studies have examined the effectiveness of the application of slow rTMS to reduce excitability in right-sided Broca’s homologue in improving naming function in patients with nonfluent aphasia.

Table 14.3.12.1 Summary of Repetitive Transcranial Magnetic Stimulation (rTMS) for Treatment of Non-fluent Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s) Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tsai et al.</strong> (2014)</td>
<td>RCT (9) N&lt;sub&gt;Start&lt;/sub&gt;=56 N&lt;sub&gt;End&lt;/sub&gt;=53</td>
<td>E: rTMS + conventional speech rehabilitation  C: Sham rTMS + conventional speech rehabilitation</td>
<td>• Concise Chinese Aphasia Test post-intervention: Overall (+); Conversation (+); Picture description (+); Expression (+); Repetition (+); Object naming (-)  • Concise Chinese Aphasia Test follow-up: Overall (+); Conversation (-); Picture description (+); Expression (+); Repetition (+); Object naming (-)  • Picture Naming Test: Naming accuracy (+); Naming reaction time (+)</td>
</tr>
<tr>
<td><strong>Baker et al.</strong> (2010)</td>
<td>RCT (8) N=10</td>
<td>E: rTMS + picture-word matching  C: Sham rTMS + picture-word matching</td>
<td>• Naming test: Trained items (+); Untrained items (+)</td>
</tr>
<tr>
<td><strong>Barwood et al.</strong> (2011)</td>
<td>RCT (8) N=12</td>
<td>E: rTMS  C: Sham rTMS</td>
<td>• Boston Diagnostic Aphasia Examination: Overall (+); Naming actions (+); Naming tools and instruments (+); Repetition of sentences (+); Picture description (+); Commands (+); Word comprehension (-); Repetition of single words (-); Responsive naming (-); Naming screening of</td>
</tr>
<tr>
<td>Study</td>
<td>Design (n)</td>
<td>N start</td>
<td>N end</td>
</tr>
<tr>
<td>----------------------</td>
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</tr>
<tr>
<td>Barwood et al. (2013)</td>
<td>RCT (8)</td>
<td>12</td>
<td>12</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waldowski et al. (2012)</td>
<td>RCT (8)</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Polanowska et al. (2013)</td>
<td>RCT (8)</td>
<td>40</td>
<td>37</td>
</tr>
<tr>
<td>Seniów et al. (2013)</td>
<td>RCT (8)</td>
<td>40</td>
<td>37</td>
</tr>
<tr>
<td>Wang et al. (2014)</td>
<td>RCT (8)</td>
<td>45</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Polanowska et al. (2013)</td>
<td>RCT (7)</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>Khedr et al. (2014)</td>
<td>RCT (7)</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td>Kindler et al. (2012)</td>
<td>RCT (5)</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Heiss et al. (2013)</td>
<td>RCT (5)</td>
<td>41</td>
<td>31</td>
</tr>
<tr>
<td>Thiel et al. (2013)</td>
<td>RCT (5)</td>
<td>30</td>
<td>24</td>
</tr>
</tbody>
</table>
Discussion
Early studies demonstrated positive results with regard to naming, generalisation and duration of treatment (Martin et al. 2004; Naeser et al. 2005).

In a randomised controlled trial, Barwood et al. (2011) demonstrated significant improvement on several domains of the BDAE following rTMS treatment, including naming actions, naming tools and instruments, repetition of sentences and the Cookie Theft picture description complexity test as well as on the Boston Naming Test. A 2-month follow-up revealed similar results suggesting some durability of treatment effect (Barwood et al., 2011).

A single case study of an individual with chronic non-fluent aphasia has also examined whether the effects of rTMS may generalise to other language abilities (Hamilton et al. 2010). In that study, significant improvement in naming was reported, in addition to improvements in picture description (number of narrative words and nouns, sentence length and use of closed class words) at 2, 6 and 10 months following treatment. In addition, that individual demonstrated significant improvement in spontaneous speech production as assessed on the Western Aphasia Battery. Similarly, both of the recently published RCTs suggest significant improvement in performance on comprehensive language assessment associated with treatment (Barwood et al. 2011; Weiduschat et al. 2011).

Weiduschat et al. (2011) however, examined the effectiveness of rTMS when used in conjunction with speech-language therapy (45 minutes/session following each rTMS treatment). All participants received model-oriented language therapy and all of them experienced improvement over time. Individuals assigned to receive rTMS improved to a greater extent. This may be attributed, to some extent, to a significant improvement in the naming subtest scores only for individuals who had received rTMS (p=0.03).

Conclusions Regarding Repetitive Transcranial Magnetic Stimulation (rTMS)

There is level 1a evidence that treatment with rTMS may improve performance on comprehensive language assessment as well as on tests of naming abilities. However, there is conflicting evidence for its effectiveness on test components such as comprehension and repetition.

There is limited level 2 evidence that theta burst stimulation may improve naming abilities among individuals with aphasia as compared to sham stimulation.

Treatment with repetitive transcranial magnetic stimulation may have positive effects on naming performance in individuals with chronic post-stroke aphasia.

14.3.13 Transcranial Direct Current Stimulation
Like transcranial magnetic stimulation, transcranial direct current stimulation (tDCS) is used to provoke changes in excitability in the brain. The polarity of the current flow determines whether excitability is increased (anodal tDCS) or decreased (cathodal tDCS) (Floel et al. 2008). In healthy adults, application of
Table 14.3.13.1 Summary of Transcranial Direct Current Stimulation (tDCS) on Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marangolo et al., (2013)a</td>
<td>Cross-over RCT (9)</td>
<td>N=12</td>
<td>E1: Anodal tDCS over left Broca’s area + Language therapy&lt;br&gt;E2: Anodal tDCS over left Wernicke’s area + Language therapy&lt;br&gt;E3: Sham stimulation + Language therapy</td>
<td>• Content units: E1 vs E2 (+); E1 v E3 (+); E2 v E3 (-)&lt;br&gt;• Verbs: E1 v E2 (+); E1 v E3 (+); E2 v E3 (-)&lt;br&gt;• Sentences: E1 v E2 (+); E1 v E3 (+); E2 v E3 (-)</td>
</tr>
<tr>
<td>Polanowska et al., (2013)a</td>
<td>RCT (8)</td>
<td>Nstart=40&lt;br&gt;Nend=37</td>
<td>E: Anodal tDCS over left Broca’s area + Language therapy&lt;br&gt;C: Sham tDCS + Language therapy</td>
<td>• Naming (-)&lt;br&gt;• Comprehension (-)&lt;br&gt;• Repetition (-)</td>
</tr>
<tr>
<td>Marangolo et al., (2013)b</td>
<td>Cross-over RCT (8)</td>
<td>Nstart=8&lt;br&gt;Nend=8</td>
<td>E: Anodal tDCS over left Broca’s area + Cathodal tDCS over right homologue + Language therapy&lt;br&gt;C: Sham tDCS + Language Therapy</td>
<td>• Accuracy: Syllables (+); Sentences (+); Words (+)&lt;br&gt;• Vocal reaction time: Words (+); Sentences (+)</td>
</tr>
<tr>
<td>Marangolo et al., (2014)</td>
<td>Cross-over RCT (8)</td>
<td>Nstart=7&lt;br&gt;Nend=6</td>
<td>E: Anodal tDCS over left Broca’s area + Cathodal tDCS over right homologue + Language therapy&lt;br&gt;C: Sham tDCS + Language therapy</td>
<td>• Picture description (+)&lt;br&gt;• Verb naming (+)&lt;br&gt;• Noun naming (+)</td>
</tr>
<tr>
<td>Polanowska et al., (2013)b</td>
<td>RCT (7)</td>
<td>Nstart=26&lt;br&gt;Nend=24</td>
<td>E: Anodal tDCS over left Broca’s area + Language therapy&lt;br&gt;C: Sham tDCS + Language therapy</td>
<td>• Naming accuracy (-)&lt;br&gt;• Response time (-)</td>
</tr>
<tr>
<td>Rosso et al., (2014)</td>
<td>Cross-over RCT (7)</td>
<td>Nstart=25&lt;br&gt;Nend=25</td>
<td>E: Cathodal tDCS over right Broca’s area + Sham stimulation, delivered to patients with Broca’s Aphasia&lt;br&gt;C: Cathodal tDCS over right Broca’s area + Sham stimulation, delivered to patients without Broca’s Aphasia</td>
<td>• Naming accuracy (+)</td>
</tr>
<tr>
<td>Marangolo et al., (2013)c</td>
<td>Cross-over RCT (7)</td>
<td>Nstart=7&lt;br&gt;Nend=6</td>
<td>E1: Anodal tDCS over left Broca’s area + Language therapy&lt;br&gt;E2: Anodal tDCS over left Wernicke’s area + Language therapy&lt;br&gt;E3: Sham tDCS + Language therapy</td>
<td>• Naming: E1 v E2 (+); E1 vs E3 (+); E2 vs E3 (-)</td>
</tr>
<tr>
<td>Lee et al., (2013)b</td>
<td>Cross-over RCT (6)</td>
<td>Nstart=11&lt;br&gt;Nend=11</td>
<td>E: Single tDCS (anodal tDCS over left Broca’s area)&lt;br&gt;C: Dual tDCS (anodal tDCS over left Broca’s area + cathodal tDCS over right homologue)</td>
<td>• Picture Naming Test: Response time (+); Accuracy (-)&lt;br&gt;• Verbal Fluency Test (-)</td>
</tr>
<tr>
<td>Richardson et al., (2015)</td>
<td>Cross-over RCT (5)</td>
<td>N=8</td>
<td>E: High-definition tDCS&lt;br&gt;C: Conventional tDCS</td>
<td>• Naming accuracy (-)&lt;br&gt;• Response time (-)</td>
</tr>
<tr>
<td>Marangolo et al., (2013)a</td>
<td>Cross-over RCT (9)</td>
<td>N=12</td>
<td>E1: Anodal tDCS over left Broca’s area + Language therapy&lt;br&gt;E2: Anodal tDCS over left Wernicke’s area + Language therapy&lt;br&gt;E3: Sham stimulation + Language therapy</td>
<td>• Content units: E1 vs E2 (+); E1 v E3 (+); E2 v E3 (-)&lt;br&gt;• Verbs: E1 v E2 (+); E1 v E3 (+); E2 v E3 (-)&lt;br&gt;• Sentences: E1 v E2 (+); E1 v E3 (+); E2 v E3 (-)</td>
</tr>
</tbody>
</table>

anodal tDCS over Wernicke’s area has been associated with improved acquisition of novel vocabulary (Floel et al. 2008), suggesting that this technique may be useful in the rehabilitation of language. A summary of studies evaluating tDCS for aphasia are presented in Table 14.3.13.1.
| **Polanowska et al.** (2013a) | E: Anodal tDCS over left Broca’s area + Language therapy |  • Naming (-)  
  • Comprehension (-)  
  • Repetition (-)  
  | C: Sham tDCS + Language therapy |
|-----------------------------|---------------------------------------------------|--------------------------------------------------|
| RCT (8)                     |                                                   | N<sub>start</sub>=40  
  N<sub>end</sub>=37 |
| Kang et al. (2011)          | E: Cross-over of sham and real tDCS + word retrieval therapy |  • Boston Naming Test: Reaction time (-);  
  Accuracy (-)  
  | Cross-over PCT  
  N=10  
  |

- Indicates no statistically significant differences between treatment groups  
+ Indicates statistically significant differences between treatment groups

**Discussion**

A single small randomised crossover trial demonstrated a statistically significant benefit for trained naming tasks associated with multiple sessions of anodal tDCS applied over the left frontal cortex paired with a picture-word naming task, however this was not observed for untrained items (Baker et al. 2010). Some possible generalisation of benefit was noted beyond the specific naming task used for training. These results are in contrast to those reported by Monti et al. (2008) who found that neither anodal nor sham tDCS applied over the Broca’s region were associated with any change in picture-naming. However, cathodal tDCS was significantly associated with naming accuracy when applied over the left frontotemporal area. This improvement was both polarity and site specific. Baker et al. (2010) also supported the potential benefit of both anodal and cathodal tDCS given their supposition that increasing and decreasing cortical excitability may not have mutually exclusive effects.

