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ASSESSMENT OF DIAGNOSTIC PROTOCOLS OF ACUTE-PHASE APHASIA IN RELATION TO SIGN LANGUAGES

[BEOORDELING VAN DIAGNOSTISCHE PROTOCOLLEN
VOOR ACUTE AFASIE IN RELATIE TOT GEBARENTALEN]

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Samenvatting

Dit onderzoek bestudeert diagnostische protocollen voor acute afasie binnen de specifieke context van de Vlaamse Gebarentaal (VGT). Afasie verwijst naar een breed spectrum aan verworven neurologische aandoeningen die het begrip en de productie van taal verstoren. Aanzienlijke verschillen bestaan betreffende de oorzaak, de ernst, de prognose en de taalvaardigheden die aangetast zijn. Op basis van spontane taaloutput worden afasiepatiënten ingedeeld volgens een vloeiend-versus-niet-vloeiende dichotomie. Het merendeel van het afasieonderzoek wordt echter uitgevoerd vanuit een westers, eentalig en audiocentrisch perspectief. Een relevant voorbeeld hiervan is de dominante oraal-auditieve ('gesproken') taal Engels. Als gevolg hiervan zijn afasieonderzoek en diagnostische praktijken grotendeels niet afgestemd op de behoeften van gebarentaligen, die gebruikmaken van de visueel-gestuele modaliteit.

Gebarentalen, ook wel visueel-gestuele talen genoemd, maken gebruik van meerdere articulatoren in de driedimensionale gebarenruimte (bijv. handen, lichaam, mond, ogen en gezicht). Dit vormt de basis voor modaliteitsspecifieke kenmerken, zoals simultaneïteit (d.w.z. het vermogen om taal op niet-lineaire wijze te structureren) en visuele iconiciteit (d.w.z. een verband op basis van de visuele gelijkenis tussen betekenis en taalkundige vorm). Bovendien zijn gebarentaligen overwegend meertalig, aangezien zij zich moeten bewegen in omgevingen waar gesproken talen domineren. Gehoorbeperking, sterk geassocieerd met de kernpopulatie, draagt verder bij aan de complexiteit van gebarentaligen.

Om deze onderzoekskloof aan te pakken, namelijk de ondervertegenwoordiging van gebarentaligen in afasieonderzoek en diagnostische praktijken, werd de volgende primaire onderzoeksvraag geselecteerd: 'Hoe kunnen diagnostische praktijken voor afasie in de acute fase worden geëvalueerd en verbeterd om beter tegemoet te komen aan de behoeften van gebarentaligen?'

In de context van dit onderzoek is de Vlaamse Gebarentaal (VGT), die door ongeveer 6.000 moedertaalsprekers (L1) in Vlaanderen en het Brussels Hoofdstedelijk Gewest wordt gebruikt, van bijzonder belang. Er werd een mixed-methods aanpak gehanteerd, bestaande uit een rapid review en een kwantitatieve en kwalitatieve dataverzameling via enquêtes.

De eerste methode richtte zich op het bestuderen van hoe huidige bevindingen uit beeldvormings- en neuropsychologisch onderzoek (1995-2025) de neurale representatie van gebarentalen in relatie tot afasie beschrijven. Het rapid review werd in januari 2026 uitgevoerd volgens de PRISMA-richtlijnen. Hierbij werden 29 peer-reviewed studies onderzocht, die elk gericht waren op ofwel taalverwerking van gebarentalen bij gezonde personen, ofwel afasie in relatie tot gebarentalen. Er werd een gestructureerde zoekopdracht uitgevoerd in de databases PubMed en Web of Science met behulp van vooraf gedefinieerde inclusie- en exclusiecriteria, evenals gerichte zoektermen in overeenstemming met het onderzoeksdoel. De gegevens werden verzameld in de referentiebeheerbibliotheek Mendeley en Microsoft Excel en geanalyseerd door één beoordelaar. De resultaten tonen aan dat gebarentalen systematisch een linksgelateraliseerd perisylvisch netwerk activeren, vergelijkbaar met gesproken talen, maar met modaliteitsspecifieke aanpassingen. Er werd met name een verhoogde betrokkenheid van pariëtale en rechterhersen helft gebieden voor visuospatiële aspecten vastgesteld. Bij afasiepatiënten leidde schade aan de linkerhersen helft tot tekortkomingen in kernaspecten van de taal, terwijl schade aan de rechterhersen helft selectief de spatiële, classifier- of visuospatiële verwerking aantastte, wat wijst op een deels modaliteitsonafhankelijk maar aangepast neurale systeem dat relevant is om in diagnostische praktijken in overweging te nemen.

De tweede methode onderzocht welke diagnostische praktijken momenteel in de Vlaamse Gemeenschap worden toegepast (in 2026) en in hoeverre logopedisten en andere gespecialiseerde klinici rekening houden met de behoeften van VGT-gebruikers. In februari-maart 2026 werden via de enquête gegevens verzameld van 20 Vlaamse medische professionals.

De kwalitatieve resultaten werden bestudeerd met behulp van MAXQDA en een beknopt literatuuronderzoek, terwijl de kwantitatieve resultaten werden geanalyseerd met Microsoft Excel. De resultaten tonen aan dat de beoordeling van afasie in de acute fase zich baseert op Nederlandse diagnostische instrumenten (bijv. ScreeLing, Nederlandse Benoemtest). Respondenten maken vaak gebruik van compensatiestrategieën zoals informele vertaling door familie of vrienden van de patiënt, het terugvallen op schriftelijke communicatie, en een afhankelijkheid van Nederlandse diagnostische instrumenten. Deze zijn onvoldoende om inaccurate evaluatie van gebruikers van de Vlaamse Gebarentaal te voorkomen. Bovendien tonen respondenten een beperkte bekendheid met en bewustzijn van visueel-gestuele taal. Hoewel de waargenomen behoefte aan (extra) training in gebarentalen in relatie tot afasie laag is, bewijzen de resultaten dat dit in feite zeer noodzakelijk is.

De studie concludeert dat er een urgente behoefte bestaat aan gevalideerde diagnostische instrumenten, niet alleen ontworpen voor gebruikers van VGT, maar ook aangepast aan gebarentaligen wereldwijd. Deze zouden de structuur moeten volgen van reeds bestaande (niet-gestandaardiseerde) testbatterijen bedoeld voor de beoordeling van afasie bij gebarentaal, zoals de BSL-ALIAB. Clinici en professionele tolken zouden ook een basisopleiding moeten krijgen over afasie in relatie tot gebarentalen, zoals VGT, om hun bewustzijn en kennis te vergroten. Samenwerking tussen (para)medici, gebruikers van de Vlaamse Gebarentaal, universiteiten en hogescholen, en dovensgemeenschappen zou hierbij zeer waardevol zijn. Zonder deze aanpassingen blijft het risico op misdiagnose en ongelijkheden in de gezondheidszorg voor gebarentaligen wereldwijd bestaan.

Summary

This study investigates diagnostic protocols for acute-phase aphasia in the specific context of Flemish Sign Language (VGT). Aphasia refers to a wide range of acquired neurological disorders that disrupt the comprehension and production of language. It displays significant variation in terms of the cause, the severity, the outcome, and the language abilities affected. Based on spontaneous language output, aphasic patients are categorised according to a fluent-versus-nonfluent dichotomy. However, the majority of research on aphasia is conducted from a Westernised, monolingual, and audiocentric perspective. A relevant example is the major oral-auditory ('spoken') language of English. As a result, aphasic research and diagnostic practices are largely unaccommodated to the needs of sign language users, who employ the visual-gestural modality.

Sign languages, also referred to as visual-gestural languages, use multiple articulators in the three-dimensional signing space (e.g., hands, body, mouth, eyes, and face). This forms the basis for modality-specific features, such as simultaneity (i.e., the ability to structure language non-linearly) and visual iconicity (i.e., a mapping based on the visual resemblance between meaning and linguistic form). Furthermore, sign language users are predominantly multilingual, as they must navigate their lives in environments where oral-auditory languages dominate. Hearing impairment, strongly associated with the core population, further adds to the complexity of sign language users.

To address this research gap, namely the underrepresentation of sign language users in aphasia research and diagnostic practices, the following primary research was selected: 'How can acute-phase aphasia diagnostic practices be evaluated and improved to better accommodate sign language users?'. Within the context of this research, Flemish Sign Language (VGT), employed by approximately 6,000 native users (L1) in Flanders and Brussels-Capital, is of particular interest. A mixed-methods approach was employed, consisting of a rapid review and a quantitative and qualitative data collection through surveys.

The first method was aimed at investigating how current neuroimaging and neuropsychological evidence (1995-2025) characterise the neural representation of sign languages in relation to aphasia. The rapid review was conducted in January 2026 in accordance with PRISMA guidelines. It examined 29 peer-reviewed studies, each focusing on either healthy sign language processing or aphasia in relation to sign languages. A structured search was conducted in databases PubMed and Web of Science using predefined inclusion and exclusion criteria, as well as focused search strings in line with the research aim. Data was collected in the reference manager library Mendeley and Microsoft Excel, and analysed by a single reviewer. Results show that sign languages consistently recruit a left-lateralised perisylvian network, similar to spoken languages, but with modality-specific adaptations. Particularly, increased involvement of parietal and right-hemispheric regions for spatial and classifier processing was observed. In aphasic patients, left-hemispheric damage led to deficits in core linguistic aspects, while right-hemispheric damage selectively impaired spatial, classifier, or visuospatial processing, suggesting a partly modality-independent but adapted neural system, relevant to consider in diagnostic practices.

The second method assessed which diagnostic practices are currently in place in the Flemish Community (i.e., 2026) and to what extent speech-language-pathologists and other specialised clinicians consider the needs of VGT users. The survey collected data from 20 Flemish medical professionals in February-March 2026. Qualitative results were examined in MAXQDA and a concise literature review. Quantitative results were analysed in Microsoft Excel. Results reveal that acute-phase aphasia assessment relies on Dutch diagnostic instruments (e.g., ScreeLing, Dutch Naming Test). Respondents frequently rely on compensatory strategies such as informal translation by the patient's family and friends, default to written communication, and dependence on Dutch diagnostic instruments. These are insufficient in mitigating the improper assessment of Flemish Sign Language users. Additionally, respondents demonstrate limited familiarity and awareness of visual-gestural language. Though the perceived need for (additional) training on sign languages in relation to aphasia is low, results prove that it is, in fact, highly necessary.

The study concludes that there is a critical need for validated diagnostic instruments designed not only for VGT users but also for sign language users worldwide. These should follow the structure of (non-standardised) sign language aphasia assessment batteries that already exist, such as the BSL-ALIAB. Clinicians and professional interpreters should also receive basic training in aphasia in relation to sign languages such as VGT to increase awareness and knowledge. Collaboration between (para)medics, Flemish Sign Language users, universities and colleges, and deaf communities would be greatly beneficial in this endeavour. Without these adjustments, the risk of misdiagnosis persists, and inequalities in healthcare for sign language users worldwide remain.

Abstract

Deze studie onderzoekt acute afasiediagnostiek binnen de context van de Vlaamse Gebarentaal (VGT). Afasie, een verworven neurologische taalstoornis, wordt voornamelijk onderzocht vanuit een westers, eentalig en audiocentrisch perspectief. Omdat gebarentaligen de visueel-gestuele modaliteit gebruiken, in tegenstelling tot de oraal-auditieve modaliteit van gesproken talen, zijn huidige diagnostische instrumenten niet aangepast aan hun noden. Een rapid review onderzocht de neurale representatie van gebarentalen in relatie tot afasie. Resultaten uit 29 beeldvormingsstudies tonen aan dat gebarentalen een linksgelateraliseerd perisylvisch netwerk activeren, vergelijkbaar met gesproken talen, maar met modaliteitsspecifieke aanpassingen. Daarnaast leidt schade aan de linkerhersenhalft systematisch tot verstoring van fundamentele taalaspecten, terwijl schade aan de rechterhersenhalft visuospatiële vaardigheden selectief beïnvloedt. Een enquête onder 20 Vlaamse clinici toont aan dat diagnostiek gebaseerd is op Nederlandstalige instrumenten en informele vertaalmethoden, met beperkte aandacht voor VGT-gebruikers. Deze bevindingen onderstrepen de noodzaak van gevalideerde diagnostische instrumenten voor gebarentaligen, verbeterde training van clinici, en een meer rechtvaardige gezondheidszorg.

Sleutelwoorden: afasie, gebarentalen, Vlaamse Gebarentaal, enquête, taalbeoordeling, rapid review

Abstract

This study examines diagnostic protocols for acute-phase aphasia in the context of Flemish Sign Language (VGT). Aphasia, an acquired neurological language disorder, is primarily researched from a Westernised, monolingual, and audiocentric perspective. As sign language users employ the visual-gestural modality, as opposed to the oral-auditory modality of spoken languages, current diagnostic practices are not adapted to their needs. A rapid review of 29 studies examined sign languages in relation to aphasia, with neuroimaging evidence showing that sign languages consistently recruit a left-lateralised perisylvian network, similar to spoken languages, but with modality-specific adaptations. Additionally, left-hemispheric damage results in core linguistic impairments, while right-hemispheric damage selectively affects visuospatial abilities. A survey of 20 Flemish clinicians revealed that assessment relies on Dutch-based tools and informal translation methods, with limited consideration of VGT users. The findings underline the need for validated diagnostic instruments for sign language users, improved clinician training, and more equitable healthcare.

Keywords: aphasia, sign languages, Flemish Sign Language, questionnaire, language assessment, rapid review

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1 Introduction

1.1 Aphasia

This research is structured around two main themes: aphasia and sign languages. This section provides a theoretical overview of aphasia as an acquired neurological language disorder. Its characterisation and causes are first discussed, followed by the distinction between acute and chronic aphasia. Subsequently, language lateralisation and specialised brain areas are examined, based on spoken language research, in order to contextualise the current aphasia classification.

1.1.1 Definition

Aphasia refers to a wide range of acquired neurological conditions that disrupt the comprehension and production of language, caused by dysfunction in specific brain regions, particularly those related to language (Bunker & Hillis, 2022; Damasio, 1992; Eling & Whitaker, 2022). All features of language can become impaired (e.g., lexical retrieval), either in isolation or more broadly across neural networks (Berti et al., 2022). Aphasia also exhibits significant variation in terms of the cause, the severity, the outcome, and the affected language abilities. Aphasic subtypes are classified based on behavioural presentation, as further discussed in chapter 1.1.6.

At its core, aphasia is an acquired disturbance of language processing that not only occurs in spoken languages [e.g., Dutch] but also in sign languages [e.g., Flemish Sign Language] (Damasio, 1992). The distinction between acquired and developmental language disorders is of utmost importance for differential diagnosis, as aphasia can otherwise be mistaken for, among other conditions, developmental language disorder (DLD). According to the CATALIZE Consensus (Bishop et al., 2017), issues in DLD occur during development and are thus not associated with biomedical conditions such as brain injury.

Bishop et al. (2013) further note that, for a language disorder such as aphasia to be considered 'acquired', impairments must emerge after language has been developed to some degree. Van Hout (1997) notes that this developmental threshold is traditionally set at 2 years old. By then, most children can be understood beyond the familial environment, and their utterances, as well as their mental lexicon, are grammatically more complex and accurate, making it possible to distinguish between developmental and acquired deficits (Sansavini et al., 2021; Van Hout, 1997). In sum, a person suffering from an aphasic syndrome previously possessed age-appropriate language abilities but acquired the language disturbances afterwards (Berti et al., 2022).

1.1.2 Aetiologies

Aphasia can be caused by virtually any cerebral insult (Bunker & Hillis, 2022). This includes traumatic injuries¹, tumoral lesions², brain infections³, congenital brain dysfunctions⁴, toxic or anoxic processes⁵, and neurodegenerative diseases⁶. Nevertheless, according to Marshall et al. (1998), a significant amount of aphasic research is derived from patients who have suffered a cerebrovascular accident (CVA), also referred to as a stroke. The reason lies in the relative uniformity of vascular lesions, allowing researchers to identify clearer and more distinct aphasic syndromes than those caused by other conditions.

Moreover, European residents-based research reports a relatively high incidence of aphasia after a stroke, namely between 23 and 38% (Pedersen et al., 1995). For these reasons, aphasia is often considered a vascular syndrome, in which behavioural presentation reflects disruption of varying language functions.

¹ Refer to Grochmal-Bach et al. (2009) for a case report on aphasia due to traumatic brain injury.

² Refer to DeDios-Stern et al. (2021) for a case report on aphasia after glioblastoma resection.

