Recovery Patterns in Bilingual Aphasia: Influential Factors & Cross-Language Transfer
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Abstract
Over two thirds of the world’s population speak more than one language, generating interest in the field of bilingual aphasia and particularly its recovery. Among the many theories on recovery patterns, it is widely accepted that parallel recovery of a bilingual’s languages is the most common. Of those cases of nonparallel recovery, the oldest theories on which language recovers best are the first language (Ribot’s law) or the dominantly used language (Pitres’ law). This review discusses the evidence for these theories in addition to considering influential factors of recovery, and exploring whether therapy in one language can transfer to untreated languages.

1. Introduction
Grosjean (1994) describes the term ‘bilingualism’ as the use of two or more languages and dialects in daily life. Following this definition, approximately two thirds of the world is now bilingual (Weisensee, 2007). As well as the commonly known early and late bilingual types, i.e. learning a second language (L2) either from birth or later in life respectively, Weinreich (1953) proposed the coordinate and compound bilingual types, which are thought to reflect different organisation and structure in the brain. The key difference is the context in which each language was learned: compound describes bilinguals who learn two names for each concept as they come across it, whereas coordinate bilinguals learn two separate concepts in the separate two contexts in which their languages were acquired, thus showing parallels between compound and early, and coordinate and late bilingual labels.

Interest in bilingualism in the context of acquired language impairment (aphasia) is growing. In 2001, Paradis reported increasing numbers of bilingual aphasia, with over 45,000 new cases in the USA alone. Accordingly, the Bilingual Aphasia Test (Paradis & Libben, 1987) was developed, enabling equal comparison of language impairments in various languages. The test is continually reproduced in more languages, generating a reliable appraisal of aphasia in a polyglot’s languages.

The interest in bilingual aphasia has generated many questions concerning the debated differential neural organisation of language, as well as how additional languages are processed. For instance, although it is widely accepted that the left hemisphere is also dominant for language in polyglots (Eviatar, Leikin, & Ibrahim, 1999), some claim that L2 is located in the right hemisphere when learnt post-pubertally (Vaid, 1983). The focal point of this review will be to evaluate the extent of successful recovery in the mother tongue and the dominant language across polyglot aphasia case studies, including an appraisal of influential factors such as aphasia type and age, in addition to the role of spontaneous recovery. Furthermore, the extent of cross-language transfer in rehabilitation will also be explored.

2. Patterns of Recovery
Paradis (1977) described 6 basic patterns in which a bilingual aphasic could recover their language abilities: parallel – both languages are impaired to a similar degree and recover at the same rate, differential – recovery rates differ relative to pre-morbid levels, selective – not all languages are fully restored, antagonistic – one language regresses as the other recovers, successive – one language may only begin to recover once the other is fully restored, and mixed/blended – languages are inappropriately mixed and interfere in the recovery process. The most commonly seen in all polyglot aphasia is parallel recovery (Junqué, Vendrell & Vendrell, 1995; Miertsch, Meisel, & Isel, 2009; Paradis, 2001), with Paradis reporting the incidence as 81% in the 132 cases he reviewed across various studies. Fabbro (1999) however, reported only 40% of bilingual aphasics demonstrating parallel
recovery, the rest experiencing nonparallel. Of these, 32% improved more in L1 than L2 and 28% showed better improvement in L2 than L1.

Nonparallel recovery is thought to occur when a lesion inhibits the retrieval of only certain types of lexical memories, as opposed to complete language loss. One of the two most established theories on nonparallel recovery belongs to Ribot (1882), whose law of regression states that older memories are more resistant to morbid dissolution than new memories, and therefore claimed that the first language learnt will be the better recovered. The other theory, Pitres’ law (1895), considers the order of language acquisition irrelevant: it is the dominantly used language that is more resistant to impairment, recovering more successfully; this may or may not be the mother tongue. These laws were originally intended for spontaneous recovery, however they can also be applied to cases where the patient has received speech therapy. The two theories will be discussed through case studies (more details in the appendix).