Cathodal tDCS was also evaluated, in a study by Jung et al. (2011), and found to be as effective as an adjuvant therapy to conventional speech therapy in a group of individuals with stroke (n=37) (Jung et al. 2011). Good response to therapy was demonstrated in the study population as a whole, however, sub-analysis showed a greater effect in individuals with a stroke onset of less than 30 days, as well as in individuals with a lower initial aphasia severity.

No adverse events were reported by participants in either of the earlier studies and the treatment appeared both safe and well-tolerated (Baker et al. 2010; Monti et al. 2008). Further investigation is warranted.

Recently published cross-over RCTs found statistically significant differences between real and sham tDCS interventions on language performance outcomes or naming accuracy on nouns, verbs, words and sentences. Despite their higher methodological quality rating, the sample sizes of these studies are very small, and the results of these studies conflict with findings from cross-over RCTs given a lower quality rating, and a single cross-over prospective controlled trial. The latter suggests that tDCS may be no more effective than a conventional sponge-based tDCS intervention or word retrieval therapy on naming accuracy and response time.

Additionally, a Cochrane Systematic Review (Elsner et al. 2015) of twelve randomized controlled trials reported no difference between the use of anodal or cathodal tDCS versus control or sham tDCS for the improvement of language impairment post-stroke, and also concluded that existing evidence was deemed to be of low-quality and remained unclear about the effectiveness of tDCS on enhancing speech-language therapy outcomes.

Interestingly, a meta-analysis (Otal et al. 2015) of nine RCTs examined whether studies using inhibitory non-invasive brain stimulation to homologous regions (i.e. low-frequency rTMS or cathodal tDCS) could be used as adjunctive therapies to enhance speech and language therapy for the degree of ‘accuracy of naming’ performance. The authors reported statistically significant improvements for this outcome
measure among patients receiving inhibitory NIBS over the non-lesioned hemisphere as an adjunct to SLT compared to sham-NIBS controls [mean effect size of 0.51 (95%CI=0.24–0.79, p=0.0003), and further, the between-study heterogeneity was found as being negligible ($I^2=0\%$). Even though this analysis combined studies based on their shared commonality for inhibitory NIBS, separate meta-analyses of anodal or cathodal tDCS examining similar outcomes would provide more validity for the effectiveness of tDCS and adjunctive therapies on the degree of ‘accuracy of naming’ performance or other language performance outcomes.

There are a number of limitations with respect to the evidence presented by the studies reviewed for the effectiveness of transcranial direct current stimulation. First, patient populations are not homogeneous with respect to their underlying deficits. Second, there is significant heterogeneity in regards to the stimulation parameters used (e.g. current intensity, frequency of duration of sessions) (de Aguiar et al. 2015). Additionally, recommendations for future protocols evaluating stimulation therapies include the use of a stringent inclusion criteria, larger patient populations and multicenter RCTs (de Aguiar et al. 2015).

Conclusions Regarding Transcranial Direct Current Stimulation (tDCS)

There is level 1a and limited level 2 evidence that anodal tDCS applied over the left frontal cortex is associated with improved naming performance in individuals with chronic post-stroke aphasia.

Site and polarity specific tDCS may improve naming ability in chronic aphasia.

14.3.14 Unilateral Forced Nostril Breathing

Unilateral Forced-Nostril Breathing (UFNB) is a yogic pranayama technique that has been linked to changes in mood, cognition and autonomic nervous system functioning and dates back as early as 5000 years (Jella & Shannahoff-Khalsa 1993). Pranayama translates to ‘regulation of the breath’ and pranayama practice constitutes several controlled breathing exercises thought to exert a number of potential physiological (e.g. spatial memory, increased oxygen consumption) and psychological (e.g. anxiety and depression) health benefits on multiple bodily domains. Some support says that this ancient practice may help to improve areas in the autonomic and central nervous system, thereby improving cognitive performance/functioning by inciting changes to the non-damaged-brain’s hemispheric electroencephalographic (EEG) amplitudes in individuals without brain damage. As such, it is hypothesized that this practice may strengthen function of damaged hemispheres and prove useful for improving verbal and spatial abilities of aphasic individuals. It has been proposed that by inhaling through only one nostril and exhaling through the other, individuals with aphasia can reduce their levels of stress to improve their cognitive and linguistic performance (R. S. Marshall et al. 2014). Though UFNB has been well-studied, further research is required to understand the impact of UFNB impact on aphasia recovery. The studies using UFNB as an intervention for aphasic individuals are included below.

Table 14.3.14.1 presents one PCT evaluating the effects of unilateral forced nostril breathing on aphasia post-stroke.

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
</tr>
</thead>
</table>
| Marshall et al. (2014) | PCT | E: Unilateral forced nostril breathing training in aphasic patients | • Beck Anxiety Inventory (-)  
• Beck Depression Inventory (-) |
N=11  C: Unilateral forced nostril breathing training in non-aphasic patients  

- Indicates no statistically significant differences between treatment groups  
+ Indicates statistically significant differences between treatment groups

### Discussion

A prospective controlled trial (Marshall et al. 2014) explored potential benefits of unilateral nostril breathing practice on attention, language, spatial abilities, depression and anxiety in an aphasic population compared to a left hemisphere damaged control group. The study found that both groups did not demonstrate statistically significant improvements from baseline to post-intervention on any of the BJLOT, CPT, and RTT. However, the authors reported that UFNB training was significantly associated with better COWAT scores for the left hemisphere damaged control group than for the aphasic group. This finding highlights that UFNB may not be efficacious in the improvement of aphasia in aphasic patients but may result in verbal improvement among non-aphasic patients.

Moreover, a recent case series that included only three participants with mild to severe aphasia, (Marshall et al. 2015) hypothesized that UFNB offered in combination with a traditional speech-language therapy would help to improve language and attention skills of aphasic individuals. That study found that each participant exhibited different levels of improvement on language assessments using the WAB-AQ, CADL-2 and ABA02. Specifically, they reported no significant change in aphasia severity and attention skill in all participants, however, they noted clinically meaningful changes in functional communication scores, diadochokinetic rates, and discourse for two of the three participants. The effect of UFNB treatment alone is unknown given that it was combined with conventional aphasia treatment.

The above-mentioned studies have provided preliminary evidence for the effectiveness of UFNB in persons with stroke, however, UFNB has not been sufficiently studied in aphasic individuals nor has it been studied as a stand-alone technique. UFNB offers several advantages, namely, it is a relatively safe and easy-to-administer method that is associated with a low cost, and can be used adjunctively with other aphasia therapies. Intervention studies and randomized controlled trials with larger sample sizes testing UFNB alone or in combination with conventional and/or other aphasia therapies for a longer trial period are required to better understand the effects of UFNB on the contralateral hemisphere. Presently, no meaningful conclusions can be drawn about its effectiveness alone or in combination with speech-language therapy. Further studies should assess the effectiveness of UFNB as a stand-alone technique in an RCT design.

**Conclusions Regarding Unilateral Forced Nostril Breathing**

*There is limited Level 2 evidence that unilateral forced nostril breathing may improve anxiety and language but not attention level, spatial ability, auditory comprehension or depression.*

*Further research is needed to determine the effectiveness of unilateral forced nostril breathing on post-stroke aphasia.*

### 14.4 Rehabilitation of Specific Aphasic Deficits
14.4.1 Specific Treatment for Word-Retrieval Deficits

Word finding difficulty, also known as a lexical retrieval deficit, is a phenomenon whereby an individual can usually supply an accurate semantic representation of an object, but they are unable to verbally label that same object (Saito & Takeda 2001). This deficit is the main feature of anomic aphasia however it is also a common problem in other types of aphasia. In all cases, this deficit can significantly impact the patient’s verbal communication.

It has been hypothesized that word-retrieval deficits stem from “an impaired access to the phonological form of the intended word” (Saito & Takeda 2001). Levelt et al. (1991) claim that lexical access involves two stages: lexical item selection, which accesses the syntactically and semantically appropriate representation of the word, and phonological encoding of the selected item, which allows for its verbal articulation. Semantic and phonological therapies are based on the theory of lexical access and are widely used for remediation of word-finding deficits in aphasia. Therapies usually employ associative learning procedures including semantic and/or phonological cueing to aid lexical access and improve word retrieval abilities. Most studies (see Table 14.4.1.1) have administered picture-naming tasks which enable the patient to make a semantic connection with the word, thus if they are to see the picture again, they may be prompted to say the word. Often if the patient fails to name the picture they are prompted by a series of cues until they are able to say the word. The cue can be either semantic, requiring the patient to focus on the meaning of the word (for example, its use in a sentence or its belonging to a certain category), or phonological, requiring the patient to understand the structure of the word (for example, its initial syllable or its proper spelling).