³ Refer to Soares-Ishigaki et al. (2012) for a case report on aphasia and herpes virus encephalitis.

⁴ Refer to Oh et al. (2019) for a case report on hyperglycaemia-induced aphasia.

⁵ Refer to Madhusoodanan et al. (2017) for a case report on aphasia in relation to Li-ECT poisoning.

⁶ Refer to Watanabe et al. (2020) for a case report on primary progressive aphasia as a prodromal state of dementia with Lewy bodies.

Specifically, the aphasic deficits correspond to the infarcted tissue and surrounding ischaemic penumbra resulting from vascular disruption (Bunker & Hillis, 2022). The ischaemic penumbra refers to a brain region around the permanently damaged core of infarction, in which damaged neurons could still regain function if blood flow is promptly restored, a phenomenon called reperfusion (Ermine et al., 2021).

1.1.3 Acute versus Chronic Aphasia

Aphasia behaves differently depending on the phase the condition is in: acute or chronic. More specifically, the acute phase of aphasia occurs within the first six weeks after the onset of the language disorder, most commonly caused by a CVA. After this period, the condition is considered chronic (Sheppard & Sebastian, 2021; Stroke Foundation, 2023). During the acute phase, active medical treatment focuses on accurate diagnosis and the prevention of further complications (ibid.). Early and accurate diagnosis of aphasia in the acute phase is critical for prognosis and rehabilitation (Godecke et al., 2021). The distinction between acute and chronic aphasia is, furthermore, essential as natural recovery and functional reorganisation occur in the first few days and weeks, in which, according to Sheppard and Sebastian (2021), the aphasic subtype is likely to evolve rapidly. This signifies that a more severe aphasic syndrome may transition into a less severe aphasic syndrome over time.

Aphasia rehabilitation patterns are variable. Once tissue is compromised, a complete recovery of the affected language abilities is improbable (Hillis et al., 2004). However, spontaneous recovery, thanks to reperfusion and neuroplasticity⁷, does play a significant role (Pedersen et al., 2004). Moreover, functional imaging studies show reorganisation of language networks even in the chronic phase of aphasia (Fridriksson et al., 2012).

⁷ Neuroplasticity refers to the ability of the nervous system to react to stimuli by reorganising its function, structure, and connections (Cramer et al., 2011).

Intensive speech-and-language therapy is crucial, and comprehension is the most significant predictor of recovery (Bunker & Hillis, 2022). As chronic-phase aphasia is beyond the scope of this study, recovery and rehabilitation patterns will not be discussed further.

In order to describe the current aphasia classification, contextualisation of language lateralisation and language-specialised brain areas is required; both will be discussed in the following chapters.

1.1.4 Lateralisation: Spoken Language Evidence

Language lateralisation is investigated through several neuroimaging techniques, which together allow for the visualisation of the anatomy, activity, and connectivity of the human brain. Functional techniques, such as fMRI⁸ and PET⁹, specifically measure brain activity and connectivity, while structural methods, such as EEG¹⁰, examine neuroanatomy. The intracarotid amobarbital procedure (IAP) or Wada Test, in which each cerebral hemisphere is temporarily paralysed through intracarotid injection of sodium amytal, also provides insights into language lateralisation as revealed by the loss of language output when the dominant hemisphere is inhibited (Van Emde, 1999).

The majority of evidence on language lateralisation, as researched through these methods, is derived from spoken languages. Typically, in right-handed people, the language-specialised brain areas are lateralised to the left cerebral hemisphere (Knecht et al., 2000). To illustrate, Packheiser et al. (2020) analysed data from 1,554 healthy adults with typical hearing.

⁸ Functional Magnetic Resonance Imaging (fMRI) is a non-invasive imaging technique that detects neural activity through monitoring changes in blood flow, and thus energy demand, in different brain areas (Lackie, 2010).

⁹ Positron Emission Tomography (PET) is a non-invasive functional technique that measures physiological function by investigating blood flow, neurotransmitters, metabolism, and radiopharmaceuticals (Berger, 2003).

¹⁰ An electroencephalogram (EEG) is a non-invasive structural measurement of the brain's electric fields in which electrodes placed on the scalp record voltage potentials (Biasucci et al., 2019).

Their sample consisted primarily of right-handed individuals; however, some participants were left-handed or ambidextrous (~100). They observed left-hemispheric language lateralisation in 82.1% of participants, comparable to traditional views of left-hemispheric language dominance. Several elements influence language lateralisation. For this study, the scope is limited to handedness, multilingualism, and particular right-hemispheric contributions to language processing.

Handedness is the most widely researched and consistently recognised contributing factor influencing language lateralisation. That is, left-handed or ambidextrous individuals have a higher probability of atypical or bilateral language lateralisation. To illustrate, Smith and Doe (2002) reported that the incidence of atypical language lateralisation in healthy left-handed and ambidextrous subjects was higher than in healthy right-handed subjects, namely 22% versus 4-6%. Consequently, left-handed or ambidextrous individuals are rarely included in studies, as they would influence the accuracy of results.

Multilingualism¹¹ is another contributing aspect. To illustrate, Park et al. (2012) conducted neuroimaging research and observed greater bilateral activation in multilingual participants in comparison with monolingual¹² individuals. Lateralisation in multilingual people is shaped by several elements; each warrants separate investigation. These include, but are not limited to, the age at which each language is acquired, the level of proficiency attained, and how frequently each language is used (Berken et al., 2016; Hull & Vaid, 2006; O'Grady et al., 2016).

¹¹ Multilingualism refers to 'the ability of societies, institutions, groups and individuals to engage, on a regular basis, with more than one language in their day-to-day lives' (European Commission, 2007, as cited in Cenoz, 2013, p. 5).

¹² Monolingualism refers to employing only one language in one's day-to-day life (Dewaele, 2015).

Lastly, it is important to note that not all language functions are typically left-lateralised. The right hemisphere has been found to contribute to emotional, prosodic, gestural, and facial aspects of language (Swanberg et al., 2007). Contrary to earlier views that the right hemisphere is not involved in language processing, contemporary studies prove otherwise. Lindell (2006), for instance, indicates that the right hemisphere contributes to recognising concrete words, processing orthography, and mediating paralinguistic aspects of language output. Functions are, however, limited concerning the recognition of abstract words, syntax, and phonology. Mitchell and Crow (2005) also note that the right hemisphere supports discourse planning and comprehension, humour, sarcasm, metaphors, and indirect requests, which are essential for effective communication. Considering these right-hemispheric contributions is vital in assessing clinical populations, as damage to the right hemisphere can lead to deficits in prosody, pragmatics, or discourse, even when left-hemisphere language areas remain intact.

1.1.5 Specialised Brain Areas: Spoken Language Evidence

Current research, primarily derived from spoken languages, appoints the cross-linguistic perisylvian¹³ network of the left hemisphere as essential for language processing (Kepinska et al., 2017). This Classic Model, also labelled the 'Wernicke-Lichtheim-Geschwind-Model', is an attempt to localise the core language brain areas. It originates from the contributions of researchers in the 19th and 20th centuries (Weiller et al., 2011). The following left-lateralised brain areas, visualised in Figure 1 with corresponding Brodman areas¹⁴, are noteworthy: Broca's and Wernicke's areas, the middle temporal gyrus, and the inferior parietal lobule encompassing the angular gyrus and the supramarginal gyrus.

¹³ The term 'perisylvian' refers to brain areas surrounding the sylvian fissure (Catani et al., 2005).

¹⁴ The cytoarchitectonic structure in the brain is often localised according to Brodmann areas (BA), named after Korbinian Brodmann (1868-1918). These anatomical brain maps show 48 cortical areas of the human cerebral cortex and are used to locate activation foci in neuroimaging studies (Zilles, 2018).

The fusiform gyrus and the superior parietal lobule are also relevant. The left arcuate fasciculus is, moreover, an important fibre pathway, and the left distributed association cortex, though not a single anatomical area, also engages in spoken language processing.

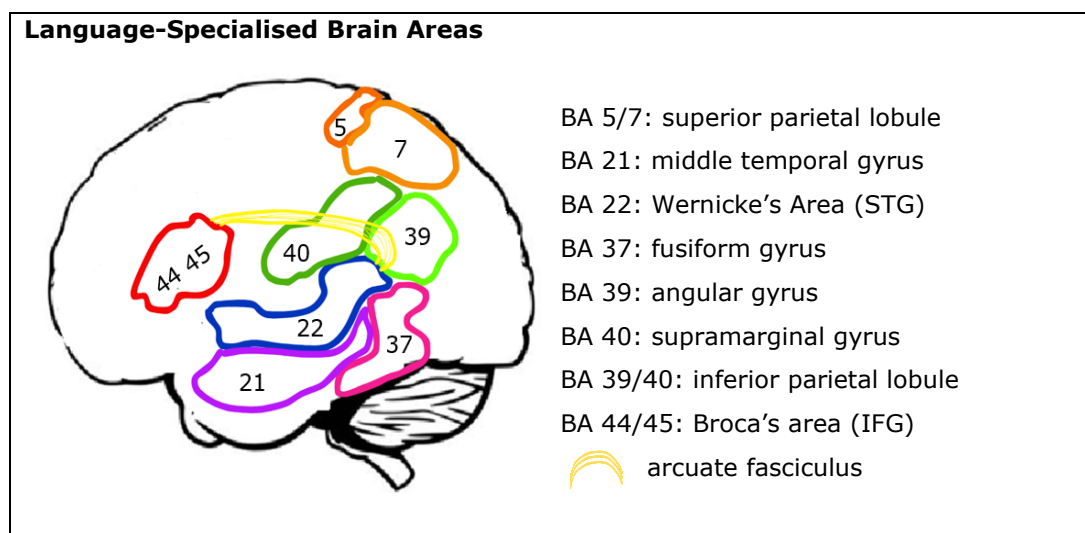


Figure 1: Lateral view of the left cerebral hemisphere with language-specialised brain areas as indicated by their corresponding Brodmann areas. The arcuate fasciculus, a fibre pathway, is also visualised. The distributed association cortex is not depicted as it does not correspond to a single anatomical area.

Broca's area, or the left inferior frontal gyrus (**IFG**), encompasses the pars triangularis and opercularis of the posterior inferior frontal gyrus in the dominant hemisphere at Brodmann areas 44 and 45 (Ardila et al., 2015; Keller et al., 2009). It is, in fact, far larger than its discoverer, French physician Pierre Paul Broca, had originally thought in 1861, as modern research now includes other areas of the frontal lobe as well (Bunker & Hillis, 2022; Hagoort, 2014). Broca's area is involved in both language production and comprehension, although lesions are seldom associated with impairments in the latter. The anterior portion of the left inferior frontal gyrus supports semantics, while its posterior portion supports phonology.

It is also crucial for language repetition, sentence structure, gesture production, and interpreting actions of others (Brown & Yuan, 2018; Flinker et al., 2015; Skipper et al., 2007). The left inferior frontal gyrus has implications not only for aphasia but also for other pathologies, such as stuttering¹⁵ (Flinker et al., 2015).

Wernicke's area, first located by German neurologist Carl Wernicke in 1874, is situated in BA 22, corresponding to the posterior segment of the superior temporal gyrus in the dominant hemisphere (DeWitt & Rauschecker, 2013). This area, also referred to as the left superior temporal gyrus (**STG**), encompasses the auditory cortex on the lateral sulcus and is responsible for language comprehension (ibid.). When this brain area is impaired, it can result in numerous clinical presentations. In addition to aphasia, Wernicke-Korsakoff Syndrome¹⁶, in which, among other brain areas, the left superior temporal gyrus is damaged due to thiamine deficiency, is a notable pathology (Manzo et al., 2014).

The **arcuate fasciculus** of the left hemisphere is also relevant in language processing, though it is not a single anatomical brain area. In fact, it is the white matter tract that contains fibres connecting the frontal, parietal, and temporal lobes in the left hemisphere, including Broca's and Wernicke's areas (Bae et al., 2022; Catani & de Schotten, 2008). In addition to language repetition (Ardila, 2010), current research suggests it holds several other functions in relation to spontaneous speech, comprehension, and naming (Fridriksson et al., 2013; Ivanova et al., 2021). Impairments to the arcuate fasciculus are not only associated with aphasia but also with schizophrenia¹⁷, among other pathologies (Abdul-Rahman et al., 2012).

¹⁵ A speech disorder marked by the disruption in the ease of verbal production, characterised by involuntary repetitions or prolongations of sounds or syllables (Büchel & Sommer, 2004).

¹⁶ This syndrome causes altered mental status (i.e., confusion or forgetfulness), rapid involuntary movements or paralysis of the eyes, and a lack of muscle coordination. It is primarily encountered in alcoholics (Manzo et al., 2014; Yoon et al., 2019).

¹⁷ Schizophrenia is a psychiatric condition characterised by hallucinations, delusions, disorganised speech or behaviour, reduced motivation and expressiveness, and impairments in executive function, memory, and processing speed (Hany & Rizvi, 2024).

The left **middle temporal gyrus (MTG)**, corresponding to Brodmann area 21, is associated with numerous tasks related to semantic cognition and lexical comprehension (Chang et al., 2015; Xu et al., 2015). It is particularly involved in understanding visual and auditory information (Xu et al., 2015). In a systematic review of task-based neuroimaging conducted by Sumner et al. (2018), hyperactivation in this brain area was observed across tasks involving semantic processing, language comprehension and production, and monitoring requiring sustained attention. A notable pathology, in addition to aphasia, is schizophrenia (Guo et al., 2014).

The left **inferior parietal lobule (IPL)** is situated within the ventral part of the posterior parietal cortex, which encompasses the anterior supramarginal gyrus (BA 40) and the angular gyrus (BA 39) (Binkofski & Buccino, 2018). The **angular gyrus (AG)** is considered an important interface that exchanges and integrates information between different modalities and processing subsystems. It is involved in sentence reading and, more generally, in comprehension of speech and written language (Obleser & Kotz, 2010). The **supramarginal gyrus (SMG)** is a substantial region for language processing, particularly in phonological working memory. It is involved in the temporary storage and manipulation of information, among other functions (Coolidge, 2023). In addition to aphasia, impairments to the left inferior parietal lobule are associated with more progressed phases of Alzheimer's disease¹⁸ (Greene et al., 2010).

The left **superior parietal lobule (SPL)** is located on the lateral side of the parietal lobe and spans Brodmann areas 5 and 7 (Corballis, 2014). Through multimodal neuroimaging approaches, Wang et al. (2015) found that this brain area is functionally organised for visuomotor, visual perception, attentional, reasoning, and working memory processes.

¹⁸ The most prevalent type of dementia, Alzheimer's disease (AD), is a neurodegenerative, progressive impairment of behavioural and cognitive functions, such as memory, language, comprehension, attention, judgment, and reasoning (Kumar et al., 2024a).

It is thus a neural hub involved in several cognitive functions that go beyond language. Therefore, impairments are associated with several cognitive, visuospatial and behavioural disorders (Kumral et al., 2023). In addition to aphasia, a notable pathology is apraxia¹⁹.

The left **fusiform gyrus**, located in the temporal-occipital lobe, corresponds to Brodmann area 37. It is involved in semantics, word retrieval, word generation, and naming (Ardila et al., 2015; Benson & Ardila, 1996; McDermott et al., 2003). Moreover, BA 37 is also involved in written language, as it shows activation during reading (Sakurai, 2004). Its core function, however, lies in visual processing (Goodale & Milner, 1992). In addition to aphasia, prosopagnosia²⁰ is a notable pathology.

The left **distributed association cortex**, also referred to as the concept centre, refers to the extrasylvian regions of the dominant hemisphere that are not always included in traditional views of the core language areas (Pratt & Whitaker, 2006). Functionally, it acts more as a conceptual hub, not a single anatomical area, from which language processes originate (Buckner & Krienen, 2013; Rutten, 2022). Damage to these distributed association networks has been linked to various disorders besides aphasia, such as Alzheimer's disease.

In addition to the aforementioned left-lateralised brain areas and other neural structures, several others are involved in language processing. It is beyond the scope of this study to research all of them. Nevertheless, brain areas or other neural structures will be noted and described further should they appear relevant in other sections.

¹⁹ Apraxia is a cognitive-motor disorder that impacts the performance of learned and high-level movements and can be categorised into several types (Goldenberg, 2013).

²⁰ Face blindness, also called prosopagnosia, is a selective visual agnosia condition characterised by the inability to recognise the identity of faces (Corrow et al., 2016).