2.1 Ribot’s Law

Structural differences between languages can cause the untreated language to improve less than the treated one. One such case is a Korean-Japanese aphasic presented by Sasanuma and Sak Park (1995). He was diagnosed with Broca’s aphasia (impairment in producing speech and writing) in both languages, however made a better recovery in Korean (L1) after therapy in that language. The patient experienced involuntary mixing in Japanese oral exercises and also struggled with certain phonological aspects, which did not occur in Korean. The intense rehabilitation in L1 may have consolidated Korean particles whilst leaving Japanese particles unpractised, thus resulting in better recovery in the mother tongue.

A similar case is that of Eviatar, Leikin, & Ibrahim (1999); patient RK, a Russian-Hebrew bilingual, suffered from transcortical sensory aphasia (TSA), similar to Wernike’s aphasia (fluent but meaningless speech with comprehension deficits). Despite therapy in both languages, the dominantly used language (L2 Hebrew) had more phonological deficits than Russian did. For instance, RK better understood Hebrew when spoken in a Russian accent and preferentially wrote Hebrew in Russian orthography. The better recovery in L1 despite anomia in both phonologically different languages is potentially explained by damage to a shared lexical retrieval system. The Hybrid Model of lexical representation in the bilingual brain (de Bot, 1992) describes a lexical system for each language connected to a shared semantic system. The ease of access to lexical systems, influenced by context and age of language acquisition, results in the mother tongue having better access to semantic memories, and proving more resistant to impairment post-onset than L2. Another Russian-Hebrew study (Gil & Goral, 2004) found the Wernike’s aphasic patient to improve more in Russian (L1) after therapy in both languages.

Additionally, Nilipour and Ashayeri (1989) reported more improvement in a structurally different L1 (Farsi) in a patient with TSA who also received therapy in that language. Patient AS also recovered his other almost equally proficient languages, L2 German and L3 English and in the critical period post-onset experienced competition from German, resulting in antagonistic recovery. Farsi was however, the most frequently used language pre-morbidly as well as the mother tongue, suggesting various possible causes for the alternating antagonistic recovery.

Faroqi and Chengappa (1997) also described a case of cross-language transfer. Patient VD had aggramatic aphasia and recovered most in L1 of her 4 languages (Telugu, Kannada, English and Hindi, respectively). Treatment in Kannada resulted in vast improvement in that and Telugu, and less in English and Hindi. As VD learnt Telugu and Kannada simultaneously at an earlier age than English and Hindi, she can be considered a compound Telugu-Kannada bilingual and a coordinate English-Hindi bilingual. Compound bilinguals are more likely to show parallel recovery than coordinate bilinguals, whose different contexts for acquisition results in nonparallel recovery (Lambert & Fillenbaum, 1959). This was observed in VD whose first two languages recovered better than the latter two overall. Furthermore, the structural similarity between Telugu and Kannada may have eased lexical retrieval in
recovery. Nevertheless, these two were also the dominantly used languages, suggesting that the improved recovery is due to several reasons.

2.2 Pitres’ Law

Miertsch, Meisel and Isel (2009) presented patient BL, whose recovery in the treated language (L3 French) transferred to L2 English, yet experienced no improvement in L1 German. The study commenced 8 years post-onset of Wernike’s aphasia, however BL had received 2.5 years of treatment in German immediately post-onset, potentially explaining its reduced recoverability in the second phase of treatment. This result contradicts the Revised Hierarchical model (Kroll & Stewart, 1994); a stronger connection existed between L1 lexicon and a conceptual memory system than between L2 and the conceptual system, thus predicting L1 to be more resistant to impairment. The transferred effects of treatment are attributed to a shared conceptual system.

Similarly, Filiputti, Tavano, Vorano, De Luca, & Fabbro’s patient EG (2002) experienced recovery from Wernike’s aphasia in his treated language (L2 Italian) which was his dominantly used, improving also in L3 Friulian and L4 English. Negative effects were seen in L1 Slovenian, which was the least used pre-onset. It is noteworthy that complete comparisons involving Slovenian are not possible due to the absence of the first of the Slovenian BAT assessments. Moreover, this patient showed almost parallel recovery in the three other languages, indicating his recovery was influenced by a transferability effect in addition to pre-onset language dominance.