Table 14.4.1.1 Summary of Treatment for Word-Retrieval Deficits in Aphasia Rehabilitation Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
</table>
| Doesborg et al. (2004) | RCT (8) | E1: Phonological therapy  
E2: Semantic therapy | - Amsterdam Nijmegen Everyday Language Test (-)  
- Semantic measures: Semantic Association Test (-);  
Synonym Judgement (-)  
- Phonological measures: Repetition non-words (-);  
Lexical decision (+) |
| De Jong-Hagelstein et al. (2011) | RCT (8) | E: Semantic and phonological treatment  
C: Role playing and conversation coaching | - Semantic Word Fluency: 3mo (+); 6mo (-)  
- Letter Fluency: 3mo (-); 6mo (+)  
- Psycholinguistic Assessment of Language Processing in Aphasia (-)  
- Amsterdam Nijmegen Everyday Language Test (-) |
| Abel et al. (2014) | RCT (6) | E1: Phonological therapy  
E2: Semantic therapy | - Picture naming ability: E1 vs E2 (-), however both groups improved from baseline |
| Altmann et al. (2014) | RCT (6) | E: Picture naming task with word generation + Gesture naming treatment  
C: Picture naming task with word generation | - Picture naming: E vs. C (-)  
However, both groups improved on untrained items from baseline  
- Category member generation (-)  
- Boston Naming Test (-)  
- Western Aphasia Battery (-)  
- Discourse Quantity: Words (+); Verbs (+);  
Utterances (-); Nouns (-)  
- Discourse Quality (-)  
- Number of words produced at assessment (+) favouring E |
Mattioli et al. (2014)  
RCT (6)  
N<sub>Start</sub>=12  
N<sub>End</sub>=12  
E: Language rehabilitation for verbal comprehension and lexical retrieval  
CG: No language rehabilitation  
• Aachen Aphasia Test: Naming (+); Writing (+); Repetition (-); Reading (-); Oral (-); Written comprehension (-); Token Test (-); Spontaneous speech (-)

Benjamin et al. (2014)  
RCT (5)  
N<sub>Start</sub>=14  
N<sub>End</sub>=14  
E: Picture and category naming training + gesture training  
C: Picture and category naming training  
• Picture naming accuracy: E vs. C (-) however both groups improved  
• Category naming accuracy: E vs. C (-) however both groups improved

Woolf et al. (2014)  
RCT (5)  
N<sub>Start</sub>=8  
N<sub>End</sub>=8  
E1: Phonological therapy  
E2: Semantic therapy  
• Word and non-word discrimination (-)  
• Discrimination of treated words (-)

- Indicates no statistically significant differences between treatment groups  
+ Indicates statistically significant differences between treatment groups

Discussion
In a recent study (Abel et al. 2014), the use of semantic or phonological cues was found to improve picture naming abilities for trained and untrained items, with a significantly greater improvement for trained items compared to untrained items. However, when phonological therapy was compared to semantic therapy designed for the improvement of speech discrimination and auditory comprehension, no improvement in discrimination of treated words, and no change in word and non-word discrimination was found (Woolf et al. 2014). Doesborgh et al. (2004) observed that at the impairment level, patients improved on semantic measures after semantic treatment and on phonological measures after phonological treatments. Furthermore, therapy-specific correlation between improvements on the Amsterdam Nijmegen Everyday Language Test was observed. The authors challenge the idea that equal improvement in verbal communication is a result of spontaneous recovery and not the result of non-specific effects such as language exercises, receiving attention, or being stimulated at a given impairment level. Another study combined phonological therapy with semantic therapy in a cognitive-linguistic treatment program that used verbal and non-verbal strategies for word retrieval, and compared it to a control communicative treatment (de Jong-Hagelstein et al. 2011). Results indicated statistically significant improvements in the level of verbal communicative abilities in both groups, however, there were no between group differences that met the clinically meaningful improvement of ≥7 points on the Amsterdam-Nijmegen Everyday Language Test (ANELT). Verbal fluency however, was found to significantly differ between the therapy group and the control group at 3 months and at 6 months. Although these findings suggest that both semantic and phonological therapy may improve lexical retrieval, it is uncertain whether there exists a difference between the two types of therapies when provided alone or in combination.

Two recent RCTs (Altmann et al. 2014; Benjamin et al. 2014) examined category naming performance after gesture therapy in combination with picture-naming therapy and reported further inconsistent findings. Participants in either gesture or no-gesture naming treatments demonstrated statistically significant improvements in language performance measured by the Boston Naming Test but not the Western Aphasia Battery however, no between-group differences were found for either of these outcomes (Altmann et al. 2014). The authors suggest that both groups improved at untrained items for picture naming as all participants demonstrated statistically significant differences from pre- to post-intervention for utterances, words, and verbs but not for nouns. Similar findings were reported for discourse quality measures, such as correct information units, propositions and grammar, but not for utterances with new information. Although both groups describe improvements, the results further
suggest that the gesture group generated more words at each subsequent assessment while the no-gesture group produced fewer words. Furthermore, the gesture therapy group demonstrated large improvements in picture description, while the no-gesture group demonstrated minimal improvements. Although these results describe significant differences between the two groups, the authors also note that the gesture group had 2 more years of education compared to the no-gesture group (p=0.08) which may have influenced the results. In another RCT (Benjamin et al. 2014), the effect of gesture therapy combined with picture naming category training was examined. No significant differences between groups for picture or category naming accuracy at any time point were found, even though both experimental and control groups demonstrated statistically significant gains for these outcomes. Based on these studies, the effect of gesture therapy in addition with picture-naming tasks on language production in aphasic individuals are inconclusive as the studies provide inconsistent findings that merit further investigation.

In an RCT by Mattioli et al. (2014), a rehabilitation program that focused on practicing verbal comprehension and lexical retrieval revealed that participants only improved on the naming and written aspect of the Aachen Aphasia test (AAT) compared to those that did not receive language rehabilitation. The remaining subtests of the AAT were not found to significantly differ between the two groups.

**Conclusions Regarding Treatment for Word-Retrieval Deficits**

*There is level 1a and limited level 2 evidence that both semantic and phonological cues may aid in lexical retrieval abilities; however, it is unclear whether there is a difference between the uses of the two types of cues.*

*There is conflicting level 1b and limited level 2 evidence regarding the effect of picture-naming therapy when combined with gesture therapy on word retrieval abilities.*

**Task-specific semantic therapy and task-specific phonological therapy may improve semantic and phonological language activities respectively in aphasia; however, it is unclear which is more beneficial.**

*Cognitive linguistic therapy with both semantic and phonological elements may improve semantic fluency. More studies are needed to determine the efficacy of picture-naming therapy in combination with gesture therapy on lexical retrieval abilities in patients with aphasia.*

### 14.4.2 Specific Treatment for Global Aphasia

Global aphasia impairs all aspects of language. Patients suffering from global aphasia experience less recovery than any other aphasia category. Language therapy for individuals with global aphasia can be costly. Moreover, efficacy of language therapy is not yet proven for this aphasia type. Specific rehabilitation for global aphasia has evolved from experience and literature and fulfils two purposes:

1. Support the capacities likely to improve with natural recovery, primarily the capacity to make categorical and associational semantic discriminations;
2. Be sufficiently easy that most severe, acute global aphasic adults could comprehend the nature and purpose of the tasks. (Alexander & Loverso 1991).

**Table 14.4.2.1 Summary of Treatment for Global Aphasia Post-Stroke**
<table>
<thead>
<tr>
<th>Author, Year Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denes et al. (1996) RCT (4) N=17</td>
<td>E: Intensive language therapy C: Standard language therapy</td>
<td>• Aachen Aphasia Test: Written language (+); Token Test (-); Repetition (-); Naming (-); Comprehension (-); Profile level (-)</td>
</tr>
</tbody>
</table>

* Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

**Discussion**

Although patients with global aphasia may experience less complete or slower rates of recovery following stroke, they may still derive significant benefit from participation in speech and language therapy as part of a comprehensive rehabilitation program (Bakheit et al. 2007). Denes et al. (1996) provided speech-language therapy using an ecological or conversation-based approach and reported that intensive therapy (approximately 130 sessions, 45 – 60 minutes in length over 6 months) was associated with significant improvement in all language modalities. In general, more significant improvements seemed to be made in individuals receiving intensive vs. regular (3 times per week) therapy. Unfortunately, between-group comparisons were limited by small sample size (Denes et al. 1996).

Although patients with global aphasia may experience significant improvement, Alexander and Loverso (1991) reported that only 2 of 5 participants were able to complete their target-specific therapy. The 2 individuals who did complete therapy demonstrated semantic capacity across categorical and associational boundaries. The authors propose that this precondition is necessary to the use of communication boards or substituted iconic language.

**Conclusions Regarding Treatment for Global Aphasia**

*There is limited level 2 evidence that speech and language therapy may be helpful for individuals with global aphasia post-stroke.*

**Language therapy may be associated with improved language function for individuals with global aphasia.**

**14.4.3 Specific Treatment for Alexia in Aphasia**

Alexia is an acquired disturbance in reading. Both left and right hemisphere pathology may induce alexia. Reading disturbances that occur after left-hemisphere injury results from linguistic deficits and may occur as an isolated symptom or as part of aphasia (Cherney 2004).

Only three studies assessed the effectiveness of specific therapy for alexia in aphasic patients (Cherney et al. 1986; Lacey et al. 2010; Lott et al. 2010). All of these studies used a case series design with no control group. In addition, these studies did not control for the type of alexia which may have affected how participants respond to the treatment. Regardless, a general positive effect of treatment was observed for each of the included studies. Further studies should be conducted with a stronger methodological design to determine if alexia-specific therapy is effective.
Conclusions Regarding Treatment for Alexia

There is limited evidence that specific therapy for alexia in aphasic patients may improve language function and reading ability post-stroke.

Additional research regarding the effectiveness of alexia-specific therapy is required.

14.5 Drug Therapy in Aphasia

An extension to the Cochrane review was made to include pharmacological treatments for aphasia following stroke (Table 14.5.1) (J. Greener et al. 2001). The authors identified 10 studies that were suitable for review. Drugs that were used in the selected trials were piracetam, bifemalane, piribedil, bromocriptine, idebenone and Dextran-40. However, it should be noted that the only pharmacological treatment for aphasia available in Canada is bromocriptine. The authors found that in most trials, the methodological quality was not measurable with only one study providing adequate data for review and analyses.

Table 14.5.1 Drug Treatment in Aphasia

<table>
<thead>
<tr>
<th>Study</th>
<th>Types of Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herrschaft 1988 (unpublished)</td>
<td>Piracetam vs. placebo</td>
</tr>
<tr>
<td>Poek 1993 (conference)</td>
<td></td>
</tr>
<tr>
<td>Platt 1993</td>
<td></td>
</tr>
<tr>
<td>Enderby 1994</td>
<td></td>
</tr>
<tr>
<td>De Reuk 1995 (unpublished)</td>
<td></td>
</tr>
<tr>
<td>Tanaka 1997</td>
<td>Bifemelane vs. no active substance</td>
</tr>
<tr>
<td>Bakchine 1990 (abstract)</td>
<td>Piribedil vs. no active substance</td>
</tr>
<tr>
<td>Gupta 1995</td>
<td>Bromocriptine vs. placebo</td>
</tr>
<tr>
<td>Price 1992 (abstract)</td>
<td>Idebenone vs. placebo</td>
</tr>
<tr>
<td>Spudis 1973</td>
<td>Dextran 40 vs. no active substances</td>
</tr>
</tbody>
</table>

Greener et al. (2001) found evidence that patients were more likely to improve on any language measure at the end of a trial if they had received piracetam, although the treatment effect was small (odds ratio 0.46; 95% CI 0.3 to 0.7). Moreover, the treatment impact was even smaller when the dropouts were included in the analyses. Greener et al. (2001) was unable to determine whether one drug was more effective than another. The main conclusion of their review was that drug treatment with piracetam might be an effective treatment for aphasia following stroke. They suggested that research should examine the long-term effects of piracetam to determine if it is more effective than speech and language therapy alone.