1.1.6 Current Aphasia Classification

Based on spontaneous spoken language output, aphasic patients are traditionally categorised in correspondence to a fluent versus non-fluent dichotomy. According to the American Speech-Language-Hearing Association (ASHA, n.d.-b), a leading professional association for speech, language, and hearing worldwide, fluency refers to 'the continuity, smoothness, rate, and effort of speech production.' It is the concurrence of normal fluency with abnormal features of fluency that marks aphasia (Gordon, 1998). Traditional clinical taxonomies distinguish eight subtypes²¹ based on this ease of expression. However, it is important to note that taxonomies often refer to fluency in terms of verbal or spoken expression (e.g., ASHA-a), which doesn't include, for instance, visual-gestural expression. Currently, the most authoritative test battery is the Boston Diagnostic Aphasia Examination (BDAE), developed by Harold Goodglass and Edith Kaplan²². In the following paragraphs, the fluent and non-fluent aphasic subtypes will be discussed separately.

1.1.6.1 Fluent Aphasias

Fluent aphasias²³ are generally caused by posterior, post-Rolandic²⁴ lesions, with Broca's area remaining intact (Pratt & Whitaker, 2006). Typically, patients have no trouble expressing themselves but experience severe (auditory) comprehension deficits. The BDAE distinguishes four (neo)classic non-fluent subtypes: Wernicke aphasia, transcortical sensory aphasia, conduction aphasia, and anomic aphasia (Bunker & Hillis, 2022).

²¹ These profiles are often termed 'cortical aphasias' (Sheppard & Sebastian, 2021) or '(neo)classic aphasias' (Berti et al., 2022).

²² For the third edition, refer to Goodglass et al. (2001).

²³ Alternate terms are 'sensory' or 'receptive' aphasias (Bunker & Hillis, 2022; Marshall et al., 1998)

²⁴ The Rolandic fissure, or central sulcus, separates the frontal and the parietal lobes on the lateral and medial surfaces of the cerebral hemisphere (Petrides, 2014).

Wernicke aphasia, or 'sensory/receptive aphasia', commonly occurs after lesions in the posterior superior temporal lobe and/or anterior inferior parietal lobe (Bunker & Hillis, 2022; Pratt & Whitaker, 2006). More specifically, it results from a dysfunction in brain regions supplied by the inferior branch of the left middle cerebral artery, which encompasses Brodmann area 22, also known as Wernicke's area, and surrounding others such as 37, 39 and 40 (Berti et al., 2022; Kirshner et al., 2003). This subtype is characterised by fluent but meaningless spontaneous language output and repetition (Bunker & Hillis, 2022; Kirshner et al., 2003).

It is further indicated by circumlocutions²⁵, empty phrases, and paraphasia²⁶ (ibid.). According to Swanberg et al. (2007), paraphasic errors are classified as phonemic (literal) paraphasias, in which syllables within a word are substituted, semantic paraphasias, in which a target word is replaced by another semantically related word, and neologistic paraphasias, in which meaningless or nonsensical words are produced instead of the intended word(s). Comprehension is thus severely disrupted, and patients have poor awareness that they are not understandable to others (Kirshner et al., 2003; Sheppard & Sebastian, 2021).

Reading and auditory comprehension are equally affected, but some patients show fewer deficits in one or the other modality. Writing is well-formed but contains spelling and word choice errors (Kirshner et al., 2003). In Wernicke aphasia, grammatical function words are also often used improperly, a phenomenon referred to as paragrammatism (Pratt & Whitaker, 2006; Sheppard & Sebastian, 2021). Furthermore, poor semantic cohesion and non-words can also be observed in writing (Bunker & Hillis, 2022).

²⁵ Circumlocutions are the tendency of an individual to talk [or sign] around the word, describing its features or meaning, without being able to retrieve the name itself (Bunker & Hillis, 2022).

²⁶ Errors in which incorrect, nonsensical, or unintended words are produced, often inserted into otherwise well-formed and grammatically correct sentences (Kaufman, 2007).

Transcortical sensory aphasia (TCS) is a relatively rare aphasic syndrome in comparison with other (neo)classic subtypes (Pratt & Whitaker, 2006). The term 'transcortical' refers to the extrasylvian regions, such as the distributed association cortex, which are not always included in traditional views regarding language-specialised brain areas (Kirshner et al., 2003; Pratt & Whitaker, 2006). Lesions are, more specifically, situated in the vascular territories of the left posterior cerebral artery or the border (watershed region) between the left posterior and the middle cerebral artery (Bunker & Hillis, 2022; Sheppard & Sebastian, 2021), corresponding to the temporoparietal regions superior and/or posterior to Wernicke's area (Berti et al., 2022).

Lesions disrupt the transmission of information from Wernicke's area to Broca's area, disturbing comprehension (Pratt & Whitaker, 2006). It is, therefore, very similar in characteristics to Wernicke aphasia, with the exception that repetition remains relatively spared (Sheppard & Sebastian, 2021). Output is fluent but often accompanied by semantic and/or neologistic paraphasia, echolalia²⁷, and naming difficulties (Swanberg et al., 2007). Reading aloud might be spared, but reading comprehension and writing are consistently affected (ibid.). The language output of patients may be misinterpreted as a psychological issue, such as schizophrenia, due to similar clinical presentations (Benson & Ardila, 1996).

Conduction aphasia, with the alternate term 'afferent motor aphasia' (Bunker & Hillis, 2022), is classically established by damage to the left arcuate fasciculus, the white matter tract connecting Broca's and Wernicke's areas (Bunker & Hillis, 2022; Pratt & Whitaker, 2006). Lesions are generally smaller than those related to Broca or Wernicke aphasia (Sheppard & Sebastian, 2021). Although people with conduction aphasia exhibit deficits, there is no irrefutable evidence that a disconnection in these white matter tracts and areas truly causes this condition (Berti et al., 2022).

²⁷ Repetition of words or utterances one has just heard [or received] (Berthier et al., 2017).

The main characteristic of conduction aphasia is that repetition skills are disproportionately impaired relative to comprehension and production (Sheppard & Sebastian, 2021). Patients also exhibit fluent but paragrammatic speech, naming deficits, an inability to repeat sentences, and defective phoneme construction (Berti et al., 2022; Sheppard & Sebastian, 2021). Patients show better awareness of word errors, with frequent attempts to self-correct phonemic paraphasic errors (Bunker & Hillis, 2022). Due to these self-corrections, conduction aphasia might be mistaken for apraxia of speech²⁸ (ibid.). Nevertheless, another type of apraxia, namely ideomotor apraxia²⁹, can occur as an associated sign (Swanberg et al., 2007).

Anomic aphasia, with equivalent names such as 'semantic', 'nominal' or 'amnesic' aphasia, is considered the mildest (neo)classic aphasic syndrome (Bunker & Hillis, 2022). It is a selective deficit of naming with no other deficits in comprehension, production, or repetition (Kirshner et al., 2003; Sheppard & Sebastian, 2021). People suffering from anomic aphasia fail to retrieve the substantive words related to concepts, often resulting in 'empty speech', but sustain a relatively spared language output rate, articulation, and syntax (Pratt & Whitaker, 2006). However, the deficits in word-finding often result in long pauses and circumlocutions, mimicking non-fluent aphasic syndromes in more severe cases (Kirshner et al., 2003; Sheppard & Sebastian, 2021). Awareness of errors may vary depending on the severity of the syndrome (Bunker & Hillis, 2022). Anomic aphasia is incredibly difficult to localise, with no confirmed associated compromised tissues or vascular territories (Bunker & Hillis, 2022; Pratt & Whitaker, 2006).

²⁸ Apraxia of speech is a cognitive-motor disorder involving impaired planning or programming of phonetic and prosodic processes required for speech (Duffy, 2020, p. 24-25).

²⁹ Ideomotor apraxia refers to the inability to perform a motor act in response to a verbal [or signed] command, even though the individual comprehends the command and has the motor capacity to carry out the same action in a different context (Kirshner & Misulis, 2023)

In contrast to the misinterpretation as a non-fluent aphasia type, the clinical presentation of anomic aphasia is quite similar to Wernicke aphasia, which also displays comprehension issues, except for the key feature of intact auditory comprehension (Pratt & Whitaker, 2006). Reading and writing may function normally but can also display abnormalities (Swanberg et al., 2007).

1.1.6.2 Non-Fluent Aphasias

Non-fluent aphasias³⁰ typically take place with anterior, pre-Rolandic lesions, usually in Broca's area, or larger ones involving the suprasylvian regions (Pratt & Whitaker, 2006). They are typically characterised by relatively intact comprehension but severe difficulty with repetition and expression, such as issues with articulation and speech initiation, resulting in slow and sparse verbal production (Benson & Ardila, 1996; Bunker & Hillis, 2022; Pratt & Whitaker, 2006).

Due to this poorly articulated verbal output, non-fluent aphasias can be mistaken for dysarthrias³¹ (Pratt & Whitaker, 2006). It is therefore crucial that other deficits (e.g., syntactic errors) are present for a differential diagnosis. Apraxia of speech also needs to be ruled out due to similar presentations, such as reduced or effortful output (Duffy, 2020). The BDAE distinguishes four (neo)classic non-fluent subtypes: Broca aphasia, transcortical motor aphasia, mixed transcortical aphasia, and global aphasia (Bunker & Hillis, 2022).

³⁰ Alternate terms are 'motor/expressive' aphasias (Bunker & Hillis, 2022; Marshall et al., 1998).

³¹ The dysarthrias are a group of neurological motor speech disorders that reflect abnormalities in the strength, speed, range, steadiness, tone, or accuracy of movements required for the respiratory, phonatory, resonatory, articulatory, or prosodic aspects of speech production (Duffy, 2020, p. 3).

Broca aphasia, also called 'expressive aphasia' or 'verbal aphasia', is typically caused by a disturbance in the superior section of the left middle cerebral artery (Bunker & Hillis, 2022). This includes the insula³² and the neighbouring frontal operculum, or the left posterior frontal cortex (O'Sullivan et al., 2019; Pratt & Whitaker, 2006). Lesions are situated in Brodmann areas 44/45, but can also span 8, 9, 10, and 46 (Berti et al., 2022). Depending on the lesions, whether localised or encompassing several brain areas, this subtype exhibits a spectrum of symptom severity, ranging from mild and/or transient to chronic (Berti et al., 2022; Bunker & Hillis, 2022). As with other non-fluent types, comprehension is relatively intact (Bunker & Hillis, 2022).

Broca aphasia is characterised by deficits in word-finding (anomia), particularly verbs, and articulation, as well as a slow rate, and impaired rhythm, stress, and intonation (i.e., dysprosody) (Bunker & Hillis, 2022; Pratt & Whitaker, 2006). Verbal output is, moreover, generally agrammatic, i.e., containing several grammatical errors (Berti et al., 2022). People with this subtype are aware of their errors, which also occur in other aspects such as reading and spelling, but struggle to produce language in what is considered a typical manner (Bunker & Hillis, 2022; Pratt & Whitaker, 2006).

Transcortical motor aphasia (TCM), also referred to as 'dynamic aphasia' (Bunker & Hillis, 2022) or 'anterior isolation syndrome' (Pratt & Whitaker, 2006), generally occurs after lesions encompassing the left frontal cortex, medial frontal cortex, or subcortical white matter, while sparing Broca's area (Berti et al., 2022; Kirshner et al., 2003). These neuroanatomical regions correspond to the vascular territories of the left anterior cerebral artery or the watershed region between the anterior and middle cerebral arteries (Bunker & Hillis, 2022).

³² The insula is an island of the cortex located within the sylvian fissure and is in continuity with the frontal-parietal opercular region on each side of the human brain (Evrard & Craig, 2015).

Transcortical motor aphasia is characterised by dysfluency and agrammatism in spontaneous language output, similar to Broca aphasia, but with relatively intact repetition (Bunker & Hillis, 2022; O’Sullivan et al., 2019). Patients display delayed speech initiation, short utterances, semantic paraphasic errors, and echolalia (Swanberg et al., 2007). Auditory and reading comprehension are relatively spared, and naming is often intact. However, writing and reading aloud are consistently compromised (ibid.).

Mixed transcortical aphasia (MTA), alternatively referred to as ‘isolation aphasia’ (Pratt & Whitaker, 2006), is generally caused by damage to the regions surrounding both Broca’s and Wernicke’s areas, with lesions occurring in the watershed areas between the left anterior cerebral artery and middle cerebral artery as well as between the latter and the posterior cerebral artery (Bunker & Hillis, 2022). Mixed transcortical aphasia appears to functionally ‘isolate’ the perisylvian areas from the rest of the left hemisphere (Bunker & Hillis, 2022; Pratt & Whitaker, 2006; Sheppard & Sebastian, 2021).

It is often considered a combination of Broca and Wernicke aphasias, as its clinical presentation is very similar (Bunker & Hillis, 2022; Marshall et al., 1998). Spontaneous production is non-fluent, with limited output and poor comprehension skills (Bunker & Hillis, 2022). Nevertheless, repetition remains relatively intact, though it may be limited to a couple of words or, at most, a few sentences (Kirshner et al., 2003; Swanberg et al., 2007). Moreover, naming, reading, and writing are severely impaired (Swanberg et al., 2007). Although articulatory fluency is typically spared, the near-automatic repetition of other people’s words, referred to as palilalia, is very prominent (Pratt & Whitaker, 2006; Swanberg et al., 2007).

Lastly, **global aphasia** is the most severe form of aphasia (Bunker and Hillis, 2022; Sheppard & Sebastian, 2021). Individuals typically experience extensive left hemisphere damage affecting Broca’s area and Wernicke’s area (Sheppard & Sebastian, 2021).

It is more specifically caused by disturbances in the superior and inferior parts of the left middle cerebral artery or upper regions, such as the insula, as well as the posterior inferior frontal lobe and the posterior superior temporal lobe and/or the anterior inferior parietal lobe (Bunker & Hillis, 2022). Global aphasia is characterised by a near-total loss of all language functions, namely in production, naming, comprehension, reading, writing, and repetition (Kirshner et al., 2003). Verbal output is extremely limited, but not to the degree of mutism, which refers to a complete loss of speech (Swanberg et al., 2007).

In addition to these eight neoclassic (non-)fluent aphasia subtypes, several others have been observed and described in research and clinical practice. However, it is beyond the scope of this study to describe all of them. Should other aphasic syndromes become relevant in other sections, they will be discussed in further detail.

1.2 Sign Languages

The next section addresses the second core theme of this research, namely sign languages. Firstly, the sociolinguistic context is examined, covering common misconceptions, acquisition, and population characteristics such as multilingualism and hearing impairment. Subsequently, Flemish Sign Language (Vlaamse Gebarentaal [VGT]) is discussed, as it is particularly relevant within the context of this research. Finally, the linguistic properties of sign languages are described.

1.2.1 Sociolinguistic Context

Traditional aphasic research and taxonomies rarely include non-typical populations, amongst which are users of sign languages. These are complex, natural languages that employ the visual-gestural modality, in contrast to spoken languages, which use the oral-auditory modality (Baker et al., 2016; Van Herreweghe & Vermeerbergen, 2022). Sign languages consist of the same morphological, semantic, phonological, and syntactic levels as other natural (spoken) languages (Baker et al., 2016), which is described in chapter 1.2.2. Like spoken languages, sign languages emerged through language contact between individuals (Van Herreweghe & Vermeerbergen, 2022).

Sign languages are primarily used in face-to-face interaction and are considered minority languages, of which most are critically endangered (Baker et al., 2016; Emmorey, 2023). Due to limited signing competence and interpreter availability, spoken languages dominate written communication and interactions with hearing people. This, combined with the lower social prestige of sign languages, results in a diglossic situation in which spoken languages function as 'high' varieties and sign languages as 'low' varieties, frequently perceived as in-group codes rather than full societal languages (Vermeerbergen & Van Herreweghe, 2023).

The plural form 'sign languages' is crucial, as it challenges the common misconception that only one single universal sign language exists³³. Like spoken languages, numerous distinct sign languages have emerged and evolved independently; American Sign Language (ASL)³⁴, British Sign Language (BSL)³⁵, Brazilian Sign Language (Libras)³⁶, and French Sign Language (LSF)³⁷ are prominent examples.

Furthermore, sign languages are not derived from spoken languages, as is often believed, but have their own complex linguistic systems and historic origins (Baker, 2021; Baker et al., 2016). For instance, ASL and BSL are mutually incomprehensible despite English being the dominant spoken language in both areas. Another relevant example is the difference between Flemish Sign Language (VGT) and Sign Language of the Netherlands (NGT), even though both regions share Dutch as the primary spoken language (Vermeerbergen et al., 2013).