Abutalebi, Della Rosa, Tettamanti, Green and Cappa (2009) also found negative effects in the untreated L1 (Spanish). JRC experienced selective recovery from Wernike’s aphasia in his treated language (L2 Italian); he recovered fully in that language whilst Spanish degenerated. A possible cause of this unusual outcome may be an impairment of language control; when Spanish was better than Italian before therapy, JRC would experience interference from Spanish when speaking Italian. However, this effect reversed as Italian grew dominant with treatment. The fact that the dominantly used language recovered better in the above cases can be explained by the activation threshold hypothesis (Paradis, 1985), which posits that for each language component to be produced, a certain threshold of activation is required. Regular practice and stimulation lowers thresholds, indicating that the dominantly used language recovers best whilst those not practiced have a higher threshold, thus are harder to recover.

A rarer case of acquired aphasia in children (Fabbro & Paradis, 1995) also suggested frequency of language as an explanation in KB’s recovery pattern, an aphasic 11-year-old girl (L1 Friulian, L2 Italian). One month post-onset she spoke simple phrases only in Italian, even when addressed in Friulian. She recovered well and rapidly in both languages, however showed heightened performance in Italian overall. This could be explained by increased meta-linguistic awareness from schooling in Italian, structural differences between the two languages, or more frequent use of Italian in communicative situations. Compared to adult cases, children improve faster although never making a complete recovery.

2.3 Discussion

Of the four language modalities, a trend has emerged depicting the expressive modalities (speaking and writing) improve only in the treated language, whilst comprehension (listening and reading) can improve in untreated languages (Pearce, 2005). Nevertheless, recent research has shown there is no general rule for language recovery that cases tend to follow.

In nonparallel cases, Albert and Obler (1978) suggest that Pitres’ law stands with greater than chance accuracy compared to Ribot’s, as they only identified language dominance as a predictor of recovery. Evidence for Pitres’ law also lies in Paradis’ activation threshold hypothesis, explaining the effect seen in Miertsch et al., Abutalebi et al. and Filippiti et al., where L1 Slovenian worsened as its activation threshold was high, whilst L2 Italian (the treated language) recovered fully due to a low threshold i.e. frequent use.

Theories on shared lexical systems tend to support Ribot’s law, such as Kroll and Stewart’s RH model (1994). In addition, some have argued that language processing is more
automatic in L1 than in L2 (Dornic, 1978; Hylenstam & Stroud, 1989, as cited in Marrero, Golden, & Espe-Pfeifer, 2002), consequently language impairment would more likely occur in the non-dominant language, thus allowing L1 to be more available. Nevertheless, it is worth noting that often the first language and the dominantly used are in fact the same language (Pearce, 2005) as was the case for patient VD (Faroqi & Chengappa, 1997). This fact renders the results of Aglioti, Beltramello, Girardi and Fabbro’s (1996) and García-Caballero, et al.’s (2007) studies particularly unusual; both found that the patient recovered more in the less used L2, contradicting both Pitres’ and Ribot’s laws.

In summary, bilingual aphasic patients show various patterns of language recovery. Between the laws of Pitres and Ribot of nonparallel recovery, the evidence suggests however that Pitre’s law, i.e. the frequency of use of a language, is more influential in recovery than the age at which the language was acquired.

3. Factors influencing recovery

There are numerous factors that can affect the recovery of aphasia such as age, degree of automatism of the languages, affectivity, visualizability, orthography, severity of aphasia, context of acquisition, and relevance of the environment to the language (Paradis & Lecours, 1979, as cited in Paradis, Goldblum, & Abidi, 1982). Ansaldo, Marcotte, Scherer, and Raboyeau (2008) named the influencing factors as proficiency level, age of acquisition, method of acquisition, and motivation. Minkowski (1963) also suggested that the patient’s own preference for a language affects its recovery. An indicator of first language loss is the patient’s level of education, perhaps due to reduced language development (Marrero, Golden, & Espe-Pfeifer, 2002). Furthermore, structurally similar languages tend to be impaired and recover more similarly than structurally different languages (Paradis, 1993). Lazar (2008) claims there are yet more factors to be discovered.

The findings concerning the particular effects of age and aphasia type on recovery are not unanimous. Lendrem and Lincoln (1985) found that neither those nor sex relates to the degree of improvement in spontaneous recovery. However, Lincoln et al. (1984) found a significant effect for age in a randomised trial measuring the effect of speech therapy in which older patients experienced reduced recoverability compared to younger patients. Similarly, in a small sample of young patients, Sands, Sarno and Shankweiler (1969) found age to be the strongest factor influencing recovery with treatment. Furthermore, Obler and Albert (1977) suggested that the degeneration of short-term-memory that occurs with aging affects the pattern of recovery in bilingual aphasics.