Unlike the Cochrane review of Greener et al. (2001), the present review excluded abstracts, conference proceedings and unpublished studies (Herrschaft 1988, Poek 1993, De Reuk 1995, Bakchine 1990 and Price 1992; Herrschaft 1988). Platt et al. (1993) examined the efficacy and tolerance of piracetam as an additional therapy of hydroxyethyl starch and measured its effect on the rate of blood flow in the brain post-stroke. Although this study has been included (see table 14.5.1), it should be noted that Platt et al. did not address aphasia or the impact of treatment on aphasia specifically (Platt et al. 1993).
14.5.1 Piracetam

Piracetam is a γ-aminobutyrate derivative, a pharmacological agent with a potential effect on cognition and memory. Piracetam is thought to improve learning and memory by facilitating release of acetylcholine and excitatory amino acids, with increases in blood flow and energy metabolism (Kessler et al. 2000). A summary of RCTs investigating the effectiveness of Piracetam at improving aphasia post stroke are presented in Table 14.5.1.2. It is important to note that Piracetam has not been approved by the FDA nor Health Canada for sale or prescription.

Table 14.5.1.2 Summary of Effect of Piracetam on Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huber et al. (1997)</td>
<td>RCT (7) N=66</td>
<td>E: Piracetam treatment + intensive language therapy C: Intensive language therapy</td>
<td>Aachen Aphasia Test: Token Test (-); Repetition (-); Written language (+); Naming (-); Comprehension (-); Profile level (-)</td>
<td></td>
</tr>
<tr>
<td>Enderby et al. (1994)</td>
<td>RCT (6) N=158</td>
<td>E: Piracetam treatment C: Placebo treatment</td>
<td>Aachen Aphasia Test: 12wk post (+); 24wk post (-)</td>
<td>Barthel Index (-)</td>
</tr>
<tr>
<td>Szelies et al. (2001)</td>
<td>RCT (6) N=24</td>
<td>E: Piracetam treatment C: Placebo treatment</td>
<td>FAS phonemic fluency task (-)</td>
<td>Corsi’s Block Span Test (-)</td>
</tr>
</tbody>
</table>

- Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

Discussion

All of the RCTs included in the review generally concluded that patients treated with piracetam demonstrated statistically significant improvements on a number of aphasia and other outcomes. Three RCTs compared piracetam to a placebo while two others also provided comprehensive language therapy. However, the outcomes assessed by these studies are not uniform and additionally, each of the trials involved small samples. An early Cochrane Systematic Review assessed the efficacy of six drugs, including bromocriptine, used to treat aphasia. Except for piracetam, the review suggests that there was no sufficient evidence of increased benefit versus harm for any of the drugs (Greener et al. 2001). The authors also reported safety concerns about piracetam, as it was found to be associated with early mortality. An updated Cochrane Systematic Review that examined the efficacy of piracetam in acute stroke included three trials that were comprised of 1002 participants, although the majority (93%) of data reported from the trials came from one study (Ricci et al. 2012). Further, the authors stated that piracetam was associated with a 31% increase in one-month mortality, although this association was attenuated when they adjusted for stroke severity in the analysis. There were also no significant differences reported between the treatment and control groups for functional outcome, dependence status or the proportion of patients who died. The review concluded that piracetam has not been sufficiently studied and further research is required. It appears that piracetam may be helpful for improving speech and language.
outcomes for post-stroke aphasia however, assessment of stroke severity may be very important for patients considering using piracetam routinely. In Canada, piracetam has not received official approval, and is not regulated by Health Canada; it has also not been issued a Drug Identification Number.

Conclusions Regarding Piracetam

*There is level 1a evidence that piracetam may be no better than placebo for comprehensive language assessment, and specific language outcomes, including semantic and phonological outcomes.*

*There is level 1b evidence that piracetam may be helpful for arm and leg motor movement, and the rate of perfusion compared to placebo.*

*There is level 1b evidence that piracetam combined with language therapy may be no better than placebo for comprehensive language assessment and other language performance outcomes.*

**Piracetam when delivered alone or combined with language therapy may be helpful for aphasia recovery.**

### 14.5.2 Bromocriptine

Bromocriptine is a dopaminomimetic ergot derivative with D2-type receptor antagonist properties that is primarily regarded as a dopamine agonist. Thus far, only a few studies used Bromocriptine to identify its effects on aphasia (See Table 14.5.2.1).

**Table 14.5.2.2 Summary of Effect of Bromocriptine on Aphasia Post-Stroke**

<table>
<thead>
<tr>
<th>Author, Year Study Design (PEDro Score) Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gupta et al. (1995)</strong> Cross-over RCT (7) N=20</td>
<td>E: Bromocriptine C: Placebo</td>
<td>• Western Aphasia Battery (-) • Boston Naming Test (-) • Wechsler Memory Scale-Revised (-) • Raven’s Progressive matrices (-) • Rey-Osterrieth Figure (-) • Mean phrase length (-) • Information index (-)</td>
</tr>
<tr>
<td><strong>Ashtary et al. (2006)</strong> RCT (7) N=38</td>
<td>E: Bromocriptine treatment C: Placebo treatment</td>
<td>• Persian Language Test (-)</td>
</tr>
<tr>
<td><strong>Sabe et al. (1995)</strong> Cross-over RCT (6) N=7</td>
<td>E: Bromocriptine C: Placebo</td>
<td>• Speech component analysis: Significant words (-); Content units (-); Pauses (-) • Controlled Oral Work Association Test (-) • Boston Naming Test (-)</td>
</tr>
</tbody>
</table>

* - Indicates no statistically significant differences between treatment groups
+ - Indicates statistically significant differences between treatment groups

**Discussion**

Bragoni et al. (2000) reported significant quantitative (e.g. dictation, reading comprehension, repetition, verbal latency) and qualitative improvements associated with the use of bromocriptine. Three RCTs included in this review have not identified significant differences in outcomes between groups that were offered either Bromocriptine or a placebo for treatment of aphasia. Studies also vary on the use of
outcome measures for speech and language performance. In 2001, a Cochrane Systematic Review assessed the efficacy of six drugs, including bromocriptine, used to treat aphasia. Except for Piracetam, the review suggests that there was not sufficient evidence of benefit from any of the drugs (Greener et al. 2001).

**Conclusions Regarding Bromocriptine**

*There is level 1a evidence that bromocriptine may be no better than placebo for treating aphasia post-stroke.*

*Bromocriptine may be helpful for aphasia recovery post-stroke, however, further research is required.*

### 14.5.3 Levodopa

Levodopa is a metabolic precursor of dopamine. Dopamine is involved in a variety of actions or mechanisms many of which may be influential in learning and executive function (Knecht et al. 2004; Seniow et al. 2009). In normal adults, the use of levodopa as an adjunct to massed training of an artificial vocabulary was associated with the speed, success and retention of novel word learning (Knecht et al. 2004). Three RCTs have examined the use of Levodopa combined with speech and language therapy in individuals with aphasia following stroke (See Table 14.5.3.1).

**Table 14.5.3.1 Summary of Use of Levodopa during Speech and Language Therapy in Aphasia Post-Stroke**

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seniow et al. (2009) RCT (7) N=40</td>
<td>E: Levodopa + speech-language therapy C: Placebo + speech-language therapy</td>
<td>- Boston Diagnostic Aphasia Examination: Animal naming (+); Repetition (+); Word discrimination (-); Commands (-); Complex ideational material (-); Visual confrontation naming (-); Body part naming (-); Body part identification (-)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Leeman et al. (2011) Cross-over RCT (7) N=12</td>
<td>E: Levodopa + computer-assisted therapy C: Placebo + computer-assisted therapy</td>
<td>- Naming accuracy (-)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Breitenstein et al. (Breitenstein et al. 2015) Germany Cross-over RCT (5) N=10</td>
<td>E: Levodopa/carbidopa + intensive language treatment C: Placebo treatment + intensive language treatment</td>
<td>- Object naming (-) - Amsterdam Nijmegen Everyday Language Test (-) - Communicative Activity Log (-) - Stroke and Aphasia Quality of Life Scale (-)</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

- Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

**Discussion**

Like Bromocriptine, Levodopa influences neurotransmission via the dopaminergic system. Early studies, both in normal adults and in individuals with aphasia following stroke, suggest that use of levodopa as an adjunct to speech and language therapy may promote learning. However, two of the RCTs included here found no significant improvement with levodopa as an adjunct to language therapy when compared to a
placebo (Breitenstein et al. 2015; Leemann et al. 2011). The authors propose that this lack of effect may be the result of a recovery ceiling where participants receiving language therapy might have already reached their maximum recovery potential. Furthermore, the authors suggest that the low number of participants and variability in the type of aphasia among participants may have affected results. Only one RCT indicated a positive effect of levodopa on repetition and word retrieval but not on any other subtests of the Boston Diagnostic Aphasia Examination (Seniow et al. 2009). Further study is required.

Conclusions Regarding Levodopa

There is level 1a and level 2 evidence that the use of levodopa may not be an effective adjunct to speech and language therapy.

The effectiveness of levodopa as an adjunct to speech and language therapy may be limited.

14.5.4 Amphetamines

The amphetamines belong to the general group of sympathomimetic amines. Effective doses can enhance performance and wakefulness, decrease feelings of fatigue, increased alertness and mood (euphoria) in humans. Methylphenidate, an amphetamine, blocks the reuptake of serotonin and norepinephrine, and has dopaminergic activity as well (See Table 14.5.4.1. for summary of RCT).

Table 14.5.4.1 Summary of Amphetamines in Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walker-Batson et al. (2001)</td>
<td>RCT (7)</td>
<td>N=21</td>
<td>E: Dextroamphetamine + speech and language therapy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>C: Placebo + speech and language therapy</td>
</tr>
</tbody>
</table>

- Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

Discussion

Only on RCT was found to use amphetamines as an adjunct treatment for aphasia. The findings demonstrate a positive effect of amphetamines on ones' communication ability however, results are to be interpreted with caution as the study included a low number of participants with various types of aphasia. Further studies of a higher methodological quality are required to determine the effectiveness of amphetamines as an adjunct to speech and language therapy.

Conclusions Regarding Amphetamines

There is level 1b evidence that dextroamphetamine may improve aphasia recovery when combined with speech and language therapy.