According to the World Health Organisation (2025b), approximately 5% of the world's population, equivalent to 415 million people, has a disabling hearing loss. The World Federation of the deaf (WFD) estimates around 70 million people belong to signing deaf communities, representing the core population of sign language users (United Nations, n.d.). Sign languages can, of course, also be acquired by hearing individuals as an additional language³⁸ (Schönström, 2021). This can occur, for instance, because they want to communicate with family or friends, or for professional reasons, such as teaching or interpreting (Schönström, 2021; Van Herreweghe & Vermeerbergen, 2022).

³³ International Sign (IS), i.e., a contact variant that emerged from interactions between people with diverse linguistic backgrounds and features more transparent signing, has also been described in recent literature (Kusters, 2024). However, it is relatively novel and requires more research. Thus, it will not be discussed further in this study.

³⁴ Refer to the National Institute on Deafness and Other Communication Disorders (2021).

³⁵ Refer to the British Deaf Association (n.d.).

³⁶ Refer to Universidade Federal da Integração Latino-Americana (2023).

³⁷ Refer to Fédération Nationale des Sourds de France (n.d.).

³⁸ The term 'additional language (Lx)' is used for any language(s) acquired after the first (Ortega, 2014).

As for sign language acquisition, only about 5–10% of deaf children are born to deaf parents and receive the consistent exposure required to acquire a sign language as mother tongue or first language (L1)³⁹. The vast majority (90–95%) have hearing parents and depend on their parents' choices regarding actively seeking contact with the deaf community (Van Herreweghe & Vermeerbergen, 2022). For them, early and fluent sign language input is usually delayed or limited (Baker et al., 2016). Children of deaf adults (CODAs) present a unique case, as they may be exposed to and interact with differing sociocultural and linguistic systems: one of their deaf signing parents and their community, and one of hearing peers and adults (Moroe & de Andrade, 2018).

Schools for the deaf, peer interactions, and the broader deaf community are crucial for providing sufficient input for natural sign language acquisition (Baker et al., 2016). When a deaf, signing child is provided with sufficient input, the order and speed of the first language acquisition are comparable to that of a hearing, speaking child (Baker, 2021). Variation in sign languages mainly depends on the nearest school, a phenomenon referred to as 'Schoolisation' (Quinn, 2010).

Multilingualism and bimodality are also relevant concepts in the sociolinguistic context and acquisition of sign languages. In this study, the term multilingualism will be used as defined by the European Commission, which states it is 'the ability of societies, institutions, groups, and individuals to engage, on a regular basis, with more than one language in their day-to-day lives' (European Commission, 2007, as cited in Cenoz, 2013, p. 5). Bimodality or 'bimodal multilingualism' refers to the ability to use languages that occupy different sensory-motor modalities, namely both oral-auditory and visual-gestural languages (Emmorey et al., 2008). It is important to note, however, that these terms do not necessarily imply equal proficiency across all languages and language skills (Sanches de Oliveira & Bullock Oliveira, 2022).

³⁹ This refers to the language(s) a child learns during the first years of language development, typically from parents, siblings, or custodians (Ortega, 2014).

Moreover, individual differences such as age of acquisition or quantity/quality of linguistic exposure also influence linguistic proficiency (Paradis, 2023). To illustrate, a person who has partial knowledge of Dutch (e.g., reading and writing skills) but is fully proficient in Flemish Sign Language (VGT) is still considered multilingual and bimodal. According to Sanches de Oliveira and Bullock Oliveira (2022), it is, therefore, more realistic to regard individuals as having their own spectrum, in which their monolingual and multilingual skills are situated.

For the majority of (deaf) sign language users, multilingualism and bimodality are the standard rather than the exception, as they must navigate their lives in environments where spoken/written languages are the primary medium of communication (Van Herreweghe & Vermeerbergen, 2022). As a result, (deaf) sign language users are often required to adapt to dominant societal norms, as society is not yet fully designed to accommodate them. Especially for the core population of sign language users, who have a disabling hearing loss, hearing impairment can negatively affect social well-being and limit participation in society (Okuba et al., 2023).

The cochlear implant (CI), a medical sensory prosthesis, plays a substantial role in providing access to auditory input. It involves an electrical device with an external portion that sits behind the ear and an internal portion that is surgically placed under the skin (Boisvert et al., 2020). It does not, however, restore typical hearing; rather, it gives an individual a representation of sound and speech by bypassing the ear and directly stimulating the auditory nerve (National Institute on Deafness and Other Communication Disorders, 2024).

In CI cases, neuroplasticity, the ability of the nervous system to react to stimuli by reorganising its function, structure, and connections, is particularly relevant (Cramer et al., 2011). When auditory input to the brain is restored, it may induce additional plasticity (Ito, 2004). This essentially means that the cochlear implant can trigger functional reorganisation towards auditory processing, enabling the brain to support the development of speech perception and spoken language comprehension (Petersen et al., 2013).

The cochlear implant thus has implications for the acquisition and use of sign languages. Prelingually deaf children who receive the cochlear implant early in childhood demonstrate exceptional success with acquiring oral-auditory languages, while later implantation, e.g., elementary school age or older, is associated with significantly less beneficial outcomes. These late-implanted individuals can detect auditory stimuli thanks to the cochlear implant, but the majority are not able to distinguish complex sounds in everyday situations even after several years post-implantation, compromising speech understanding and oral-auditory learning (Kral & Sharma, 2012). Therefore, parents or custodians of deaf children are commonly advised, or even pressured, to opt for the cochlear implantation and prioritise spoken language development at a young age. If the acquisition of a sign language is primarily approached from a compensatory perspective, namely alleviating communicative barriers associated with hearing impairment, stronger reliance on spoken language through cochlear implantation may reduce the perceived necessity of this endeavour. The debate surrounding cochlear implants and sign languages, therefore, does not concern the communicative value of sign languages alone, but also broader questions of linguistic diversity, cultural belonging, and intergenerational transmission within the deaf community.

In European residents-based research, in nearly all countries, an increase in paediatric cochlear implants was observed (De Raeve et al., 2020). In the context of Flanders specifically, recent research demonstrates a continued decrease in the age of first implantation among children with congenital hearing loss, with the median age at first implantation being 12 months or younger during the five most recent years of the study period (Mertens et al., 2021). Moreover, 95% of deaf children grow up in Dutch-speaking hearing families and are increasingly mainstreamed into Dutch-medium education (Debeerst, 2014; VLOK-CI, 2011). This medical and educational orientation may reduce exposure to Flemish Sign Language (Vlaamse Gebarentaal [VGT]) during crucial periods of language acquisition. Consequently, it may place additional pressure on the language's long-term vitality.

Flemish Sign Language or Vlaamse Gebarentaal (VGT) is the primary sign language of interest to this research. According to an estimate by Loots et al. in 2003, 6,000 people in the Flemish Community use Flemish Sign Language as a first language (L1). VGT consists of five regional varieties that have emerged in and around different Flemish deaf educational institutions. These are comparable to the geographical locations of the five Flemish provinces: West-Vlaanderen, Oost-Vlaanderen, Antwerpen, Vlaams-Brabant, and Limburg (Vanhecke & De Weerdt, 2004; Wille et al., 2022). Additionally, there is a relatively high degree of intraregional variation, influenced by gender, age, register, and other factors (Vanhecke & De Weerdt, 2004). Flemish Sign Language has been culturally recognised as a language used by the deaf community in Flanders and Brussels-Capital since April 26, 2006 (Vlaamse Overheid, 2006).

1.2.2 Linguistic Properties

Although signed languages and spoken languages share fundamental linguistic aspects, such as phonology, morphology, vocabulary, and syntax, sign languages operate on a different spectrum of structural possibilities (MacSweeney et al., 2008a; Schönström, 2021). In contrast to spoken languages, which consist of particular sounds, sign languages rely on the combination of manual and non-manual parameters (MacSweeney et al., 2008a). Generally, research examines five phonological parameters⁴⁰: handshape, location, movement, (hand) orientation, and a non-manual parameter (i.e., movements performed by the body, face, or head). These are near-equivalents to spoken languages' phonemes, meaning a change in the form of one of these parameters can result in a change in a sign's meaning, making them highly contextualised (Schönström, 2021).

⁴⁰ Refer to Sandler (2012) for an overview of the phonological organisation of sign languages.

The visual-gestural modality of sign languages allows structural possibilities that are not (always) possible for oral-auditory languages. For instance, thanks to the use of three-dimensional space, a signer can indicate the relation between the verb and its arguments by changing the phonological parameters of the verb in accordance with the location of its arguments (Baker et al., 2016; Vermeerbergen et al., 2013).

Furthermore, by employing a wider range of articulators, sign languages are known for their simultaneity. This means that, rather than organising language linearly, sign languages can structure it simultaneously (Vermeerbergen et al., 2013). This occurs at the level of the utterance, where manual signs can be combined with non-manual markers, such as raising the eyebrows to create a polar question. Additionally, it appears at the grammatical level, with, for instance, the relative position of elements in locative sentences (ibid.).

Moreover, sign languages also exhibit a high degree of (visual) iconicity (Baker et al., 2016; Vermeerbergen et al., 2013). This refers to a mapping between meaning and a visual or auditory form (Perniss et al., 2010), further defined by Dingemanse et al. (2015, p. 604) as ‘the resemblance-based mapping between aspects of form and meaning in which aspects of the form and meaning of words are related by means of perceptuomotor analogies’. In essence, something in the meaning motivates the form of the sign (Schönström, 2021). This can be illustrated by the VGT examples of ‘TO/A DRINK’ and ‘TO/A BIKE’, presented in Figures 2 and 3, respectively.

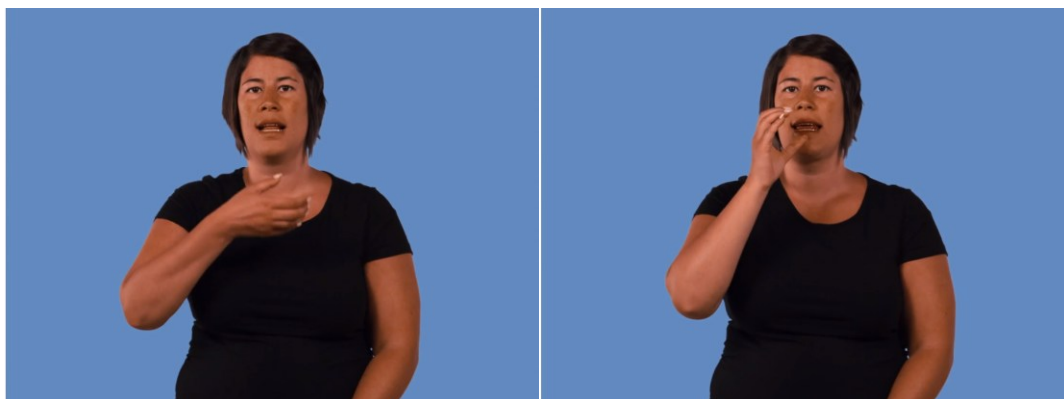


Figure 2: The VGT sign for TO/A DRINK (Woordenboek Vlaamse Gebarentaal, n.d. -a)

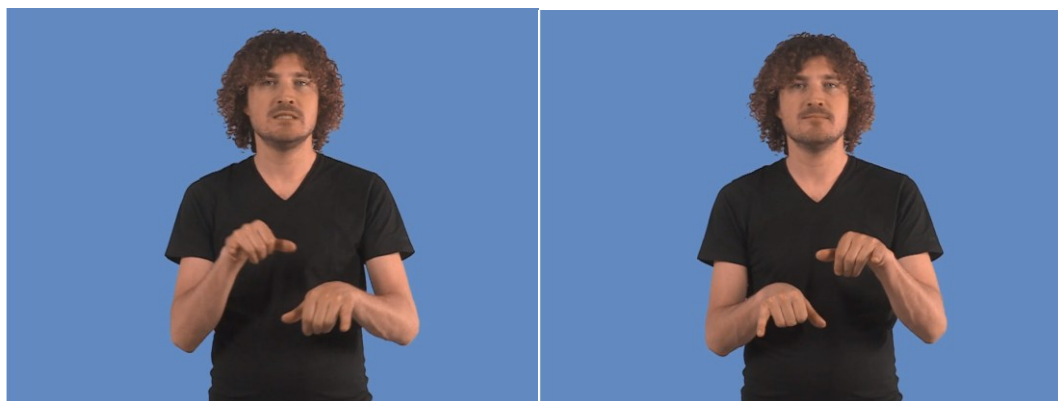


Figure 3: The VGT sign for TO/A BIKE (*Woordenboek Vlaamse Gebarentaal, n.d.-b*)

According to Emmorey (2014), iconicity is arguably persistent in sign languages. Conversely, native signers typically use such forms without consciously reflecting on their iconic motivation (Klima & Bellugi, 1979, as cited in MacSweeney et al., 2008a). Nevertheless, for Lx students, namely non-native learners of a sign language, iconicity does influence language acquisition, as it helps them retain words or signs thanks to their previously acquired conceptual knowledge (Ortega, 2017).

Lastly, it is essential to distinguish signs from (pantomimed) gestures, which are the manual movements that individuals use while producing language (Trettenbrein et al., 2021). Although sign languages are at least partially gestural because they convey information using gestures instead of sounds, signs and gestures remain fundamentally different (ibid.). Firstly, although gestures can express a variety of concepts, they rely on depiction and individual variation, as opposed to conventionalised form-meaning mappings of language (Kika & Emmorey, 2023). Additionally, signs have internal phonological structure, participate in hierarchical, generative lexical processes, combine into sentences, follow grammatical constraints, serve as a primary means of communication, and are shared within a community. In contrast, co-speech gestures lack internal linguistic structure, are rarely combined hierarchically, and function as part of a coexpressive system rather than an independent language (Emmorey, 2002).

1.3 Problem Statement and Research Aims

Research on acquired language disorders, such as aphasia, remains predominantly Westernised, monolingual, and audiocentric⁴¹. Despite well-established assessment protocols for spoken languages, validated tools for sign language users are scarce⁴². As a result, current acute-phase diagnostic protocols do not meet the needs of sign language users, potentially leading to under- or misdiagnosis. Contributing factors to this overarching issue include limited sign language expertise among medical professionals, under-representation in research, a small and heterogeneous sign language population, and a focus on majority (Western) oral-auditory languages, such as English.

Moreover, the core population of sign language users has a disabling hearing impairment, which is associated with greater social isolation, reduced educational and employment opportunities, and poorer mental health outcomes, including depression and low self-esteem (Okuba et al., 2023). People with profound hearing loss also experience increased healthcare use and communication barriers in healthcare settings (ibid.). This is related to the concept of health literacy, which, according to the World Health Organisation (2025a), refers to the ability to access, understand, evaluate, and utilise information to maintain good health. Limited health literacy has been linked to poorer health outcomes (Sørensen et al., 2012) and is, according to several studies, more common among individuals with profound hearing loss (Barnett et al., 2011; McKee et al., 2015; Piao et al., 2023).

⁴¹ I.e., focused on speaking and hearing

⁴² For instance, the American Speech-Language-Hearing Association only mentions spoken languages in their overview of aphasia (ASHA, n.d.-a). Sign language research primarily focuses on 'majority' sign languages such as ASL (Lillo-Martin & Henner, 2021) of which some non-standardised proficiency test batteries exist (i.e., Maller et al., 1999).

This may be explained by barriers such as limited access to information in sign language, restricted availability of interpreting services, and insufficient inclusion in preventive healthcare programmes (Morisod et al., 2022; Napier & Kidd, 2013). These structural barriers can make it more difficult for sign language users to seek appropriate care, especially when hearing professionals, who most often do not use a sign language, cannot relate to their experiences and/or are not properly equipped to address their needs.

The first aim of this research is to provide a rapid overview of existing literature on sign languages regarding language networks and aphasia. Although the central problem affects sign language users worldwide, this study will further focus on Flemish medical professionals involved in acute-phase aphasia diagnostic protocols and their patients, who are VGT users (L1/Lx). The aim is, subsequently, to map the current situation of acute diagnostics in deaf/hearing VGT users and, lastly, to establish recommendations for adapting current acute-phase aphasia screening protocols within the Flemish community.

By bridging neurolinguistics and clinical practice, this study contributes to a better understanding of how language modality influences the manifestation and assessment of aphasia, provides a visual-gestural perspective on language networks, and facilitates the representation of this minority population. Addressing aphasia in relation to sign language is essential for improving scientific knowledge transfer, clinical accuracy, treatment outcomes, equitable healthcare, and quality of life for this population.