Some argue that age relates to the patient’s aphasia type, thus affecting their recovery, as patients with Broca’s aphasia and expression impairments were significantly younger than global and Wernike’s aphasics (Eslinger & Damasio, 1981; Kertesz & Sheppard, 1981). Eslinger and Damasio suggest that neuropsychological language mechanisms may change with age to result in higher prevalence of Wernike’s aphasia in older patients. Alternatively, findings show that with age middle cerebral artery strokes tend to move posteriorly, causing Wernike’s aphasia.

Sarno and Levita (1979) reported that despite improvement, global aphasics remained more impaired than patients with other aphasia types, a potential explanation being that the severity of impairment, which is associated to aphasia type, also affects recoverability; global aphasia is more severe an impairment than other aphasia types. They also found that aphasia type affected recovery in different stages. In the first 6 months post-onset Wernike’s aphasics improved more than Broca’s aphasics, however in the next 6 months Wernike’s aphasics recovered least whilst global aphasics improved the most. Moreover, Kertesz and McCabe (1977) claimed that aphasia type is related to the degree of improvement and final recovery of a language. Contrastingly, Lincoln et al. (1984) found no significant differences between the language scores of patients with different aphasia types. However, Lendrem and Lincoln (1985) showed that despite initial minimal differences in spontaneous recovery, by 34 weeks post-onset Broca’s aphasics showed more improvement than global and Wernike’s aphasics.
In conclusion, the evidence suggests that both age and aphasia type influence language recovery independently, and perhaps even together. Due to the association between aphasia type and severity, it appears Broca’s aphasia patients recover better than Wernike’s aphasics, and global aphasia patients are predicted to have the least recoverability of their languages. Interestingly, of the case studies described, the younger subjects were those with Broca’s aphasia; patient VD (Faroqi & Chengappa, 1997) recovered all four languages after treatment in only one, and case 2 (Sasanuma & Suk Park, 1995) improved similarly in both languages excluding writing abilities. Nevertheless, there is no overall observable difference in recovery either in age or aphasia type.

4. Effects of Intervention
4.1 Spontaneous Recovery vs. Treatment

It is widely accepted that speech therapy generally benefits recovery from aphasia (Basso, 1999; Robey, 1994). A review by Bhogal, Teasell and Speechley (2003) concluded that regular sessions of therapy can greatly affect recovery during the chronic stage (>6 months post-onset). Nevertheless, there is no treatment method that is yet confirmed as the most effective. Additionally, the mechanics of how therapy shapes recovery are still unspecified.

When evaluating the efficacy of intervention, there must be a distinction between natural recovery and the results of treatment. Spontaneous recovery describes the physiological changes that occur in the initial period post-onset, but the exact time-period is much debated. Most agree that spontaneous recovery mechanisms operate up to and past the first 3 months (Gil & Goral, 2004). Therefore, the relationship between therapy and spontaneous recovery is a grey area for researchers in the first few months, made harder to clarify by currently unanswerable questions, such as whether a polyglot’s languages are affected differently by natural recovery.

In the previously described case studies, most omitted information on the time that therapy began (e.g. Eviata et al., 1999; Faroqi & Chengappa, 1997; Nilipour & Ashayeri, 1989). Some did not take spontaneous recovery into account when formulating treatment plans (e.g. Abutalebi et al., 2009; Filiputti et al., 2002), as treatment commenced 4 weeks and 6 weeks post-onset respectively, consequently rendering the reliability of therapy outcomes questionable due to premature initiation. The only instances where the effect of intervention did not compete with spontaneous recovery were studies starting several years post-onset, such as in Miertsch et al. (2009), who studied patient BL 8 years after his stroke.