Dextroamphetamine appears to improve aphasia recovery when combined with language therapy.
14.5.5 Bifemelane
Amaducci et al. (1981) proposed that cholinergic activity could be literalised to the left temporal lobe. Thus, damage to this area may result in anomia and verbal memory deficits. Moreover, Tanaka et al. (1997) suggested that neurological syndromes other than aphasia (e.g. Alzheimer’s disease), where anomia and verbal memory deficits are present, are associated with temporal lobe disease and are thus correlated with reduced cholinergic activity. It is worth noting that Bifemelane is not used clinically in the treatment of aphasia.

Table 14.5.5.1 Summary of Amphetamines in Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year Study Design (PEDro Score) Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanaka et al. (1997) RCT (6) N\text{start}=4 N\text{end}=4</td>
<td>E: Bifemelane (300mg) C: No treatment</td>
<td>• Comprehension: E (+) • Naming (Animal category): E (+)</td>
</tr>
</tbody>
</table>

* Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

Discussion
Bifemelane has not been sufficiently studied for post-stroke aphasia and there have been no new studies assessing its pharmacological effects on aphasia recovery.

Conclusions Regarding Bifemelane

There is level 1b evidence that Bifemelane may improve comprehension and naming; however more research is needed.

Bifemelane may improve comprehension and naming; however, more research is needed to determine its effectiveness at facilitating aphasia recovery.

14.5.6 Dextran-40
Dextran-40, or low molecular-weight dextran, was chosen as a potential treatment for acute stroke because of its role in altering red cell charge and in decreasing platelet aggregation. It is worth noting that this drug is not used clinically in the treatment of aphasia.

Table 14.5.6.1 Summary of Amphetamines in Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year Study Design (PEDro Score) Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spudis et al. (1973) RCT (4) N=59</td>
<td>E: Dextran-40 C: No treatment</td>
<td>• Consciousness, Language: greater proportion of participants in E improved</td>
</tr>
</tbody>
</table>

* Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

Discussion
Pharmacological effects of Dextran-40 on post-stroke aphasia have not been sufficiently studied, therefore further research is warranted.

**Conclusions Regarding Dextran-40**

*There is level 1b evidence that Dextran-40 may result in better outcomes than the non-treatment control.*

Dextran-40 treatment may result in better outcomes for aphasia recovery compared to no treatment; however, more research is needed to determine its effectiveness on other language deficits.

### 14.5.7 Moclobemide

Moclobemide is a reversible monoamine oxidase (MAO)-inhibitor, which causes a general increase in the concentrations of neurotransmitters. On the premise that enhancement of CNS neurotransmission might improve aphasia recovery, one randomized controlled trial has examined the effectiveness of moclobemide in the treatment of aphasia (Table 14.5.7.1).

**Table 14.5.7.1 Summary of Moclobemide in Aphasia Post-Stroke**

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
</tr>
</thead>
</table>
| Laska et al. (2005) | RCT (9) | N=90 | E: Moclobemide treatment C: Placebo treatment | • Reinvang’s Aphasia Test (-)  
• Amsterdam-Nijmegen Everyday Language Test (-) |

- Indicates no statistically significant differences between treatment groups  
+ Indicates statistically significant differences between treatment groups

**Discussion**

Moclobemide has not been sufficiently studied for post-stroke aphasia and further research is warranted to assess its pharmacological effects on aphasia recovery.

**Conclusions Regarding Moclobemide**

*There is level 1b evidence that the use of Moclobemide may not improve verbal communicative abilities of individuals with aphasia.*

More research is needed to determine the effectiveness of Moclobemide on aphasia recovery.

### 14.5.8 Donepezil

Donepezil is a selective acetylcholinesterase inhibitor used to stabilize cognitive deficits in individuals with mild to moderate dementia. Use of donepezil in patients with mild to moderate vascular cognitive impairment has been associated with significant improvements in cognitive and global function, including improvements in the performance of activities of daily living (Passmore et al. 2005). The results of an open-label, 20-week pilot study (Berthier et al. 2003) suggested that patients with chronic post stroke aphasia experienced improvement in language function following treatment. The open label pilot study
and subsequent RCT are summarised in Table 14.5.8.1.

**Table 14.5.8.1 Summary of Donepezil in Aphasia Post-Stroke**

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score) Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
</table>
| Berthier et al. (2006) RCT (7) N=26 | E: Donepezil treatment C: Placebo treatment | • Aphasia Quotient (+)  
• Psycholinguistic Assessments of Language Processing in Aphasia: Picture naming (+); Non-word repetition (-); Word repetition (-); Spoken word-picture matching (-); Spoken sentence-picture matching (-); Auditory lexical decision (-); Auditory phonemic discrimination-word pairs (-)  
• Communicative Activity Log: 16wk (-); 20wk (+)  
• Stroke Aphasic Depression Questionnaire (-) |

* - Indicates no statistically significant differences between treatment groups  
+ Indicates statistically significant differences between treatment groups

**Discussion**

The studies summarised above (Berthier et al. 2006; 2003) reported improvement in global language function on the WAB-AQ during treatment with donepezil HCl, however these improvements were not maintained at follow-up. In addition, gains do not extend to functional, everyday communication as evidenced by the lack of improvement on the Communicative Activity Log associated with treatment (Berthier et al. 2006). Although no significant differences between the donepezil group and the placebo group was found on the CAL, there was however, a significant difference between the higher dose and the lower dose of donepezil measured by the CAL (Berthier et al. 2006).

Recently, Berthier et al. (2014) used a similar crossover study design to compare effects between massed sentence repetition therapy (MSRT) and distributed speech-language therapy (DSLT) on verbal output, short-term memory, and repetition in patients receiving donepezil. Unlike in the previous studies where the patient sample was characterized by a general aphasia deficit, the patients in this study had a much rarer form of aphasia characterized by a deficit in speech conduction. Similar to the other two studies, Berthier et al. (2014) reported statistically significant improvements on language function assessed by the WAB-AQ and other repetition tasks such as the repetition of novel sentences, word triplet repetition scores, and the percentage of picture description-correct information units. Despite intervention type, no statistically significant changes were found in language processing or cliché repetitions, and further inconsistent findings were reported for word pair repetition measured under different conditions.

Although the above-mentioned studies suggest that donepezil may enhance improvement in linguistic domains, results should be interpreted with caution due to a number of methodological limitations, such as the absence of an appropriate control group, lack of double-blinding procedures, small patient populations, and practice effects.

**Conclusions Regarding Donepezil**

*There is level 1b evidence that donepezil may produce some improvement on global language function, this improvement is reported only during active treatment and may not extend to everyday communication ability.*
14.5.9 Memantine
Memantine is an antagonist of the N-methyl-D-aspartate (NMDA) receptor. Its use has been evaluated among patients with Alzheimer’s Dementia and those with vascular dementia. A single RCT has examined the use of memantine alone and in conjunction with constraint-induced language therapy for the treatment of chronic aphasia following stroke (Table 14.5.9.1).

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berthier et al. (2009)</td>
<td>RCT (8) N=28</td>
<td>E: Memantine treatment + constraint induced aphasia treatment C: Placebo treatment+ constraint induced aphasia treatment</td>
<td>Western Aphasia Battery: Aphasia Quotient (+); Naming (+); Spontaneous speech (+); Auditory comprehension (+); Repetition (-) Communicative Activity Log (+)</td>
<td></td>
</tr>
<tr>
<td>Barbancho et al. (2015)</td>
<td>RCT (8) N_{Start}=28 N_{End}=27</td>
<td>E: Memantine treatment + constraint induced aphasia treatment C: Placebo treatment+ constraint induced aphasia treatment</td>
<td>Aphasia Quotient (+)</td>
<td></td>
</tr>
</tbody>
</table>

- Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

Discussion
There is limited evidence for the effectiveness of constraint-induced language therapy on chronic aphasia following stroke. An earlier study (Berthier et al. 2009) found that treatment with constraint-induced aphasia therapy (CIAT) alone, and in combination with memantine, led to statistically significant improvements on comprehensive language assessment and tests for naming abilities (Berthier et al. 2009). Combination therapy appeared to augment the effect of CIAT and, while removal of memantine was associated with some loss of benefit. Assessment using WAB-AQ demonstrated that patients in both groups maintained improvements compared to both baseline and placebo conditions. A recent study (Barbancho et al. 2015) also examined the effect of memantine or placebo alone and each in combination with CIAT on language recovery, and reported similar findings. Results from their study showed that the treatment group demonstrated statistically significant improvements in comprehensive language assessment outcomes (using the WAB-AQ) following memantine therapy (weeks 0-16), and demonstrated additional improvements in language performance when CIAT was supplemented (weeks 16-18), as compared to the improvement group. The study’s placebo group did not show any improvement on the WAB-AQ, but exhibited improvements after CIAT was introduced.

The effectiveness of CIAT alone and with memantine therapy in the above-mentioned studies has been rated as ‘moderate’ to ‘good’ methodological quality. There are other limitations with respect to differences in trial design, statistical power and sample sizes used in each of these studies. Berthier et al. (2009) provided a justification for the study sample size using 80% power, and mentioned whether the results reported showed any clinically relevant benefit; these points were not transparent in Barbancho et al. (Barbancho et al. 2015) though a similar sample size was used. As there are only two studies presenting evidence for the effectiveness of memantine therapy in combination with CIAT on aphasia severity, further study is warranted.
Conclusions Regarding Memantine

*There is level 1a evidence for the effectiveness of memantine therapy on the treatment of chronic aphasia. Combination therapy using constraint-induced language therapy and memantine may provide additional benefit than either therapy used independently.*

Memantine offered in combination with constraint-induced language therapy may improve language and communication, however further research is still warranted.

14.5.10 Galantamine

Galantamine is an acetylcholinesterase inhibitor that also modulates nicotinic receptors (Erkinjuntti et al. 2002; Erkinjuntti et al. 2004). It has primarily been shown to be of benefit in terms of cognition, behaviour and the performance of activities of daily living when used in the treatment of Alzheimer’s dementia. A single study has examined the use of galantamine for the treatment of chronic aphasia (Table 14.5.10.1).

Table 14.5.10.1 Summary of Galantamine in Aphasia Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong et. al. (2012)</td>
<td>E: Galantamine treatment  C: No treatment</td>
<td>Western Aphasia Battery (+)</td>
</tr>
<tr>
<td>RCT (7) N=45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Indicates no statistically significant differences between treatment groups
+ Indicates statistically significant differences between treatment groups

Discussion

A single study suggested that cholinergic boosting via galantamine may be helpful in treating chronic aphasia post stroke. Hong et al. (2012) demonstrated that the administration of galantamine led to a statistically significant and clinically meaningful improvement (≥20 points on the aphasia quotient (AQ) of the Western Aphasia Battery from baseline to endpoint) in linguistic function and improved WAB-AQ scores in the treatment group, but not in the control group. Multivariable logistic analyses adjusting for potential confounders showed that the presence (compared to absence) of subcortical lesions (OR=30.3; 95% CI: 1.1 to 805.9, p=0.041) was significantly associated with a good responsiveness to galantamine administration (i.e. patients with subcortical lesions are 30 times more likely to respond well to galantamine than those without subcortical lesions). However, the 95% confidence interval associated with the OR is substantially large, and additionally with a smaller sample size, the results of this study should be interpreted with caution.