2 Research Questions

The following primary research question has been selected: 'How can acute-phase aphasia diagnostic practices be evaluated and improved to better accommodate sign language users in the Flemish Community?'. It is divided into three sub-questions, which are as follows:

1. How does current⁴³ neuroimaging and neuropsychological evidence characterise the neural representation of sign languages in relation to aphasia?
2. Which diagnostic protocols are currently used for assessing acute-phase aphasia in the Flemish Community?
3. To what extent do Flemish speech-language therapists consider the needs of VGT users when assessing acute-phase aphasia?

This research adopts a cross-sectional, explorative design to investigate the problem statement and research questions. It consists of two parts: a rapid review and a quantitative and qualitative data collection through surveys, the latter in combination with a concise literature review. Therefore, this research employs a mixed-methods approach. Expected outcomes include (1) a synthesis of neurological evidence regarding sign language aphasia and the brain, (2) an overview of current Flemish diagnostic practices, and (3) a set of modality-sensitive recommendations for adapting existing diagnostic protocols or developing new ones for VGT users.

⁴³ For this study, 'current' neuroimaging evidence refers to research published from 1995 to 2025, reflecting the widespread adoption of functional Magnetic Resonance Imaging (fMRI) and other imaging methods relevant research regarding healthy sign language processing and sign language aphasia.

3 Rapid Review

3.1 Methodology

3.1.1 Identification

To provide a replicable and unbiased overview of current neuroimaging and neuropsychological evidence on sign languages, sign language processing and, in particular, sign language aphasia, a rapid review was conducted from January 5 to January 9, 2026. This rapid review aimed to streamline the process for more timely answers, as this research operates within a limited timeframe. Through this synthesis, the review aims to identify brain areas systematically involved in healthy sign language processing (1) and to examine how acquired aphasia manifests in sign language users (2).

Insights into the selection, identification, evaluation, analysis, and synthesis of scientific evidence will be provided in accordance with Preferred Reporting Items for Systematic reviews and Meta-Analyses [PRISMA]⁴⁴. A flowchart is provided in Appendix A. No automation tools were used in the selection or screening process. All records were collected, screened, and documented in Mendeley (i.e., a reference manager library) and Microsoft Excel by a single reviewer. To minimise human error, the screening and documentation process was repeated four times.

PubMed and Web of Science served as the primary databases thanks to their extensive data of peer-reviewed biomedical and healthcare literature. No other databases were consulted. Eligibility criteria ensured a focused and accurate selection of studies. First and foremost, studies were not selected if they were not peer-reviewed, a criterion that is inherently met by articles indexed in PubMed and Web of Science.

⁴⁴ Refer to Page et al. (2021a, 2021b) for an explanation of and an elaboration on these guidelines;

Study types included books and documents, adaptive clinical trials, case reports, classical articles, clinical studies, (controlled) clinical trials, and comparative studies. Meta-analyses or other systematic reviews served as secondary literature but are not part of the data sources for this rapid review, as they would risk repeating results from the selected studies. Abstracts were excluded as they do not provide an in-depth exploration of the research question and objectives. Articles published from 1995 to 2025 were included. This timeframe provides a focused overview, from the development of neurobiological methodologies to modern neuroimaging research in relation to sign languages. Articles written in languages other than English or Dutch were not selected due to the researcher's language profile and a lack of resources for translation. Regarding the population of these research articles, studies were only eligible if they involved users who utilise a sign language as their modality of communication (L1/Lx).

To identify brain regions systematically engaged in healthy sign language processing and to explore parallels and divergences between sign languages and spoken languages, the following inclusion criteria were selected. Studies must base their findings regarding healthy sign language processing on either neuroimaging techniques or neurophysiological assessments. The reason lies in the fact that these objectively reveal the brain structures responsible for language processing. Regarding sign languages in relation to aphasia, only studies that examined aphasia of the acquired type were selected. As research articles concerning acute-phase aphasic patients are very limited, chronic or unspecified reports were also allowed. Studies examining any sign language were included for both methodological and theoretical reasons. Methodologically, the limited research output on VGT as a minority language, in addition to no known publications on VGT and the brain, required the inclusion of additional sign languages to ensure adequate data coverage.

Theoretically, evidence from research on spoken languages indicates that the neural organisation of language is largely cross-linguistic⁴⁵, a principle also presumed for sign languages.

Keywords included 'deaf', 'signer', 'aphasia', 'sign language', 'neuroimaging', 'brain activation', 'assessment', and 'protocol'. Synonyms and alternate terms were also used to ensure a comprehensive search. Specifically, 'signed language', 'manual language', 'visual-gestural modality' and 'visuospatial language' were added for sign languages, whereas 'acquired language disorder', '(post-stroke) language impairment' and 'signed aphasia' were selected for aphasia. Keywords were combined using Boolean operators (AND/OR), quotation marks, nesting, and specific symbols (e.g., * to indicate different endings to a keyword). Appropriate filters, such as timeframe, study type, and writing language, were employed.

While keyword searching, the specific characteristics of each database were kept in mind (e.g., manual tags in PubMed). Combining all of these keywords into a single search proved too restrictive and did not retrieve any results. However, using specific sequences of keywords within each thematic block allowed for flexible, reproducible searches that yielded sufficient relevant studies. This approach ensured comprehensive coverage while maintaining specificity to the neural and cognitive aspects of sign languages in relation to aphasia. Search strings were adapted per database and included the following⁴⁶:

1. ('sign language' OR 'signed language' OR 'visual-gestural modality' OR 'manual language' OR 'visuospatial language') AND ('aphasia' OR 'language impairment' OR 'signed aphasia')
2. 'sign language' AND ('neuroimaging' OR 'brain activation')

⁴⁵ Refer to Malik-Moraleda et al. (2022) for an investigation across 45 spoken languages and 12 language families, which reveals a universal language network.

⁴⁶ Due to zero results for search strings combining 'assessment' or 'protocol' and keywords relating to sign languages, these were eventually excluded from the results section.

3.1.2 Evaluation

Data were extracted using a structured table per stage in Microsoft Excel, including the publications' titles and authors, DOI if applicable, the database from which records were retrieved, and the search strings used. During the identification phase, **136** records were retrieved independently by the researcher, of which 9 were indexed in PubMed and 127 in Web of Science. Duplicate records were removed (n=11), resulting in 125 studies. No additional records were excluded at this stage, and all remaining records were retained.

Titles and abstracts were then screened against the eligibility criteria. Meta-analyses and (systematic) reviews (n=16) that slipped through the filtering system were excluded. If, by screening the titles and abstracts, the studies did not provide sufficient references to healthy sign language processing (n=40). For instance, if they discussed sign language linguistics only or were case reports focused on outcome, they were not selected. Moreover, language impairments unrelated to acquired aphasia (n=20) were excluded. Subsequently, 49 records were sought for retrieval, of which 41 full texts could be accessed and indexed in Mendeley for further assessment against the eligibility criteria. A total of 12 reports were excluded: 6 studies did not provide sufficient reference to healthy sign language processing, 3 reported (language) impairments unrelated to acquired aphasia upon further inspection, and 3 lacked sufficient neuroimaging, neurophysiological, or lesion-based evidence.

3.1.3 Selection

Eventually, **29** studies were selected and included for synthesis, comprising neuroimaging, neuropsychological, and lesion-based investigations of sign language processing in both deaf and hearing populations. Two broad categories were identified: healthy sign language processing in general and sign languages in relation to acquired aphasia. All included studies are detailed in Appendix B.

This lists the articles' characteristics, such as the sign language(s) and spoken language(s) in question, the participants' handedness, and clinical condition (aphasia versus no aphasia), and their hearing status. From all records retrieved, 15 were comparative group studies, 6 were experimental task-based studies, and 8 were lesion-based studies. Due to the heterogeneity of the included records, no quantitative meta-analysis was conducted.

3.1.4 Analysis

The analysis of this rapid review was carried out using a qualitative synthesis approach in Mendeley, aimed at extracting, comparing, and interpreting findings from neuroimaging, neuropsychological, and lesion-based studies. Patterns of neural activation, lateralisation, and aphasia-related impairments were identified across participant groups, including deaf and hearing signers, as well as aphasic versus non-aphasic individuals. Within-group consistency and across-group divergences were evaluated to determine which brain regions are systematically involved in healthy sign language processing and how these regions are affected in acquired aphasia. The researcher conducted a critical appraisal, considering study quality, sample size, and methodology during synthesis and evaluating whether the applied methods were reliable to draw proper conclusions.

Due to the single-reviewer screening and extraction, the heterogeneity of methods and populations, and the absence of formal meta-analysis, generalisability may be limited. However, study characteristics and limitations were factored into the interpretation. The analysis process was also repeated four times to minimise human error. The certainty of evidence and risk of bias will be evaluated in the results chapter of this rapid review.

3.2 Results

In the following chapters, the results of the rapid review will be discussed. This section consists of two parts: evidence from sign language aphasia (3.2.1) and evidence from healthy sign language processing (3.2.2). To answer the first sub-question of this research, namely 'How does current neuroimaging and neuropsychological evidence characterise the neural representation of sign languages in relation to aphasia?', both sections will be synthesised in the discussion (3.3). The 29 selected studies investigated a wide variety of research questions, individual characteristics, lesion locations, and neuropsychological and language assessments. The complete list is available in Appendix B.

3.2.1 Sign Language Aphasia

3.2.1.1 Study Characteristics

In total, 8 of 29 studies were lesion-based, describing individuals with acquired aphasia, resulting in deficits in the production and comprehension of the sign language they used as their modality of communication (L1/Lx). Group studies and single-case reports will be discussed separately. Study characteristics will also be visualised in Tables 1 and 2 for group studies and single-case reports, respectively, in their individual sections.

The included sign languages were British Sign Language (BSL), American Sign Language (ASL), Israeli Sign Language (ISL), and Japanese Sign Language (JSL). Israeli Sign Language and Indian Sign Language (Refer to 3.2.2) use the same abbreviation and will, therefore, be specified in this study beyond ISL.

All studies identified unilateral brain lesions that frequently involved the left temporal, frontal, and parietal regions. Nevertheless, several studies also encountered right-hemispheric damage (Atkinson et al., 2003; Hickok et al., 1998; Hickok et al., 2002; Hickok et al., 2009; Pickell et al., 2005), and Saito et al. (2005) reported occipital⁴⁷ and callosal⁴⁸ lesions. Regarding procedures to confirm the acquired aphasic syndrome in patients, several batteries were employed. Hickok et al. (1999) used an ASL-adapted version of the Boston Diagnostic Aphasia Examination (BDAE) battery, language measures also included in Rogalsky et al. (2013). Hickok et al. (2002) and Pickell et al. (2005) both specify using a test adapted from the word discrimination subtest, also included in the ASL-adapted BDAE battery. Saito et al. (2005) administered a naming task, adapted from the Western Aphasia Battery (WAB)⁴⁹, and Haluts et al. (2024) conducted the span test for basic monomorphemic signs from the SIMBA battery⁵⁰. Nevertheless, how participants obtained their aphasia diagnosis was not specified, as this was not relevant for the studies' research aims.

Hearing status varied across studies: most participants were deaf, with only a few hearing individuals included. Specifically, Atkinson et al. (2003) had five deaf and one hearing participant; Hickok et al. (1998) included twenty deaf signers; Hickok et al. (2002, 2009) each had one hearing participant among otherwise deaf samples; and Rogalsky et al. (2013) studied only deaf signers. In single-case reports, two participants were deaf, and one was hearing. Formal assessment of hearing status was not reported in any study.

⁴⁷ The occipital lobe comprises the posterior part of the cerebral cortex and is mainly involved in visual processing (Webb, 2017).

⁴⁸ The corpus callosum is a large white matter tract that connects and allows communication between the two cerebral hemispheres (van der Knaap & van der Ham, 2011).

⁴⁹ This battery was originally developed by Kertesz (1979) and revised (2007) as the Western Aphasia Battery-Revised (WAB-R).

⁵⁰ This refers to The Sign-language Immediate Memory Battery for Assessment. Refer to Haluts & Friedmann (2020) for elaboration on an aphasia battery that specifically focuses on cross-modal bilingual aphasia and phonological output buffer issues.

Regarding sign language experience, Atkinson et al. (2003) reported that all individuals were considered lifelong, early, or native users of their sign language. The same is true for Hickok et al. (1998, 2002), Rogalsky et al. (2013) and the single case in Pickell et al. (2005). Hickock et al. (2009) offered a diverse range of signing experience and did not specify how many of their participants they considered native or early signers. Nevertheless, in Table 1 (Hickok et al., 2009, p. 12), it is apparent that half of the individuals had been exposed to ASL within their first five years of life. Saito et al. (2005) described their patient as 'having learned Japanese Sign Language (JSL) in a community of deaf people in his school days', and Haluts et al. (2024) stated theirs was an adult learner and daily user of Israeli Sign Language.

Concerning handedness, all participants were reported to be right-handed, except for the single case in Pickell et al. (2005) and Haluts et al. (2024), and one participant in the group study of Atkinson et al. (2003). Haluts et al. (2024) specified that their participant had previously considered herself left-handed but, at the time of the research, used both hands when writing and signing due to repeated left-handed fractures during childhood. Across all studies, how handedness was formally assessed was not explicitly mentioned.

Which specific languages participants also knew and/or used daily in addition to the sign language of interest is not certain. Haluts et al. (2024) explicitly stated that their participant was a bimodal multilingual. Thus, this patient employed several languages across both the oral-auditory and visual-gestural modality. Pickell et al. (2005) only mentioned their participant's experience with ASL. Saito et al. (2005) reported that their single case could communicate fluently with hearing people using reading and writing in Japanese. Atkinson et al. (2013) assessed both English and BSL in their group study for their hearing participant. Hickok et al. (2002, 2009) explicitly stated that one subject was hearing and bilingual (ASL and English). Moreover, Hickok et al. (1998) only discussed ASL. Finally, Rogalsky et al. (2013) reported that all participants had some experience with written English in addition to BSL, but that this was not formally assessed.

Across studies examining sign language aphasia, lesion information relied on structural imaging. Hickok et al. (1998, 2002, 2009) employed CT⁵¹ and MRI to classify lesions. Pickell et al. (2005) utilised high-resolution MRI to map a single right-hemisphere lesion in detail, while Saito et al. (2005) used T2-weighted MRI for their single-case report. Haluts et al. (2024) documented a left temporo-parietal stroke using structural MRI. Atkinson et al. (2003) applied structural lesion localisation in studies of aphasia after left perisylvian damage. Finally, Rogalsky et al. (2013) combined CT and MRI scans with lesion overlay and subtraction techniques.

A wide variety of assessments were employed across these studies. These included neuropsychological, linguistic, and non-linguistic tests. Due to the number of different assessments, details per publication will be provided in the more in-depth synthesis of the results, namely in chapters 3.2.1.2 and 3.2.1.3 for group studies and single-case reports, respectively.

3.2.1.2 Sign Language Aphasia across Group Studies

Regarding the hemispheric lateralisation of sign language, across all group lesion studies, left-hemispheric damage (LHD) was consistently associated with sign language aphasia, affecting comprehension and/or production. In contrast, right-hemispheric damage (RHD) left core linguistic abilities (production, comprehension, writing, reading) generally spared, though selective impairments in spatial, classifier⁵², or visuospatial processing were occasionally observed. Study characteristics such as the publication year, the involved sign language, the sample size, hearing status and handedness of participants, and the observed lesion locations can be consulted in Table 1 below.

⁵¹ Computed Tomography is a structural neuroimaging technique that involves computer-processed X-rays, which create tomographic images (virtual 'slices') of the brain (Allely et al., 2015).

⁵² Classifier constructions involve a handshape morpheme, representing a particular object, together with the location and movement of the hands in the three-dimensional signing space, and iconically portray object motion or spatial relationships without adding lexical items (Emmorey, 2003).

Study	Year	Sign Language	Sample Size	Hearing Status	Handed -ness	Lesion Locations
Atkinson et al.	2003	BSL	6	5 deaf 1 hearing	5 r 1 l	LHD/RHD frontal, parietal, temporal
Hickok et al.	1998	ASL	20	deaf	r	LHD/RHD, frontal, parietal, temporal, occipital
Hickok et al.	2002	ASL	19	18 deaf 1 hearing	r	LHD/RHD, posterior temporal
Hickok et al.	2009	ASL	21	20 deaf 1 hearing	r	LHD/RHD, frontal, parietal, temporal
Rogalsky et al.	2013	ASL	34	deaf	r	LHD/RHD, frontal, parietal, temporal

Table 1: Study characteristics of sign language aphasia in group studies

Atkinson et al. (2009), as seen in Table 1, examined six lifelong signers of BSL (five deaf, one hearing) with unilateral brain lesions as a result of a cerebrovascular accident (CVA), also referred to as a stroke. Lesion sites were variable, spanning frontal, temporal, or parietal regions in either the left or right hemisphere. One participant ('Basil') was left-handed and hearing. This study used the following neuropsychological tests: Line Cancellation, Wechsler Adult Intelligence Scale (WAIS-III) Block Design, Raven's Progressive Matrices (RPM), the Pyramids and Palm Trees Test (Picture Version; PPT-P), and the Benton Test of Line Orientation. Regarding BSL language assessments, a picture naming test, a sign-to-picture matching test, and a BSL verb and sentence comprehension test were conducted.