4.2 Cross-Language Transfer

With regards to therapy in polyglot aphasia, there is little recent research on the transferability of treatment benefits to a patient’s untreated languages. Early studies (e.g. Fredman, 1975) suggest that intervention in one language will indeed transfer to other languages, however they lack adequate information about the specific language skills recuperated. These findings have been frequently replicated in recent literature (Edmonds & Kiran, 2006; Gil & Goral, 2004; Miertsch et al., 2009). In a review of 14 studies of therapy in polyglot aphasics, Faroqi-Shah, Frymark, Mullen, and Wang (2010) reported that most studies showed cross-language transfer (CLT), especially when L1 was treated. Notwithstanding, there are also unsuccessful reports of CLT, for example Abutalebi et al. (2009) reported selective recovery, due to findings that treatment in L2 produced negative effects in L1.

Results differ when considering the language to be treated. Fredman (1975) and Voinescu, Vish, Sirian and Maretsis (1977) proposed that the untreated language will also benefit when therapy in is L2. Some studies showed therapy benefitted the treated and untreated languages except for L1. This result was found in Filiputti et al. (2002) where treatment in L2 Italian transferred to L3 Friulian and L4 English but not L1 Slovenian, which was not frequently used pre-onset. Miertsch et al. (2009) had similar findings with BL whose
treatment in L3 French transferred to dominantly used L2 English but had no effect on L1 German.

Contrastingly, Faroqi and Chengappa (1997) reported CLT in all three languages as a result of therapy in L4, with the most improvement in L1. This was also seen in Gil and Goral (2004) whose patient’s therapy in Hebrew (L2) generalised to Russian (L1), improving more than L2. Durieu (1969) and Linke (1979, both cited in Filiputti et al., 2002) also suggested that the untreated L1 improves more than the treated L2.

Fredman’s self-report data from bilinguals demonstrated that treatment in L2 is successful in benefiting L1, regardless of structural similarities between the languages. However, this result seems unusual in the literature as most studies find that the structural similarity of a bilingual’s languages does indeed affect the transferability of therapeutic effects. Nevertheless, one must consider the validity of Fredman’s results from self-report questionnaires and the lack of objective testing. Paradis’ structural distance hypothesis (1993) states that structurally related languages are impaired and recover similarly, as well as increase the probability of CLT, possibly due to similar neural representation in the language area (Paradis, 2001). For instance Sasasnuma and Suk Park’s case 2 (1995) retained oral impairments in Japanese, despite almost equal improvement, as Japanese phonology differs to that of the treated language, Korean, thus hindering complete CLT. Voinescu et al. (1977) also argued that therapy rehabilitates only the structures that the languages share, indicating language structure to be salient to treatment transferability.

5. General Discussion

There is no general rule for recovery patterns of bilingual aphasics. It is acknowledged that a high proportion of patients recuperate their languages equally, however there are still numerous cases of nonparallel recovery. Of all the variables that influence recovery rate and pattern such as age, aphasia type and structural similarity of languages, evidence from single and cross-case studies suggests that the frequency of use of a language is more salient than the order of its acquisition. Theories like Paradis’ activation threshold hypothesis (1985) support this outcome, yet the Hybrid Model of lexical representations (de Bot, 1992) and the RH model (Kroll & Stewart, 1994) both propose the first language has easier access to lexical memories than L2. Arguably, it is only possible to integrate these theories and consider all correct when L1 is the most frequently used language.

Countless issues in the recovery of polyglot aphasia are still in need of answers, such as, despite the various hypotheses and language models, why are there still such vast discrepancies across the literature in language recovery that remain unexplained? Or, which is the most effective method of treatment? As discussed, speech therapy greatly influences the success of recovery, even transferring to untreated languages in the majority of cases. Notwithstanding, spontaneous recovery can be mistaken for the results of intervention if treatment begins within approximately 3 months post-onset, as seen in some of the case studies. The latter question could be resolved by a cross-therapy study, although it is questionable how conclusive the results could be, as too many variables i.e. aphasia types and severity, perhaps requiring different structural training, may hinder concrete findings.

A further issue that has seen much debate over the years is the language selected for therapy. Common practice is treating just one language (Green, 2005; Paradis, 2001), which as previously examined, can be successful in improving untreated languages, as many argue that therapy in two languages inhibits overall recovery (Chelnov 1948). Intervention in only one language is particularly advised in cases of pathological switching and mixing (Fabbro, 2001). Nevertheless, some therapists still choose to rehabilitate both languages, particularly if the patient has equal proficiency (Kohnert, 2004). This was observed in Eviatar et al. (1999), and also Gil and Goral (2004) who switched to therapy in Russian (L1) after over 3 months in Hebrew (L2).