Conclusions Regarding Galantamine

*There is level 1b evidence that galantamine may have a beneficial effect on post-stroke aphasia; however, Galantamine has not been studied sufficiently in aphasia recovery.*

Treatment with Galantamine may result in improved linguistic function; however, it has not been studied sufficiently in aphasia recovery to draw any meaningful conclusions.
14.6 Cochrane Reviews of Therapies for Aphasia

There are currently three Cochrane Reviews examining treatments for aphasia post-stroke. All three examine very different treatment approaches including pharmacological treatments, transcranial Direct Current Stimulation, and speech and language therapies. These reviews are an important synthesis of the information pertaining to these therapy approaches, and have been summarized in Table 14.6.1.

Table 14.6.1 Summary of Cochrane Reviews for aphasia therapies Post-Stroke

<table>
<thead>
<tr>
<th>Author, Year Country Title</th>
<th>Description</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greener et al. (2010) UK Pharmacological treatments for aphasia</td>
<td>10 trials were included in this review (N= 4 to 927 participants) Inclusion Criteria: randomized controlled trials with a pre-specified aim of examining the effects of a pharmacological treatment on language function in a stroke population Objective: to assess whether a pharmacological treatment for language function is better than a) no treatment, b) speech-language treatment, or c) another drug therapy</td>
<td>Drugs examined in the 10 identified studies included piracetam, bifemelane, piribedil, bromocriptine, idebenone, and dexetran-40. Only piracetam trials contained adequate information for consideration in the review. Data from four piracetam trials found a statistically significant difference in speech and language outcomes in favour of the treatment group compared with placebo (OR=0.46, 95%CI 0.3 to 0.7). No statistically significant differences were found in rates of death or adverse events.</td>
</tr>
<tr>
<td>Brady et al. (2012) UK Speech and language therapy for aphasia</td>
<td>39 RCTs were included in the review (N=2518 participants) Inclusion Criteria: Randomized controlled trials examining Speech-Language Therapy (SLT) compared with no intervention, social support intervention, or another form of SLT intervention (i.e. differs in intensity, duration, or theoretical approach) Objective: to assess the effectiveness of a SLT intervention compared with a) no intervention, b) a social support intervention, or c) a different SLT intervention</td>
<td>SLT vs. no intervention (19 studies (N=1414)): In meta-analysis, significant between group differences were found on measures of functional communication (p=0.008, SMD=0.26, 95%CI 0.03 to 0.48). Significant differences were also seen in measures of receptive language (reading comprehension: p=0.05, SMD=0.29, 95%CI 0 to 0.58; other comprehension: p=0.02, MD=8.04, 95%CI 1.55 to 14.52), as well as expressive language (general expressive: p=0.02, SMD=0.77, 95%CI 0.14 to 1.39; written language: p=0.002, SMD 0.45, 95%CI 0.16 to 0.74) in favour of SLT. No between group differences were noted in meta-analysis of measure of impairment severity. SLT vs. social support intervention (7 trials (N=279)): No differences were noted between groups on measures of functional communication. Receptive language improved in measures of comprehension only, favouring the control group over SLT therapy (p=0.04, SMD=0.97, 95%CI -1.70 to -0.04). Expressive language outcomes were somewhat conflicting with greater improvements seen in the SLT group in measures of sentence expression (treated items, p=0.01, MD=3, 95%CI 0.63 to</td>
</tr>
</tbody>
</table>
5.37), however, social support control groups were shown to make greater improvements over SLT therapy in single word expression (p=0.003, MD=-7.0, 95%CI -11.67 to -2.33), general expressive language (p=0.0007, MD=-1.56, 95%CI -2.46 to -0.66), and written language (p=0.01, MD=-1.39, 95%CI -2.49 to -0.29). Measures of severity as measured by the PICA also favoured control groups over SLT, with social support control groups experiencing a greater decrease in severity (p=0.005, MD-1.13, 95%CI -1.91 to -0.35).

SLT vs. SLT (25 RCTs (N=910 participants)): These studies were grouped into experimental SLT vs. conventional SLT (improved word fluency in SLT group, p=0.005), high intensity vs. low intensity SLT (greater improvements in communication in high intensity SLT group, p=<0.05), group vs. one to one SLT (no between group differences), volunteer vs. professional facilitated SLT (no between group differences), computer facilitated vs. professional facilitated SLT (no between group difference), semantic vs. phonological SLT (greater improvements in phonological SLT (auditory lexical decision) p=0.01), cognitive linguistic vs. communication SLT (no between group difference), verbal comprehension vs. preposition comprehension SLT (no between group difference), functional vs. conventional SLT (greater functional communication improvements in functional SLT group, p=0.001), constraint induced language therapy vs. conventional SLT (no between group difference), and operant training vs. conventional SLT (greater improvements with conventional SLT in expressive language, p=0.02 (word fluency) and p=0.05 (graphic subtest)), and severity of impairment (p=0.05)).

Authors concluded that this review provided some evidence that SLT is effective for improved functional communication, receptive and expressive language following stroke. However, study heterogeneity and methodological quality precludes the ability to recommend any one SLT therapy over another.

**Elsner et. al. (2013)**
Germany

Transcranial direct current stimulation for aphasia post stroke

| Five trials (N=54 participants) were included | Inclusion Criteria: RCTs and randomized crossover trials were included in the review. All trials compared transcranial Direct Current Stimulation (tDCS) (with or without speech-language therapy) |
| Naming accuracy did not appear to be effected by study group (anodal, cathodal or sham tDCS). | No evidence of improvement was observed between groups when divided by time post stroke (acute, subacute or chronic). |
with sham tDCS or sham plus speech-language therapy

**Objective:** to assess the effectiveness of transracial Direct Current Stimulation treatment for aphasia following stroke

Subgroup analysis of tDCS location (lesion or non-lesion hemisphere) and type of stimulation (anodal, cathodal, or sham) showed no difference in naming accuracy between groups. There is no evidence that tDCS therapy is able to improve aphasia outcomes.

Overall, the three Cochrane reviews examining interventions for aphasia and communication impairment following a stroke event that have been conducted to date are largely inconclusive. Although a large number of studies have been conducted examining pharmacological treatments for aphasia, only piracetam has been able to demonstrate any effectiveness in the treatment of aphasia. Speech-Language Therapy has also been widely studied and has some evidence to support its effectiveness. However, variability between studies, measures of outcome, and interventions themselves lead to difficulties in drawing definite conclusions regarding the efficacy of this intervention approach. Finally, transcranial Direct Current Stimulation is lacking in evidence to support its effectiveness as a treatment for aphasia and communication disorders following a stroke event.

### 14.7 Apraxia

Apraxia is a disorder of voluntary movement where one cannot execute willed, purposeful activity despite the presence of adequate mobility, strength, sensation, co-ordination, comprehension, and motivation. Common apraxias are listed in Table 14.7.1.

<table>
<thead>
<tr>
<th>Type</th>
<th>Site of Lesion</th>
<th>Manifestation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor or Ideomotor</td>
<td>Often left hemisphere.</td>
<td>Can automatically perform a movement but cannot repeat it on demand.</td>
</tr>
<tr>
<td>Ideational</td>
<td>Often bilateral parietal.</td>
<td>Can perform separate movements but cannot co-ordinate all steps into an integrated sequence.</td>
</tr>
<tr>
<td>Constructional</td>
<td>Either parietal lobe but right more often than left.</td>
<td>Unable to synthesize individual spatial elements into a whole (e.g., cannot draw a picture).</td>
</tr>
<tr>
<td>Dressing</td>
<td>Either hemisphere, right more often than left.</td>
<td>Inability to dress oneself despite adequate motor ability.</td>
</tr>
</tbody>
</table>

#### 14.7.1 The Importance of Apraxia Post-Stroke

Roughly 30% of patients in the acute phase of stroke show evidence of apraxia (Donkervoort et al. 2000; Faglioni & Basso 1985). However, as noted by Koski and colleagues (2002), there is considerable variability in the estimate across studies because of the lack of standardized assessment tools and the wide variations in criteria for diagnosing the disorder. Elsewhere, incidence rates of apraxia in left hemispheric stroke patients have ranged from 28% (De et al. 1980) to 57% (Barbieri & De 1988). Typically, incidence of apraxia is higher after damage to the left hemisphere (50%), than to the right hemisphere (<10%) (De et al. 1980).

Information provided by analysis of the data from the Copenhagen Study suggested that the frequency of apraxia may be substantially lower than previously reported. Out of 618 stroke patients, Pedersen et al. (2001) identified apraxia of any type in 9.1%. Manual apraxia was found in 7% of patients and oral apraxia
in 6%. Manual and oral apraxia were both associated with left-sided stroke lesions and strokes of greater severity (Pedersen et al. 2001).

While it has been suggested that the presence of apraxia can lead to severe disabilities in activities of daily living (Bjorneby & Reinvang, 1985; Saeki et al., 1995; Sundet et al., 1988; Foundas et al., 1995; Rothi & Heilman, 1997), results of the Copenhagen Study suggest that this is not necessarily the case. When the influence of manual and oral apraxia on functional outcome (represented by performance on the Barthel Index) was examined, taking initial Barthel Index scores, initial stroke severity and history of prior stroke, comorbidity, gender, age and handedness into account, no significant independent relationship could be found between apraxia and functional outcome. Unsal-Deliialioglu et al. (2008) demonstrated that patients with apraxia may experience significant gains in function over the course of rehabilitation, although admission and discharge FIM scores may be significantly lower than their non-apraxic counterparts (Unsal-Deliialioglu et al. 2008).

It has been suggested that apraxia and aphasia are associated (Papagno et al. 1993). Unsal-Deliialioglu et al. (2008) reported that, in a group of patients with right-sided post-stroke hemiplegia, patients with apraxia recorded lower aphasia assessment scores than non-apraxic patients (Unsal-Deliialioglu et al. 2008). In the Copenhagen Study, the association between apraxia and other neurological symptoms was investigated (Pedersen et al. 2001). While apraxia was found to be significantly associated with aphasia ($r=0.28$ for manual apraxia and $r=0.36$ for oral apraxia, $p<0.001$ for both), associations with body hemineglect and anosognosia for hemiplegia were of a similar magnitude.