Atkinson et al. (2003) also assessed processing of faces and facial actions with the Benton Test of Face Recognition, the Ekman and Friesen Test of Facial Expression Categorisation, Warrington Recognition Memory Test, Reduced Warrington Test, and Car Recognition Test. For the participants with right-hemispheric damage, the researchers also administered speech reading tests in English (picture sorting, speech reading numbers and proper names). Finally, they administered an experimental BSL negation task with two pictures in a vertical array, one of which was the negative of the other. For the hearing participant ('Basil'), it was also possible to test spoken English negation.

Participants with left-hemispheric damage (LHD) experienced significant language impairments in both sign language comprehension and production, whereas participants with right-hemispheric damage (RHD) performed language tasks, including speechreading, within a normal range. Language deficits in the LHD group were not alleviated by a higher degree of iconicity, as performance was impaired even for highly iconic signs. Moreover, left-hemispheric language deficits were dissociated from visuospatial abilities. Participants exhibiting visuospatial deficits outperformed others on language tasks. In contrast, participants with RHD showed selective impairment in comprehending negation.

They performed worse than LHD participants when processing negation expressed without a lexical or manual marker, though other aspects of sign language remained intact. Difficulties were associated with specific impairments in processing facial images and expressions; however, they did not reflect generalised face-blindness.

Hickok et al. (1998) examined twenty deaf lifelong signers of ASL with unilateral brain damage. Their sample consisted of twelve individuals with LHD and eight people with RHD, which can be consulted in Table 1.

Aetiologies were variable: ischaemic infarcts⁵³ (n=17), haematomas⁵⁴ (n=2), one tumour, and one aneurysm⁵⁵ rupture. The affected brain regions varied in size and location, spanning frontal, parietal, temporal, and occipital regions in the left and right hemispheres. The following assessments were used in this study. Regarding visuospatial abilities, the Drawing Copy Task and the Hierarchical Figure Task, both from the ASL-adapted Boston Diagnostic Aphasia Examination (BDAE) Drawing Subtest, were administered. Concerning language assessments, they used paraphasias per minute and as a proportion of total signs, along with scores on the Sign Discrimination Subtest and the ASL-adapted Token Test, with errors derived from the Response Questions and Cookie Theft portions of the ASL-adapted BDAE.

Participants with left-hemispheric damage (LHD) demonstrated substantial sign language deficits, while right-hemispheric damage (RHD) individuals showed preserved linguistic abilities. Nevertheless, RHD participants did show impairments in global visuospatial processing, i.e., processing the overall big picture/context. Conversely, LHD participants only displayed selectively impaired, local-level visuospatial abilities, i.e., regarding fine details and specific features.

Hickok et al. (2002), as seen in Table 1, investigated eighteen lifelong signers of ASL, all but one deaf, with unilateral brain lesions as a result of various aetiologies. These included ischaemic infarcts (n=15), haematomas (n=3), one tumour, and one aneurysm rupture. Eleven participants had obtained left-hemispheric damage (LHD), and seven had experienced right-hemispheric damage (RHD). According to Hickok et al. (2002), 'one RHD subject was hearing and bilingual (ASL and English), and inclusion of the hearing participant did not alter results'.

⁵³ An ischaemic infarct/stroke is caused by a thrombosis (local blood clot) or embolism (travelling blood clot), causing occlusion and reducing blood flow to the brain (Lui et al., 2025).

⁵⁴ A haematoma is an acute swelling due to a vessel rupture with a collection of blood (Hanson & Gasiorowski, 2014).

⁵⁵ An aneurysm is a pathologic dilatation of an artery, which can cause it to rupture (Robertson & Watton, 2013).

Individuals were grouped by the presence or absence of posterior temporal lobe involvement to test their research hypotheses. Hickok et al. (2002) theorised that the LHD group would perform more poorly than the RHD group on all tests and that those with temporal lobe damage would be more impaired than those without temporal damage. Participants were administered two tests of ASL comprehension. The first was adapted from the Word Discrimination Subtest of the Boston Diagnostic Aphasia Examination (BDAAE), and the second was an ASL-adapted version of the Token Test.

The LHD group performed notably worse than the RHD group on all three language tasks, which consisted of an isolated single-sign comprehension task, a sentence-level comprehension task concerning simple one-step commands, and a sentence-level comprehension task including more complex multclause/multistep commands. Moreover, the group with left temporal lobe involvement was significantly impaired on all tasks, while participants without left temporal involvement achieved near-perfect scores (>95%) on single-sign and simple-sentence tasks, even when they had suffered extensive frontal or parietal damage. In contrast, the RHD group showed preserved basic comprehension, with only mild deficits regarding complex sentences.

Hickok et al. (2009) included 21 right-handed signers with unilateral lesions in their sample (Refer to Table 1). All but one participant was deaf. Thirteen had suffered left-hemispheric damage (LHD), and eight had experienced right-hemispheric damage (RHD). Aetiologies were not further specified. Prior to brain injury, all individuals had been fluent in ASL, their primary system of communication. As mentioned previously, Hickok et al. (2009) did not specify which participants they considered lifelong signers. The study specifically focused on lexical versus classifier production and presented participants with a story narration task designed to elicit both lexical signs (fixed meaning) and classifier signs (conveying size, shape, movement, and placement). More specifically, this refers to a narrative production task involving a wordless picture book story (i.e., 'The Paint Story').

On the one hand, LHD signers made significantly more lexical errors than RHD signers, involving lexical aspects such as handshape. On the other hand, RHD signers notably performed worse on classifier signs, particularly in spatial and movement components.

Rogalsky et al. (2013) studied 34 deaf lifelong signers of ASL with unilateral focal cortical lesions (Refer to Table 1). Fourteen individuals had experienced left-hemispheric damage (LHD), while ten had suffered right-hemispheric damage (RHD). Aetiologies consisted of ischaemic infarcts (n=29), haematomas (n=4), and one tumour. Fifteen of these participants were also included in the study of Hickok et al. (2002); however, research aims and questions differed. Rogalsky et al. (2013) furthermore reported that all participants had some experience with written English, but that this was not formally assessed.

Tests included a wide variety of language and spatial cognitive measures conducted as part of the basic neuropsychological assessment. The language measures involved an ASL-adapted version of the Boston Diagnostic Aphasia Exam (BDAE). The primary assessments were two comprehension subtests: the 'sign discrimination' and 'commands' task. Lesion locations were divided according to frontal, temporal, or parietal involvement to test competing neural models of action understanding.

Left frontal lesions were associated with production deficits but did not impair sign comprehension, even in participants with severe non-fluent deficits. Signers with left-frontal lesions involving Broca's area and surrounding areas scored near-perfect on comprehension of individual signs. They also performed comparably to RHD signers on signed sentence instructions, as measured by the commands test. Individuals with left temporal lobe lesions, conversely, showed comprehension impairments, particularly on the commands test, with scores mostly deviating from those with left frontal or right hemisphere lesions.

3.2.1.3 Sign Language Processing across Single-Case Reports

Concerning the hemispheric lateralisation of sign language in single-case reports, impaired left-hemispheric regions were, in 2/3 of studies, also associated with sign language aphasia. Study characteristics such as the publication year, the involved sign language, the sample size, hearing status and handedness of participants, and the observed lesion locations can be consulted in Table 2 below.

Study	Year	Sign Language	Sample Size	Hearing Status	Handed -ness	Lesion Locations
Haluts et al.	2024	ISL	1	hearing	l + r	LHD temporo- parietal
Pickell et al.	2005	ASL	1	deaf	l	RHD perisylvian
Saito et al.	2005	JSL	1	deaf	r	LHD occipital & temporal, corpus callosum

Table 2: Study characteristics of sign language aphasia in single-case reports

Haluts et al. (2024), as seen in Table 2, described a case of a hearing, multilingual, and ambidextrous person. More specifically, ‘Sunny’ knew Hebrew, Romanian, English, and was an adult learner and daily user of Israeli Sign Language (ISL). During childhood, the participant considered herself left-handed, but at the time of the study was using both hands for signing and writing due to numerous past injuries to her left hand. In this single-case report, an extensive list of assessments was administered.

Firstly, the participant’s spoken Hebrew was assessed, using picture naming tasks, reading aloud, morphologically complex words, construct state nominals, sentence completion, verb inflexion, repetition, and multidigit number repetition. Written Hebrew and fingerspelled output were tested through picture naming, dictation, delayed copying, and sentence writing. English phonological output was assessed with (non-)word tasks.

Concerning Israeli Sign Language (ISL), this was assessed through picture naming, reading-then-signing, repetition of existing signs, non-signs, and two-digit numbers. Error analyses were performed across all modalities, including spontaneous speech and signing. 'Sunny' displayed aphasia and orthographic output buffer dysgraphia⁵⁶ after having suffered a left temporo-parietal stroke. She displayed left perisylvian lesions (superior temporal gyrus, insula, planum temporale⁵⁷, and superior parietal lobule). She experienced phonological output buffer deficits across spoken and signed languages, affecting handshape, movement, location, and orientation in Israeli Sign Language.

Pickell et al. (2005) described a case in which a left-handed, lifelong ASL signer who had suffered a right-hemispheric perisylvian stroke presented with aphasia, as seen in Table 2. The participant performed naming tasks (e.g., pen, wristwatch, animals) and computational tasks such as subtractions (e.g., 100-7) and calculations (e.g., number of quarters in \$1.75). Visuospatial tasks included copying three 'nonsense' figures and a picture of a cube with 45-degree rotation and mild distortion, drawing an analogue clock set to 11:10, and bisecting lines. A motor task, not further specified, revealed mild left motor neglect. A general neurological examination was also performed. Regarding sign language tasks, comprehension tests included the Sign Discrimination Test and the ASL Token Test. Additional comprehension measures were the Commands Subtest of the BDAE and the Complex Ideational Material subtest. Production tasks included spontaneous signing during the Cookie Theft picture⁵⁸ and the Paint Story narratives. Paraphasic errors were analysed across all types and phonological parameters.

⁵⁶ According to Haluts et al. (2024), this type is a selective impairment in the short-term memory component responsible for holding the sequence of letters to be written. It can occur as a developmental or an acquired deficit, the latter of which is the case for 'Sunny'.

⁵⁷ The planum temporale is a triangular brain area located on the superior temporal gyrus (STG), which corresponds to Wernicke's area in the left hemisphere. It consists of the secondary auditory cortex and is believed to be involved in language processing (Shapleske et al., 1999).

⁵⁸ For a visualisation, refer to 4.2.2.

Visuospatial abilities were largely preserved, though hierarchical figures testing revealed subtle impairments at the local-feature level. Mild left-sided neglect was noted, though performance on line bisection and line cancellation tasks was largely intact. Sign language production and comprehension were significantly impaired. Phonemic paraphasias were specifically noted in all ASL parameters. These findings indicate a dissociation between severely impaired language functions and relatively spared visuospatial processing.

Saito et al. (2005), as seen in Table 2, reported a deaf JSL signer with lesions in the left occipital and temporal lobes, as well as the corpus callosum. Sign language experience was not specified, but the researchers stated that the participant learned JSL in a deaf community during his school days, in addition to speech reading Japanese.

The participant was assessed across several aspects of Japanese Sign Language (JSL) as well as written and fingerspelled Japanese. Daily routine observation and basic cognitive tasks were used to evaluate general intelligence, memory, habits, and constructional abilities, including copying geometric figures. Sign language comprehension was tested with instruction tasks involving lexical signs and fingerspelled Kana⁵⁹, as well as pointing to objects among visually presented items. Naming abilities were assessed using the Western Aphasia Battery (WAB) for sign words and fingerspelled Kana. Repetition of sign language was evaluated by asking the patient to imitate individual sign words and sequences of fingerspelled Kana. Reading and writing abilities were tested in both Japanese Kana and Kanji⁶⁰, including writing names of visually presented objects, composing short sentences, and translating between written text and JSL.

⁵⁹ A Japanese syllabic writing system that consists of two written forms: Hiragana (another Japanese writing system used to express particles and grammatical distinctions) and Katakana (based mainly on Chinese logographs, used for loan words and foreign words) (Colman, 2009).

⁶⁰ A Japanese logographic writing system based mainly on Chinese logographs (Colman, 2009)

The patient demonstrated deficits across all language modalities, including comprehension, production, reading, and writing in Japanese Kana and Kanji and Japanese Sign Language (ISL). The severe sign production impairments could not be completely attributed to the medial temporal lesions, which would explain the word comprehension and retrieval deficits, but not those related to articulation. Moreover, though the damage to the corpus callosum may have caused the aphasic syndrome, it could not be justified fully due to the absence of shown laterality in sign language production.

3.2.1.4 Risk of Bias and Certainty of Evidence

The included studies on sign language aphasia varied in participants' characteristics, methodology, task design, and research aims. This introduces difficulties regarding synthesising and interpreting results. In this section, the risk of bias and certainty of evidence in these research articles are assessed.

Most of the sample sizes were small, with three studies offering single-case reports (Haluts et al., 2024; Pickell et al., 2005; Saito et al., 2005). Additionally, the largest sample, provided by Rogalsky et al. (2013), consists of only 34 participants, with some overlapping participants from an earlier study by Hickok et al. (2002), though the research aims differed. This increases the risk of selection bias and could limit generalisability. However, it is important to note that the population size of sign language users is already relatively small. Identifying possible participants with acquired sign language aphasia is therefore challenging. Moreover, the ratio for acquired aphasia in spoken languages could very well be similar. For instance, while the sample of Atkinson et al. (2003) included only six BSL signers with acquired aphasia within a population of 22,000 in England and Wales (Office for National Statistics, 2022), compared to 52.6 million English users in the same region, a far larger population size.

Hearing status differed, with four studies including one hearing signer (Atkinson et al., 2003; Haluts et al., 2024; Hickok et al., 2002; Hickok et al., 2009). Some researchers do acknowledge that deafness itself may have implications for the brain organisation of language. However, Hickok et al. (2002, 2009) underscored that results did not change if the hearing signer was excluded from the analysis. Atkinson et al. (2003) also attempted to compensate for Basil's hearing status by giving him more (extensive) tests. Hearing status was also not explicitly formally assessed. Participants were included in these studies if they (1) used a sign language and (2) were diagnosed with an acquired aphasic syndrome. Sometimes (e.g., Atkinson et al., 2003), a distinction was made between 'deaf' and '(born) profoundly deaf'. However, as not all studies specified this, further conclusions could not be drawn. The precise implications of different hearing statuses on aphasia in relation to sign languages, despite cross-study consistency, require further research and cannot be derived from this data.

Handedness also varied, with most participants being right-handed, but some reports included left-handed or ambidextrous signers (Atkinson et al., 2003; Pickell et al., 2005; Haluts et al., 2024). Handedness is a known factor that could potentially affect language organisation and may therefore influence results. Nevertheless, excluding the left-handed participant in Atkinson et al. (2003) did not alter the general results, and Pickell et al. (2005) acknowledged their participant had reversed cerebral dominance. Additionally, handedness was not formally assessed across all studies, resulting in complications similar to hearing status. Handedness was also not further specified, ignoring potential differences in, e.g., using cutlery, playing racket sports, writing, signing, etc.

Furthermore, issues occur regarding multilingualism and bimodality and how these concepts are defined. Multilingualism and bimodal language experience were rarely explicitly documented and were challenging to interpret. As previously mentioned, most sign language users are inherently multilingual (Van Herreweghe & Vermeerbergen, 2022), but this is not always mentioned or labelled in this manner.

However, this does not necessarily mean that all of these participants did not know other spoken or signed languages, merely that they were not relevant in these studies. Thus, most of these participants may qualify as multilinguals, which in turn may have repercussions for language organisation, but this cannot be deduced with certainty.

Regarding language experience, it was often inferred rather than systematically assessed. Differences in sign language experience may have repercussions for the accuracy of results. However, heterogeneity was not as extensive as results remained consistent across all studies, and most participants were part of the same group, namely, (deaf) lifelong signers.