The language selected for intervention can be the dominantly used, the one used in the environment, the most impaired, the least impaired, or the language with more emotional significance for the patient (Ansaldo, Marcotte, Scherer, & Raboyeau, 2008). Some even suggest the selection should be the patient’s own decision (Fabbro, 1999; Paradis, 2001).
For instance, Miertsch et al.’s patient (2009) chose treatment in L3 French because of emotional connections to that language over his others. Abutalebi et al.’s patient (2009) chose his therapy to be in Italian (L2). In line with the activation threshold hypothesis (Paradis, 1985), Ansaldo et al. (2008) proposed that treatment in the dominantly used language will be enhanced by exposure in spontaneous communicative circumstances. However, Krapf (1961) advocated that the mother tongue should be treated, whilst Chelnoc (1948), Hilton (1980), and Lebrun (1988, all as cited in Gil & Goral, 2004) suggested the better recovered language should be rehabilitated.

In conclusion, more research is required to consolidate findings in various aspects of bilingual aphasia, however it may be too complex to ever establish a common rule that applies to, and explains such varied patterns of recovery seen in the literature.
### Appendix

Table 1. Case studies providing evidence for Ribot's law.

<table>
<thead>
<tr>
<th>Age/Sex/handedness</th>
<th>Languages proficiencies</th>
<th>Aetiology</th>
<th>Initial aphasia diagnosis &amp; post-morbid language abilities</th>
<th>Rehabilitation description</th>
<th>Recovery pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sasanuma &amp; Suk Park (1995) – case 2</td>
<td>L1: Korean L2: Japanese (almost equal pre-onset)</td>
<td>Haemorrhage at subcortical region of fronto-parietal lobe.</td>
<td>Broca’s aphasia. Impairment degree &amp; pattern similar in both, but worse oral &amp; writing in L2.</td>
<td>3 months stimulation approach in L1 (3x45mins per week) total of 36 sessions.</td>
<td>More improvement in writing in L1 than L2, similar recovery of both in other modalities. L1 improved more overall.</td>
</tr>
<tr>
<td>Gil &amp; Goral (2004) – patient KV</td>
<td>L1: Russian L2: Hebrew (dominantly used yet less proficient)</td>
<td>Left fronto-parietal CVA.</td>
<td>Initially expressive-receptive aphasia in both. Later Broca’s aphasia in L2 and anoma in L1.</td>
<td>3½ months in L2 then 1½ months in L1 (5x45mins per week). Switched due to better progress in L1.</td>
<td>Anomic in both. Nonparallel recovery. Less treated L1 recovered better, showing lack of CLT from therapy in L2.</td>
</tr>
<tr>
<td>Nilipour &amp; Ashayeri (1989) – patient AS</td>
<td>L1: Farsi (dominantly used) L2: German L3: English</td>
<td>Left frontotemporal trauma.</td>
<td>TSA. Alternating antagonistic recovery of L1 &amp; L2 with temporary loss of English during critical period. Severe anoma &amp; language mixing.</td>
<td>2 months treatment in L1. Recovered voluntary control over 3 languages 1½ months post-onset.</td>
<td>Differential recovery. L1 improved most yet with semantic anoma, then L2 &amp; L3 respectively. Successful CLT.</td>
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Table 2. Case studies providing evidence for Pitres’ law.

<table>
<thead>
<tr>
<th>Age/Sex/handed-ness</th>
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</tr>
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<tbody>
<tr>
<td>Miertsch, Meisel, &amp; Isel (2009) – patient BL</td>
<td>L1: German L2: English (dominantly used) L3: French</td>
<td>Left hemisphere ischemic CVA.</td>
<td>Wernike’s aphasia. Severe sensorimotor dysphasia. Auditory language processing (especially phonological working memory) more impaired than visual language processing.</td>
<td>T1: 2.5 years treatment in L1 (3-5 per week) T2: 8 yrs post-onset – treatment in L3 (45 x2 per day) with focus on oral &amp; auditory word finding.</td>
<td>T1: Mild-mid Wernike’s aphasia in all languages. T2: L2 and L3 improved significantly, treatment didn’t transfer to L1, possibly due to previous therapy.</td>
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References