14.7.2 Anatomical Substrates of Apraxia

Although apraxia is more commonly associated with strokes affecting the left parietal lobe, it may also occur in lesions to the right parietal lobe, the temporal or frontal lobes, and even subcortical regions including white matter and the basal ganglia (Leiguarda 2001). According to Koski et al. (2002), “...the parietal cortex subserves an important component of the praxis system, especially concerned with the knowledge or representation of overlearned actions. It is recognized, however, that damage to cortical and/or subcortical regions outside the left parietal cortex, including the right hemisphere, have also been associated with apraxia and it is assumed that each of these different neural regions makes its own distinct contribution to the representation of action...”

14.7.3 Recovery of Apraxia Post-Stroke

While apraxia usually improves over time, spatiotemporal errors in imitation or tool use may persist (Maher & Ochipa 1997). Basso and colleagues (1987) (as cited by van Heugten et al. (2000)) investigated the recovery from ideomotor apraxia (IMA) in acute stroke patients and attempted to identify predictive variables of IMA. They observed that recovery was related to the site of lesion in that patients with anterior lesions demonstrated better recovery. Recovery was not related to age, education, sex, type of aphasia and the initial severity or the size of the lesion.

14.7.4 Treatment of Apraxia

The presence of apraxia in the acute phase post-stroke serves as a barrier to rehabilitation since the process of motor learning may depend on imitation. Moreover, in aphasic patients, the presence of apraxia prevents the teaching of gestural communication as part of therapeutic interventions (Koski et al. 2002).
A recent review of the literature identified studies describing 10 treatment approaches: multiple cues, error reduction, six-stage task hierarchy, conductive education, strategy training, transitive/intransitive gesture training, rehabilitative treatment and errorless completion + exploration training (Buxbaum et al. 2008). Most of the reports identified are single-case, or single-case series. Only two of these treatment approaches have been investigated using randomized controlled trials and are described below. Please note that “rehabilitative treatment” is sufficiently similar to gesture training to be included with it for the purposes of the present review.

14.7.4.1 Strategy Training

Strategy training provides individuals with limitations in activities of daily living with compensatory strategies to promote independence. Our review identified one study investigating the effectiveness of this technique on apraxia of speech production and three trials examining the effectiveness of this technique on motor apraxia and ataxia.

Table 14.7.4.1.1 Summary of Treatment of Ideomotor Apraxias and Ataxia

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design (PEDro Score)</th>
<th>Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donkervoort et al. (2001)</td>
<td>RCT (8)</td>
<td>N_start=113 N_end=102</td>
<td>E: Strategy training to compensate for apraxia + usual occupational therapy C: Usual occupational therapy only</td>
<td>• Barthel ADL (at post-treatment) (+) • Barthel ADL (at 5mo follow-up) (-)</td>
<td></td>
</tr>
<tr>
<td>Geusgens et al. (2006)</td>
<td>RCT (8)</td>
<td>N_start=113 N_end=102</td>
<td>E: Strategy training to compensate for apraxia + usual occupational therapy C: Usual occupational therapy only</td>
<td>• ADL Observation scores (at 8wks) (+) • ADL Observation scores (at 20wks) (-)</td>
<td></td>
</tr>
</tbody>
</table>

+ Indicates statistically significant differences between treatment groups  
- Indicates no statistically significant differences between treatment groups

Discussion

All studies employed a strategy training approach to treating motor apraxia and ataxia. This approach was successful in all studies with Activities of Daily Living (ADL) assessments revealing significant improvements (Mireille Donkervoort et al. 2001; Geusgens, van Heugten, et al. 2006). However, two of these studies, Geusgens et al.(2006) and Donkervoort et al.(2001) noted that these improvements did not last in the long-term with no differences reported between the intervention group and the control group at eight weeks and 20 weeks respectively.

Both Cicerone et al. (2005) and Cappa et al. (2005) include the above studies in their review of evidence for the remediation of apraxia. Both concluded that apraxia may be treated effectively through the use of compensatory or strategy training. Cappa et al. (2005) further recommended treatment focused on structured, functional activities. Further studies are required and assessment of transfer of training effects to untrained activities is recommended.

Conclusions Regarding Treatment of Ideomotor Apraxias and Ataxia

**There is level 1a evidence that strategy training is effective in the treatment of apraxias post-stroke. Training effects may include improvement in performance of activities of daily living that appear to be sustained over time.**
Strategic or compensatory training appears to be effective in the treatment of apraxia post-stroke.

14.7.4.2 Gesture Training

Gesture training focuses on training of both transitive and intransitive gestures. Studies examining the impact of gesture training on ideomotor apraxia are summarized in Table 14.7.4.2.1.

Table 14.7.4.2.1 Summary of Gesture Training in the Treatment of Ideomotor Apraxia

<table>
<thead>
<tr>
<th>Author, Year Study Design (PEDro Score) Sample Size</th>
<th>Intervention</th>
<th>Main Outcome(s) Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smania et al. (2006) RCT (5) N\text{Start}=41 N\text{End}=17</td>
<td>E: Limb apraxia treatment C: Conventional aphasia treatment</td>
<td>• Ideomotor apraxia (+) • Gesture comprehension (+) • ADL (+)</td>
</tr>
</tbody>
</table>

+ Indicates statistically significant differences between treatment groups
- Indicates no statistically significant differences between treatment groups

Discussion

Smania et al. (2006) reported improvement in activities of daily living associated with treatment that appeared to be sustained for 2 months following the end of intervention. Further examination regarding the generalization and longevity of treatment effects is recommended.

Conclusions Regarding Gesture Training

There is level 1b evidence that gesture training may be associated with improvements in ideomotor apraxia extending to activities of daily living. These effects may be sustained for at least 2 months following the end of treatment.

Gesture training is an effective intervention for the treatment of ideomotor apraxia post stroke.

14.8 Cochrane Reviews for the Treatment of Apraxia Following Stroke

Currently, there is only one Cochrane review in existence examining the effectiveness of treatments for motor apraxia following a stroke event. This review included three randomized controlled trials.

Table 14.8.1 Summary of Cochrane Reviews for Apraxia Treatments following stroke

<table>
<thead>
<tr>
<th>Author, Year Country Title</th>
<th>Description</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>West et. al. (2009) UK Interventions for motor apraxia following stroke</td>
<td>Three identified studies met the criteria for inclusion in this review (total n=132 stroke patients). Inclusion Criteria: Randomized Controlled Trials in which a treatment for motor apraxia compared with no intervention or an alternate intervention were included.</td>
<td>A meta-analysis of two studies found that there was a significant treatment effect at the end of the intervention period in the experimental group (mean difference 1.28, 95%CI: 0.19 to 2.38, ( p=0.02 )) One study examined maintenance of functional gains 6 months post stroke and did not find evidence of a lasting effect of treatment (mean difference 0.17, 95%CI: -1.41 to 1.75, ( p=0.83 ))</td>
</tr>
</tbody>
</table>
Studies examining drug therapies alone were excluded.

Objectives:

- To determine if interventions targeted at the rehabilitation of apraxia post stroke have a sustained effect in the reduction of disability (6 months after treatment)
- To determine if any targeted intervention for apraxia is more effective in reducing disability for a sustained period of time

Authors concluded that there is currently not enough evidence to make conclusions regarding the effectiveness of treatments for motor apraxia following stroke.

The current Cochrane review of interventions for motor apraxia following stroke was not able to provide any conclusions regarding the efficacy of these therapies.
Summary

1. **There is level 1a and level 2 evidence that language therapy may not improve communicative ability, performance on comprehensive language assessments, comprehension or oral expression when compared to no treatment.**

2. **There is limited and conflicting level 1a and level 2 evidence for the effect of language therapy on communicative ability when compared to a non-aphasia therapy program.**

3. **There is level 2 and level 4 evidence that comparisons between similar types of aphasia therapy may not result in differences for the improvement of communicative ability, comprehension, language and cognitive impairment, non-verbal reasoning, verb acquisition and performance on comprehensive language assessments.**

4. **There is level 1a evidence that intensive language therapy may not improve performance on comprehensive language assessments, cognitive and language tasks or communicative ability when compared to standard language therapy; however, level 2 evidence is conflicting.**

5. **There is level 1b evidence that 19.3hrs of speech therapy program may improve performance on comprehensive language assessments compared to standard therapy (6.9hrs).**

6. **There is level 1b and level 2 evidence that volunteers can provide speech and language therapy and achieve similar outcomes in terms of comprehension and communicative ability when compared to speech-language pathologists.**

7. **There is level 1b and level 2 evidence that immediate language therapy may not improve reading comprehension, auditory comprehension or non-verbal reasoning when compared to deferred therapy; however, the evidence for communicative ability is conflicting.**

8. **There is level 1a evidence that group treatment may improve communicative ability but not conversational ability, non-verbal reasoning, verbal expression, auditory comprehension or fluency as compared to individual treatment.**

9. **There is level 1b evidence that group treatment, individual treatment and combined group and individual treatment may not produce different results in terms of word retrieval.**

10. **There is limited level 2 evidence that immediate group therapy may improve language impairment when compared to deferred group therapy; however, evidence for the effect on communicative ability is conflicting.**

11. **There is conflicting level 1b evidence in reference to the effectiveness of a community-based language program on communicative ability when compared to a recreational activities program; however, evidence suggests that the community-based program may not improve performance on comprehensive language assessments.**

12. **There is level 1b evidence that training conversation partners to acknowledge and reveal competence of individuals with aphasia may enhance the conversational skill of both parties when compared to delivering an informative video presentation to conversation partners.**

13. **There is limited level 2 evidence that a caregiver and patient education program may improve knowledge of aphasia but not activity level, community integration or family functioning when compared to no treatment.**

14. **There is level 1a evidence that computer-based aphasia therapy may improve word retrieval ability in the short-term but not language function or word retrieval ability in the long-term when compared to standard language therapy.**
15. **There is limited level 2 evidence that computer-based aphasia therapy may improve communicative ability and language function when compared to no treatment.**

16. **There is level 2 evidence that a reading comprehension focused computer-based treatment may improve communicative ability and language skills assessed at the impairment level when compared to a cognitive rehabilitation focused computer-based treatment.**

17. **There is conflicting and limited level 2 evidence in reference to the effect of audio-visual naming training on word retrieval ability when compared to audio only naming training.**

18. **There is limited level 2 evidence for the use of remote assessment when compared to face-to-face assessment; however, preliminary findings suggest that the interventions are comparable.**

19. **There is limited level 2 evidence that the use of teleconferencing for remote speech and language treatment is comparable to face-to-face treatment in individuals with aphasia following stroke.**

20. **There is level 1b evidence that supplementary-filmed programmed language instruction combined with speech therapy may be as effective as traditional speech therapy for aphasia recovery post-stroke.**