Lastly, measurement bias may also affect findings, as studies used heterogeneous neuropsychological and language assessments. These included assessments may influence effect estimates and comparisons between LHD and RHD participants. Despite these differences, consistent patterns could be found across studies. Additionally, many studies used a mixed-methods approach, providing complementary assessments. The applied tests are also standardised and/or widely known, such as the Benton Judgment of Line Orientation and the ASL-adapted BDAE battery. Measurement bias can be mitigated, as it is not the intent of this rapid review to research specific aspects of aphasia; it is aimed at mapping general patterns of sign language aphasia. Thus, it does not lower the generalisability or accuracy of results.

In conclusion, small sample sizes and variety in participant characteristics introduce potential selection and measurement biases. Due to the variety of the research articles, statistical analysis is limited, and a meta-analysis could not be conducted. Nevertheless, though most studies focused on ASL, BSL, JSL, or ISL, the findings may provide useful insights for understanding sign language aphasia in other minority sign languages, including VGT, as the cerebral language network is cross-linguistic (Refer to Malik-Moraleda et al., 2022).

Despite methodological differences, group and case studies consistently reported that left-hemispheric lesions are associated with core sign language deficits (comprehension, production, writing, reading), and right-hemispheric lesions primarily affected visuospatial and spatial processing, including classifier processing.

According to the GRADE SCALE (The Grading of Recommendations Assessment, Development and Evaluation⁶¹), the quality of evidence is **moderate**. Risk of bias, which may be present due to the variable participant characteristics, reduces validity. However, results were consistent and precise, evidence could be generalised to other sign languages, and no clear evidence of publication bias was found.

3.2.2 Healthy Sign Language Processing

3.2.2.1 Study Characteristics

In total, 21 studies examined healthy processing across several sign languages, including American Sign Language (ASL), British Sign Language (BSL), Chinese Sign Language (CSL), and Indian Sign Language (ISL). Six articles were experimental, task-based studies, while fifteen studies conducted comparative analyses across multiple variables, such as deaf signers versus hearing signers, sign languages versus spoken languages and early versus late acquisition. Additionally, one comparative study focused specifically on differences between signs and gestures (Husain et al., 2009) and another on fingerspelling versus lexical signs (Lee et al., 2025).

Sample sizes varied, ranging from 12 to 70 participants. The majority of signers were regarded as deaf, with some hearing signers included in two comparative studies (Horwitz et al., 2003; Kovelman et al., 2008). In addition, individuals were explicitly labelled as multilingual (ASL + English) in two studies (Horwitz et al., 2003; Kovelman et al., 2008).

⁶¹ For a detailed explanation on how to assess certainty of evidence according to the GRADE approach, refer to Kirmayr et al. (2021).

Regarding language experience, most participants were considered lifelong signers, though two studies reported late learners or different proficiency levels (Li et al., 2014; Twomey et al., 2017). Most participants were right-handed, with only two studies including left-handed signers (Alotaibi et al., 2024; Lee et al., 2025), and one study not specifying handedness (Husain et al., 2009).

All study characteristics, including the authors and year of publication, the involved (sign) languages, sample sizes, hearing status, handedness, and applied methods, can be referred to in Tables 3 and 4, for comparative and experimental studies, respectively.

Study	Year	(Sign) Language	Sample Size	Hearing Status	Handed -ness	Methods
Capek et al.	2009	BSL vs English	26	13 deaf signers 13 hearing non-signers	26 r	fMRI
Corina et al.	2007	ASL vs English	20	10 deaf signers 10 hearing non-signers	20 r	PET
Emmorey et al.	2009	ASL vs English	28	14 deaf signers 14 hearing non-signer	28 r	fMRI
Horwitz et al.	2003	ASL + English vs English	31	11 hearing signers 20 hearing non-signers	31 r	PET cyto-architectonic mapping
Husain et al.	2009	ASL (vs gestures)	12	12 deaf signers	not specified	fMRI
Kassubek et al., 2004	2004	ASL vs English	22	7 deaf signers 15 hearing non-signers	All r	fMRI
Kovelman et al.	2008	ASL + English vs English	32	4 hearing signers 20 hearing non-signers 7 deaf non-signers	32 r	fNIRS

Kumar et al.	2024 b	Indian Sign Language (ISL) + Hindi vs Hindi	70	35 deaf signers 35 hearing non-signers	70 r	fMRI
Lee et al.	2025	BSL + English (vs finger-spelling)	24	24 deaf signers	23 r 1 l	ERP priming
Li et al.	2014	Chinese Sign Language (CSL) (proficiency levels)	50	14 deaf 36 hearing	50 r	fMRI
Liu et al.	2020	Chinese Sign Language (CSL) + Chinese Mandarin Chinese Mandarin	29	14 signers 15 signers Deafness not specified	29 r	fMRI DPA finger-printing
MacSweeney et al.	2008 b	BSL + English	47	23 deaf 24 hearing signers	47 r	fMRI
MacSweeney et al.	2002	BSL (topography)	18	18 deaf signers	18 r	fMRI
Malaia et al.	2012	ASL vs English	30	17 deaf signers 13 hearing non-signers	30 r	fMRI
Twomey et al.	2017	BSL (acquisition time)	60	deaf signers	60 r	fMRI

Table 3: Study characteristics of sign language processing across comparative studies

Study	Year	Sign Language	Sample Size	Hearing Status	Handed-ness	Methods
Alotaibi et al.	2024	ASL	24	deaf	23 r 1 l	fMRI DTI
Corina et al.	2003	ASL	16	deaf	r	PET
Newman et al.	2010 a	ASL	14	deaf	r	fMRI
Newman et al.	2010 b	ASL	17	deaf	r	fMRI
Okada et al.	2016	ASL	16	deaf	r	fMRI
San José-Robertson et al.	2004	ASL	16	deaf	r	PET

Table 4: Study characteristics of sign language processing across experimental studies

Task types varied considerably. Lexical and sign production tasks were carried out in Corina et al. (2003), Kassubek et al. (2004), and San José-Robertson et al. (2004). Okada et al. (2016) employed sign perception and action execution tasks. General sentence and narrative processing were investigated in Newman et al. (2010a, 2010b), Malaia et al. (2012), MacSweeney et al. (2002), and Lee et al. (2025). Furthermore, Kumar et al. (2024b) charted large neural networks supporting sign language processing. Phonological judgement tasks were conducted by MacSweeney et al. (2008b), Twomey et al. (2017), and Husain et al. (2009). Morphosyntactic processing and fingerspelling were researched by Lee et al. (2025) and Alotaibi et al. (2024).

Moreover, differences between linguistic signs and non-linguistic gestures/pantomimes were examined in Husain et al. (2009), Emmorey et al. (2009), Corina et al. (2007), and Capek et al. (2009). Li et al. (2014) examined functional differences related to hearing status and proficiency levels. Finally, cross-linguistic and bimodal language influences were explored in Horwitz et al. (2003), Kovelman et al. (2008), Kumar et al. (2024b), Liu et al. (2020), and Lee et al. (2025). In general, task types and stimuli overlapped and varied across the selected studies, providing a wide range of information relevant to healthy sign language processing.

Most studies used fMRI. Alotaibi et al. (2024) utilised Diffusion Tensor Imaging (DTI⁶²). Corina et al. (2003, 2007), San José-Robertson et al. (2004), and Horwitz et al. (2003) employed PET, the latter in combination with cytoarchitectonic mapping. Liu et al. (2020) used fMRI and DPA fingerprinting⁶³.

⁶² Diffusion tensor imaging (DTI) mathematically depicts the three-dimensional diffusion water properties in tissue across several directions within each 3D pixel (voxel) of the brain or other tissues and is part of diffusion Magnetic Resonance Imaging (dMRI), an imaging method that measures the water diffusion of molecules in biological tissues (Park & Yu, 2024).

⁶³ Distributed Activity Patterns (DPA) fingerprinting is an fMRI-based method that allows the identification of a person's unique brain activity patterns during tasks. Brain activation is first modelled using a general linear model (GLM) to obtain subject-specific t-maps (statistical brain images). Local activity patterns are then extracted using a moving searchlight that captures

Emmorey et al. (2009) applied fMRI in combination with a functional connectivity analysis, conducting a Seed-based Correlation Analysis (SCA⁶⁴). Kovelman et al. (2008) used fNIRS,⁶⁵ and Lee et al. (2025) carried out an ERP priming study⁶⁶.

3.2.2.2 Sign Language Processing Results across Studies

Research consistently shows that sign language relies mainly on a left-lateralised perisylvian network for core linguistic functions (e.g., lexical retrieval, phonological processing) with the right hemisphere supporting visuospatial, prosodic, narrative, and metalanguage processing (Corina et al., 2003; Corina et al., 2007; Newman et al., 2010b; Twomey et al., 2017). Although areas such as the SMA⁶⁷ and certain subcortical structures are often noted, this study focuses only on the brain areas most frequently examined and consistently activated in healthy sign language processing.

More specifically, the following left-lateralised brain areas and overarching regions were consistently activated during sign language production, comprehension, grammatical processing, and lexical retrieval: the inferior frontal gyrus (IFG), superior temporal gyrus (STG), the middle temporal gyrus (MTG), the fusiform gyrus, the inferior parietal lobule (IPL), and the superior parietal lobule (SPL). These are visualised in Figure 4.

multivoxel patterns around each voxel, creating distributed activity patterns (DPAs) across the whole brain (Liu et al., 2020).

⁶⁴ A fundamental fMRI technique which measures the time-series correlation between a chosen 'seed' region (ROI) and all other voxels in the brain, creating a functional connectivity brain map (Emmorey et al., 2009; Nieto-Castanon, 2020).

⁶⁵ Functional Near Infrared Spectroscopy (fNIRS) is a neuroimaging method similar to fMRI that indirectly measures brain activity based on the concentration of oxygenated and deoxygenated cortical haemoglobin. It relies on optical properties and uses infrared light (Burns et al., 2018)

⁶⁶ An ERP priming study combines an electroencephalogram (EEG) with exposure to stimuli (priming paradigms), measuring how a prime stimulus influences the neural processing of a subsequent target stimulus (Bosch & Leminen, 2018).

⁶⁷ A brain area located in the superior frontal gyrus, involved in the initiation of sequential, voluntary movements, including speech. It is subdivided into two parts: the SMA proper (caudal) and the pre-supplementary motor area (pre-SMA, rostral) (Vachha & Middlebrooks, 2022)

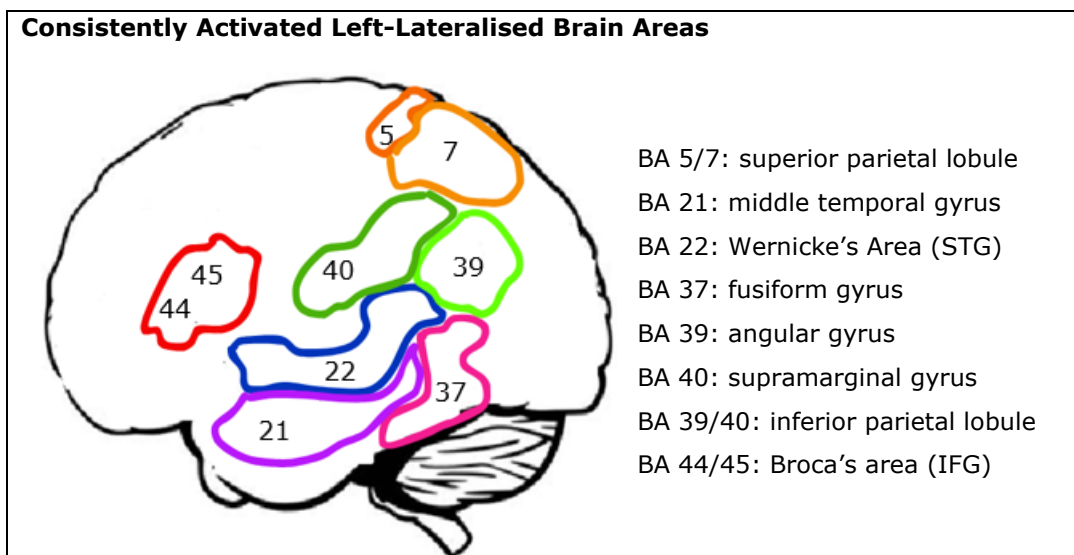


Figure 4: Lateral view of the left cerebral hemisphere with consistently activated brain areas across selected studies, as indicated by their corresponding Brodmann areas.

The **left inferior frontal gyrus** (IFG, BA 44/45), also known as Broca's area, was consistently activated during signing production and perception, and was a brain area of interest in almost all studies. For instance, Corina et al. (2003) and Emmorey et al. (2009) found high levels of activation in Broca's area during ASL verb generation. Newman et al. (2010a) also encountered activation during the integration of morphological information required for grammatical processing of ASL. Moreover, San José-Robertson et al.'s (2004) PET data demonstrated activation during lexical retrieval of signs, and Husain et al. (2009) encountered engagement during categorical/semantic discrimination employing fMRI. During phonological similarity judgment tasks in MacSweeney et al. (2008b), Broca's area showed activation during both BSL and English. Lee et al. (2025) further observed that it was activated during sign language processing and fingerspelling. According to Kumar et al. (2024b), Broca's area was involved in semantic processing, phonological retrieval, and integration of sign language information. The PET and cytoarchitectonic mapping data by Horwitz et al. (2003) further showed that BA 45 (the pars triangularis), rather than BA 44 (the par opercularis), is primarily engaged during production, both during singing and speaking (ASL + English). BA 44 was activated during the execution of the required complex motor movements across both modalities.

Additionally, the **left superior temporal gyrus** (STG, BA 22), known as Wernicke's area, was regularly involved, particularly for sign language comprehension. According to Malaia et al. (2012), the left STG showed activation during phonological processing of ASL. This was also encountered in Li et al.'s (2014) study of CSL, even without auditory input. Liu et al. (2020) further add that the left STG was engaged during syntactic and semantic processing of CSL. Malaia et al. (2012), focusing on atelic versus telic signs (i.e., with a clear endpoint versus ongoing), concluded that the Left STG showed increased activation, consistent with phonological processing based on spatial properties of signs. While primarily recruited for sign language comprehension, Wernicke's area was activated during the production and planning of sign language, albeit to a lesser degree. For instance, San José-Robertson et al. (2004) state that it was recruited for phonological encoding, articulation, and verb generation. Okada et al. (2016) also found activation during sign language production in ASL naming tasks.

The **left middle temporal gyrus** (MTG, BA 21) was also recruited during healthy sign language processing. Newman et al. (2010a) found that it was a part of a general ASL network, and Capek et al. (2009) encountered activation during sign language production. Corina et al. (2003) observed engagement during verb generation, and Liu et al. (2014), based on their fMRI data, observed involvement during the semantic and motion-based processing of signs. Alotaibi et al. (2025) also found that the left MTG was engaged during discrimination tasks and the production of basic sentences using BSL. However, the left MTG appeared to play a larger role in visual processing (Alotaibi et al., 2025; Capek et al., 2009).

A frequently activated, visual-linguistic brain area was the **left fusiform gyrus** (BA 37). Lee et al. (2025) found engagement during sign language processing and fingerspelling. According to San José-Robertson et al. (2004), the left fusiform gyrus was part of the visual brain regions involved in the phonological encoding and articulation of ASL signs. Li et al. (2014) and Corina et al. (2003) both encountered activation during the observation of signs.

More precisely, Corina et al. (2003) encountered engagement of the left fusiform gyrus during sign verb generation in relation to ASL conjunctions. Corina et al. (2007) demonstrated activation during action observation tasks, related to the visual features of signs. Finally, MacSweeney et al. (2002) and Okada et al. (2016) demonstrated that the left fusiform gyrus was involved in the interpretation of meaningful movements, which specified referent location or motion during BSL.

Moreover, the **left inferior parietal lobule** (IPL), encompassing the angular gyrus (BA 39) and the supramarginal gyrus (BA 40), appeared to be regularly involved in healthy sign language processing. Newman et al. (2010b) found engagement during understanding/interpreting sentences, and Lee et al. (2025) during fingerspelling. Kumar et al. (2024b) encountered slight engagement during word processing, visual recognition, semantic integration, and articulatory planning in Indian Sign Language. MacSweeney et al. (2002) found activation of the left inferior parietal lobule in relation to the precise coordinate mapping of handshape, location, and movement in topographic BSL. In another study, MacSweeney et al. (2008b) linked the left IPL to phonological and spatial integration of sign-specific spatial parameters based on activation patterns observed with fMRI. Li et al. (2014) encountered activation during the observation of signs.