21. **There is limited level 5 evidence that speech rehabilitation involving biological feedback may be helpful for aphasia recovery; however, the use of video clips alone may not result an improvement. Further research regarding filmed language instruction is required.**

22. **There is level 1b and limited level 2 evidence that melodic intonation therapy may be as effective as standard language therapy for the improvement of word retrieval ability or performance on comprehensive language assessments; however, evidence regarding its effect on repetition is conflicting.**

23. **There is limited level 2 evidence suggesting that melodic intonation therapy may improve responsive speech but not repetition when compared to no language treatment.**

24. **There is conflicting and limited level 1a evidence for the effectiveness of constraint-induced aphasia therapy (CIAT) on language performance, as compared to conventional treatment or placebo.**

25. **There is limited level 2 evidence that CIAT administered by experienced therapists may be as effective as CIAT administered by trained lay persons for aphasia recovery.**

26. **There is limited level 2 evidence that CIAT may be as effective as the PACE treatment for the improvement of confrontational word retrieval in individuals with aphasia or other language disturbances caused by stroke.**

27. **There is level 1a evidence that treatment with rTMS may improve performance on comprehensive language assessment as well as on tests of naming abilities. However, there is conflicting evidence for its effectiveness on test components such as comprehension and repetition.**

28. **There is limited level 2 evidence that theta burst stimulation may improve naming abilities among individuals with aphasia as compared to sham stimulation.**

29. **There is level 1a and limited level 2 evidence that anodal tDCS applied over the left frontal cortex is associated with improved naming performance in individuals with chronic post-stroke aphasia.**

30. **There is limited Level 2 evidence that unilateral forced nostril breathing may improve anxiety and language but not attention level, spatial ability, auditory comprehension or depression.**
31. **There is level 1a and limited level 2 evidence that both semantic and phonological cues may aid in lexical retrieval abilities; however, it is unclear whether there is a difference between the uses of the two types of cues.**

32. **There is conflicting level 1b and limited level 2 evidence regarding the effect of picture-naming therapy when combined with gesture therapy on word retrieval abilities.**

33. **There is limited level 2 evidence that speech and language therapy may be helpful for individuals with global aphasia post-stroke.**

34. **There is limited evidence that specific therapy for alexia in aphasic patients may improve language function and reading ability post-stroke.**

35. **There is level 1a evidence that piracetam may be no better than placebo for comprehensive language assessment, and specific language outcomes, including semantic and phonological outcomes.**

36. **There is level 1b evidence that piracetam may be helpful for arm and leg motor movement, and the rate of perfusion compared to placebo.**

37. **There is level 1b evidence that piracetam combined with language therapy may be no better than placebo for comprehensive language assessment and other language performance outcomes.**

38. **There is level 1a evidence that bromocriptine may be no better than placebo for treating aphasia post-stroke.**

39. **There is level 1a and level 2 evidence that the use of levodopa may not be an effective adjunct to speech and language therapy.**

40. **There is level 1b evidence that dextroamphetamine may improve aphasia recovery when combined with speech and language therapy.**

41. **There is level 1b evidence that Bifemelane may improve comprehension and naming; however more research is needed.**

42. **There is level 1b evidence that Dextran-40 may result in better outcomes than the non-treatment control.**

43. **There is level 1b evidence that the use of Moclobemide may not improve verbal communicative abilities of individuals with aphasia.**

44. **There is level 1b evidence that donepezil may produce some improvement on global language function, this improvement is reported only during active treatment and may not extend to everyday communication ability.**

45. **There is level 1a evidence for the effectiveness of memantine therapy on the treatment of chronic aphasia. Combination therapy using constraint-induced language therapy and memantine may provide additional benefit than either therapy used independently.**

46. **There is level 1b evidence that galantamine may have a beneficial effect on post-stroke aphasia; however, Galantamine has not been studied sufficiently in aphasia recovery.**

47. **There is level 1a evidence that strategy training is effective in the treatment of apraxias post-stroke. Training effects may include improvement in performance of activities of daily living that appear to be sustained over time.**

48. **There is level 1b evidence that gesture training may be associated with improvements in ideomotor apraxia extending to activities of daily living. These effects may be sustained for at least 2 months following the end of treatment.**
References


Hoffmann, T., Worrall, L., Eames, S., Ryan, A. (2010). Measuring outcomes in people who have had a stroke and their carers: can the telephone be used? Top Stroke Rehabil, 17(2), 119-127.


Appendix

**Acute Stroke**
1. There is conflicting level 1a and level 2 evidence as to whether speech-language therapy improves comprehension and expression of verbal and written language in aphasia when compared to standard therapy or no treatment.

2. There is limited level 2 evidence that similar speech-language therapies do not differ at improving comprehension or production of verbal or written language in aphasia when compared to no treatment.

3. There is level 1a evidence that semantic and phonological training improve lexical retrieval in aphasia; however it is unclear whether the two differ in level of improvement.

4. There is level 1b evidence that bromocriptine does not improve comprehension or production of verbal or written language in aphasia when compared to placebo.

5. There is level 1b evidence that dextroamphetamine as an adjunct to speech-language therapy improves verbal communication in aphasia when compared to placebo.

6. There is level 1b evidence that moclobemide does not improve comprehension or production of verbal or written language in aphasia when compared to placebo.

**Subacute Stroke**
1. There is level 1b and level 2 evidence that speech-language therapy does not improve verbal communication in aphasia when compared to standard therapy.

2. There is level 1a evidence that intensive speech-language therapy does not improve comprehension or production of verbal or written language in aphasia when compared to standard speech-language therapy.

3. There is level 1b and level 2 evidence that immediate speech-language therapy does not improve comprehension or production of verbal or written language in aphasia when compared to delayed speech-language therapy.

4. There is level 1b evidence that 20hr of speech-language therapy improves comprehension and production of verbal and written language in aphasia when compared to 7hr of standard therapy.

5. There is level 1b and level 2 evidence that volunteer-facilitated and therapist-administered speech-language therapies do not differ at improving comprehension or production of verbal or written language in aphasia.

6. There is level 1b evidence that group therapy improves verbal communication in aphasia when compared to individual therapy.

7. There is level 1b evidence that melodic intonation therapy for aphasia improves repetition, but not verbal communication, when compared to conventional speech-language therapy.

8. There is level 2 evidence that melodic intonation therapy for aphasia improves responsiveness, but not repetition, when compared to no treatment.

9. There is level 1b evidence that CIT does not improve comprehension or production of verbal or written language in aphasia when compared to conventional speech-language therapy.

10. There is conflicting level 1a and level 2 evidence as to whether rTMS improves naming, repetition, comprehension, and expression in aphasia when compared to sham stimulation.
11. There is level 1a evidence that excitatory anodal tDCS over the left frontal cortex does not improve naming, repetition, or comprehension in aphasia when compared to sham tDCS.

12. There is level 2 evidence that intensive speech-language therapy improves comprehension and production of written language in global aphasia when compared to standard therapy.

13. There is level 1b evidence that piracetam improves short-term comprehension and production of verbal and written language in aphasia when compared to placebo.

14. There is conflicting level 1a evidence as to whether levodopa as an adjunct to speech-language therapy improves naming and repetition in aphasia when compared to placebo.

15. There is level 1b evidence that bifemelane improves naming and comprehension in aphasia when compared to no treatment.

16. There is level 1a evidence that strategy training for apraxia improves activities of daily living for up to 8 weeks when compared to standard therapy.

Chronic Stroke

1. There is level 2 evidence that speech-language therapy does not improve comprehension or production of verbal or written language in aphasia when compared to no treatment.

2. There is level 2 evidence that volunteer-facilitated and therapist-administered speech-language therapies do not differ at improving verbal communication in aphasia.

3. There is level 1b evidence that group therapy does not improve comprehension or production of verbal or written language in aphasia when compared to individual or dyadic therapy.

4. There is level 2 evidence that immediate group therapy improves comprehension and expression of verbal and written language in aphasia when compared to delayed group therapy; however the evidence for verbal communication is conflicting.

5. There is conflicting level 2 evidence as to whether a community-based speech-language program improves comprehension and production of verbal and written language in aphasia when compared to a recreational activities program.

6. There is level 1b evidence that training conversation partners of individuals with aphasia improves conversational skills of both parties when compared to delivering an informative presentation to conversation partners.

7. There is level 1a evidence that computer-based therapy does not improve comprehension or production of verbal or written language in aphasia when compared to therapist-administered therapy; however there is level 1b evidence that it improves short-term lexical retrieval abilities.

8. There is level 2 evidence that computer-based reading therapy improves comprehension and production of verbal and written language in aphasia when compared to computer-based stimulation therapy and no treatment.

9. There is level 2 evidence that speech-language therapy supplemented with systematic filmed instructions does not improve comprehension or production of verbal or written language in aphasia when compared to speech-language therapy alone.

10. There is level 1b evidence that CIT improves comprehension and production of verbal and written language in aphasia when compared to conventional speech-language therapy.

11. There is level 2 evidence that volunteer-facilitated and therapist-administered CIT do not differ at improving performance on comprehension and production of verbal and written language in aphasia.
12. There is level 1a evidence that rTMS improves naming, description, repetition, expression, and conversation in aphasia, but not responsiveness or comprehension, when compared to sham stimulation.

13. There is level 2 evidence that theta burst TMS improves naming in aphasia when compared to sham stimulation.

14. There is level 1a evidence that excitatory anodal over the frontal cortex improves, and in combination with inhibitory cathodal tDCS over right frontal cortex, improves naming in aphasia when compared to sham tDCS; however tDCS over the temporal cortex is not associated with such improvements.

15. There is level 2 evidence that high-definition tDCS does not improve naming performance in aphasia when compared to conventional tDCS.

16. There is level 1a and level 2 evidence that semantic and phonological training improve lexical retrieval in aphasia; however it is unclear whether the two differ in level of improvement.

17. There is conflicting level 1b and level 2 evidence as to whether gestural training during the picture naming task improves lexical retrieval in aphasia.

18. There is level 1b evidence that piracetam as an adjunct to language therapy improves comprehension and production of written language in aphasia when compared to language therapy alone.

19. There is level 1a evidence that bromocriptine does not improve comprehension or production of verbal or written language in aphasia when compared to placebo.

20. There is level 2 evidence that levodopa as an adjunct to intensive speech-language therapy does not improve verbal communication in aphasia when compared to placebo.

21. There is conflicting level 1b evidence as to whether donepezil improves comprehension or production of verbal or written language in aphasia when compared to placebo.

22. There is level 1a evidence that memantine as an adjunct to constraint-induced therapy improves comprehension and production of verbal and written language in aphasia when compared to placebo.

23. There is level 1b evidence that galantamine improves performance on comprehension and production of verbal and written language in aphasia when compared to no treatment.

24. There is level 2 evidence that gesture training for apraxia improves motor function and activities of daily living when compared to standard therapy.