According to Alotaibi et al.'s (2024) results, the left inferior parietal lobule is also engaged for motor learning and memory. As regards the left angular gyrus (BA 39) specifically, Newman et al. (2010a) found word order cues prompted activation. For the left supramarginal gyrus (BA 40), Corina et al. (2007) encountered activation during action observation in relation to the visual processing of signs. It was also involved in the interpretation of meaningful movement, as it specified referent location or motion. Furthermore, engagement was observed in the phonological and spatial integration of signs (MacSweeney et al., 2002; MacSweeney et al., 2008b).

Finally, the **left superior parietal lobule (SPL)**, encompassing Brodmann areas 5 and 7, is involved in spatial organisation, phonological processing, and lexical retrieval. Corina et al. (2007) and MacSweeney et al. (2002) both encountered activation during action representation of signs, the latter in relation to topographic sentence comprehension. Furthermore, MacSweeney et al. (2002) found that the left superior parietal lobule played a role in the monitoring of movement (fingers + hands). Alotaibi et al. (2024) highlight its role in motor learning and memory, based on encountered activation patterns during BSL production and discrimination tasks. MacSweeney et al. (2008b) further note engagement of the left SPL during spatial and phonological integration of BSL signs.

Numerous studies also observed right-hemispheric or bilateral activation. Several brain areas were recruited for narrative, prosodic, visuospatial, and metalanguage processing. It is important to note, however, that the activation patterns across studies were consistently stronger in the left hemisphere. The consistently activated right-lateralised brain areas are visualised in Figure 5.

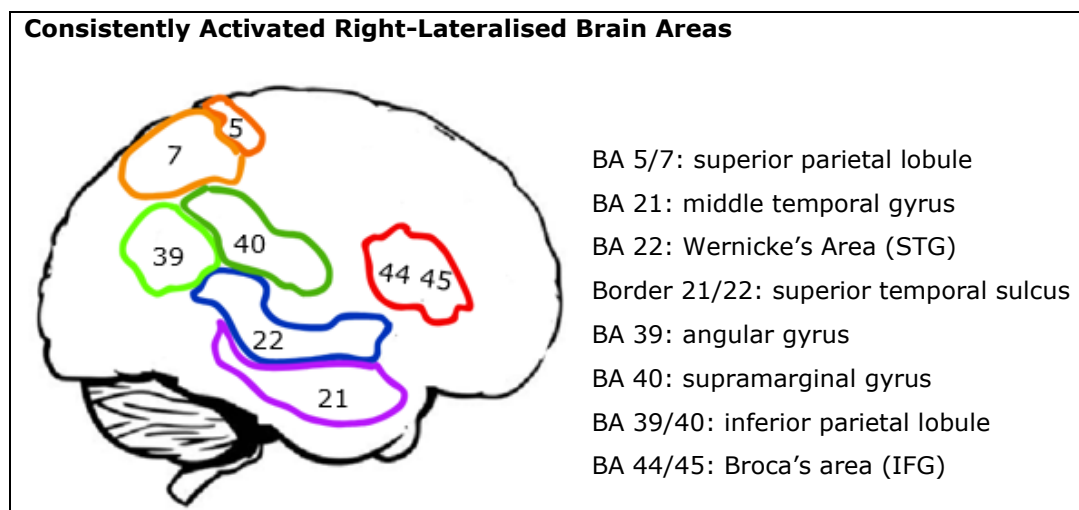


Figure 5: Lateral view of the right cerebral hemisphere with consistently activated brain areas across selected studies, as indicated by their corresponding Brodmann areas

Newman et al. (2010b) found that the **right inferior frontal gyrus** (IFG) and the **right superior temporal sulcus** (STS⁶⁸) were recruited during narrative and prosodic processing tasks in ASL. Bilateral engagement was most common, especially when processing spatial, phonological, or morphologically complex aspects of sign languages. In addition to their left-hemispheric homologues, the **right superior temporal gyrus** (BA 22) and the **right middle temporal gyrus** (BA 21) were consistently engaged during both sign perception and comprehension (Capek et al., 2009; Okada et al., 2016; Kumar et al., 2024b). The **bilateral superior temporal sulci** were involved in grammatical and movement-based processing (Newman et al., 2010a; Malaia et al., 2012). The **bilateral IPL and SPL** were also recruited during phonological, spatial, and topographic processing (MacSweeney et al., 2002; MacSweeney et al., 2008b; Kumar et al., 2024b).

Regarding participant characteristics such as handedness, sign language experience, multilingualism, and hearing status, the following results were established, based on the specific research aims of each study. Corina et al. (2003) found that left-hemispheric brain areas were strongly recruited for sign production regardless of which hand was used for signing. The results of both left-handed participants in Alotaibi et al. (2024) and Lee et al. (2025) were consistent with the right-handed majority. In other selected studies, handedness was not researched further.

Concerning sign language experience, MacSweeney et al. (2008b) found that early exposure led to the typical recruitment of left-lateralised networks, whereas later learners often showed a more distributed language organisation. Alotaibi et al. (2024) investigated the effects of short-term sign language learning during a training course.

⁶⁸ The right superior temporal sulcus (STS) is a cerebral groove involved in a variety of social processes, such as theory of mind (stimulating mental processes of others). It encompasses several Brodmann areas, such as 21 and 22 (Beauchamp, 2015).

This involved participants being taught to discriminate and sign basic BSL sentences for three consecutive months, with 1 hour of practice each day. They found that the left angular gyrus (BA 39) in particular showed functional activation, increased connectivity, and structural microstructural change after short-term BSL learning. Li et al. (2014), based on their findings, note that greater proficiency is linked to stronger engagement of the left inferior frontal gyrus and the superior temporal gyrus. Furthermore, Capek et al. (2009) and Twomey et al. (2017) found that the bilateral superior temporal cortex (STG + STS) became active during healthy sign language processing, even though the input was visual instead of auditory, the latter of which is typical for spoken languages. In other selected studies, sign language experience was not researched further.

Multilingualism was explicitly addressed in two studies. Horwitz et al. (2003) reported activation of Broca's area during ASL and English. Kovelman et al. (2008) found that posterior temporal regions (STG/MTG) were consistently engaged across modalities. As regards fingerspelling, Lee et al. (2025) found partial bilateral activation due to its orthographic-motor properties, whereas printed words remained more strongly left-lateralised. In other selected studies, multilingualism was not researched further.

Across studies, both deaf and hearing signers engaged the left perisylvian network (Kassubek et al., 2004; MacSweeney et al., 2008b). The strongest effect of hearing status was found in the superior temporal cortex (STG + STS) during visual sign processing, particularly in the right hemisphere. Capek et al. (2009) and Twomey et al. (2017) found that activation was stronger, or even bilateral, in deaf signers. Moreover, several studies reported stronger bilateral engagement of the parietal, occipital, and temporal lobes, as well as enhanced connectivity between the temporo-parietal network and sensorimotor regions (Kassubek et al., 2004; Kumar et al., 2024b; Li et al., 2014).

Additionally, Corina et al.'s (2007) study showed that, when viewing signs, deaf signers displayed different activation patterns, including greater involvement of the posterior occipito-temporal regions. Conversely, hearing non-signers primarily recruited parietal, premotor, and frontal areas, required for action understanding.

Three studies also investigated the neural distinction between signs and gestures, with Husain et al. (2009) appointing it as their primary focus. Emmorey et al. (2009) found that linguistic ASL signs engaged several left perisylvian areas (IFG, STG, IPL, SPL), while non-linguistic gestures and pantomimes recruited more right-hemispheric areas, such as the right posterior STG and the right fusiform gyrus. Moreover, Emmorey et al. (2009) demonstrated that deaf signers did not show stronger engagement in the left inferior frontal gyrus and inferior parietal lobule during sign perception in comparison to gestures and pantomimes. Husain et al. (2009) encountered certain overlapping activation patterns during the perception of signs and culturally meaningful gestures (e.g., thumbs up=positive). However, when the tasks required language processing (e.g. categorical discrimination), signing activated the typical left-lateralised inferior frontal areas more strongly.

3.2.2.3 Risk of Bias and Certainty of Evidence

The included experimental task-based (n=6) and comparative studies (n=15) varied considerably in participant characteristics, task design, methodology, and research aims. This introduces potential risks when synthesising and interpreting the results. In this section, the risk of bias and the certainty of evidence for these articles will be assessed.

Firstly, one could argue that the sample sizes were relatively small, ranging from 12 to 70 participants. This, however, can be mitigated for the same reasons as explained in 3.2.1. To illustrate, Twomey et al. (2017) examined a sample of 60 BSL users, whereas the 2021 Census data for England and Wales indicate that approximately 22,000 people use British Sign Language compared to 52.6 million English speakers (Office for National Statistics, 2022).

Therefore, sample size and population size may very well be proportionate. Additionally, researchers used control groups or within-subject contrasts to increase the reliability of results, which are overall complementary across the selected studies.

Participant variability represents another potential risk. Differences in hearing status, age of acquisition, sign language proficiency, multilingualism, and handedness were present across studies. While these factors may influence neural organisation, as explained in chapter 3.2.1.3, several comparative studies explicitly examined these variables rather than ignoring them. Most importantly, the left-lateralised perisylvian network was consistently associated with healthy sign language processing across all studies.

Task and stimulus heterogeneity may be the most exacerbating factor, as it makes direct comparisons of results very challenging. However, broader conclusions can be drawn thanks to the involvement of non-linguistic control conditions. The same core left-lateralised perisylvian network also consistently emerges across studies. Methodological differences do not per se introduce bias but rather strengthen the results, with triangulation providing complementary neuroimaging perspectives.

According to the GRADE SCALE (The Grading of Recommendations Assessment, Development and Evaluation), the quality of evidence is **moderate**. Small sample sizes may potentially lower the validity of results, but are mitigated by the fact that they are representative of a small population. Nevertheless, the imprecision of effects concerning handedness, hearing status, and multilingualism across studies increases the risk of bias. Overarching results did remain consistent, indicating a left-lateralised perisylvian network with modality-specific recruitment of other brain areas. Finally, no clear evidence of publication bias was found.

3.3 Discussion

Through synthesis, the rapid review intended to explore how current neuroimaging and neuropsychological evidence characterise the neural representation of sign language in relation to aphasia (RQ1). Across the selected studies, two main themes were investigated. These include causal evidence from acquired sign language aphasia (3.2.1) and correlational evidence from healthy sign language processing (3.2.2). In this section, the results of these reports will be discussed.

As examined in the theoretical framework (1.2.2), sign languages utilise the three-dimensional signing space, for example, to encode grammatical relations (Baker, 2021; Vermeerbergen et al., 2013), can structure language simultaneously, possess a high level of visual iconicity (Klima & Bellugi, 1979, as cited in MacSweeney et al., 2008a; Ortega, 2017), and are known for their classifier constructions (Emmorey, 2003). All are associated with additional or stronger recruitment of specific neural networks, as is reflected in the results of this rapid review.

Overall, current neuropsychological and neuroimaging reports, together with lesion-based evidence, demonstrate that sign languages rely predominantly on a core left-lateralised perisylvian network, similar to spoken languages, but with modality-specific adaptations in certain left-hemispheric or right-hemispheric brain areas. These include the left parietal regions on the one hand and the right IFG, STS, STG, and MTG on the other hand.

In lesion-based studies, damage to the left hemisphere consistently affected core linguistic aspects, such as lexical retrieval, semantic composition, and phonological, morphological, and syntactic processing. This suggests that, when (the connections between) left-lateralised language-specialised brain areas in this network are disrupted, an aphasic syndrome similar to spoken languages may develop.

It underscores that sign languages are not merely visual but rather natural, complex, and inherently linguistic communication systems. Right-hemispheric damage (RHD) across lesion-based studies left core linguistic abilities generally spared, though selective impairments in spatial, classifier, or visuospatial processing were occasionally observed. This underscores the need for clinical assessments to evaluate these deficits and take the full context of sign language impairments into consideration.

Additionally, the right hemisphere appears to play a (slight) role in sign language processing, for instance, in classifier constructions, though activation patterns were generally weaker. Evidence from, for instance, Hickok et al. (2009) indicated that left-hemisphere damage primarily produces lexical errors, whereas right-hemisphere damage disproportionately affects classifier use and spatial mapping. For acquired aphasia in sign language users, this underscores the need for aphasia assessments that extend beyond lexical signs and incorporate classifier production, spatial mapping, and narrative tasks to detect subtle deficits.

Moreover, stronger activation patterns were observed in the left parietal cortex. The inferior parietal lobule (IPL) and superior parietal lobule (SPL), which support visuospatial abilities, appear to be more heavily recruited for the grammatical and spatial aspects of sign languages. Disruption of left-hemispheric parietal regions can therefore impair language functions such as classifier placement, verb agreement, and topographic structuring. Bilateral parietal regions also appear to contribute to spatial mapping and topographic representation of signs. This underlines the importance of closely evaluating these regions when an aphasic syndrome occurs.

Concerning participant variables, the following conclusions can be drawn. Deaf and hearing signers appeared to share the same core left-lateralised language network, though deaf signers show enhanced occipito-temporal activation, likely reflecting increased reliance on visual input.

Concerning handedness, left-handed signers showed similar activation patterns in the left inferior frontal gyrus, superior temporal gyrus, and parietal regions. Therefore, results suggest that handedness did not significantly influence activation patterns. The only exception is Saito et al.'s (2005) aphasic participant, who experienced a linguistic deficit after damage to the right hemisphere. However, this single case may be an exception to the rule, as research shows that the incidence of atypical language lateralisation in healthy left-handed and ambidextrous subjects is generally higher (Smith & Doe, 2002). Despite implicit or explicit multilingualism and bimodality, neural organisation also remained strongly left-lateralised and associated deficits resulted in an aphasic syndrome.

Though hearing status, handedness, and multilingualism/bimodality did not appear to significantly alter activation patterns, further research is required to detect subtle, but important, differences. For instance, all factors may influence recovery trajectories and complicate acute assessment, particularly when both signed and spoken languages are involved. Clinically, this highlights the importance of evaluating hearing status and handedness and assessing each language modality separately, rather than assuming proficiency in one predicts performance in the other.

Differences in sign language experience and age of acquisition are equally or even more relevant to consider, as research indicates that they can play an important role in language processing. Mayberry and Lock (2003), for instance, found that adults, regardless of hearing status or language modality, performed at near-native levels in a second language after having acquired it early in life. By contrast, deaf adults who experienced little or no accessible input in a second language early in life performed poorly. Thus, their findings provide evidence for neuroplasticity in relation to language processing.

Similarly, results from this rapid review indicated that sign language experience and age of acquisition play a role in the neural representation of language, as 'earlier' exposure led to more typical left-lateralisation patterns, and 'later' exposure to a more distributed network. Greater proficiency also appeared to engage core left-hemispheric areas (IFG, STG) (Li et al., 2014), while bilateral superior temporal regions were recruited for visual processing, reflecting modality-specific adaptations (Capek et al., 2009; Twomey et al., 2017). Moreover, short-term training (i.e., three months) also appeared to induce functional and structural changes, particularly in the left angular gyrus (Alotaibi et al., 2024).

Concerning the processing of signs versus gestures in the brain, neuroimaging consistently showed that signs activate left perisylvian regions, whereas gestures rely more on bilateral or right-hemispheric networks. Thus, sign language users with left-hemispheric damage might still be able to comprehend or produce gestures, but might not be able to do so for the corresponding sign(s). Overall, this suggests that signers categorise perceived actions during processing as linguistic (i.e., signs) or non-linguistic (i.e., gestures). The distinction between genuine language deficits and preserved gestural communication is therefore clinically relevant and should be assessed separately.

4 Surveys

4.1 Methodology

Drawing on the theoretical framework and the results of the rapid review, an online survey was created and distributed between the 18th of February and the 18th of March 2026 to investigate the following research questions:

- Which diagnostic protocols are currently used for assessing acute-phase aphasia in the Flemish Community (RQ2)?
- To what extent do Flemish speech-language therapists consider the needs of VGT users when assessing acute-phase aphasia (RQ3)?

The survey, created in Dutch via Qualtrics, targeted medical experts involved in acute-phase aphasia diagnostics at Flemish or Brussels hospitals. Potential participants were identified via Neurocom.be, a Belgian professional resource on neurological communication disorders, and through information publicly available on hospital websites. Invitations were distributed by email in mid-February, with a reminder sent out at the beginning of March. Respondents were required to provide consent for their involvement, data collection and processing, and potential publication of results, in accordance with the General Data Protection Regulation. This informed consent form can be referred to in Appendix C. Respondents who did not meet the eligibility criteria or withheld consent were automatically redirected to the end of the survey.

The questionnaire covered four main themes: (1) demographic information, (2) multilingualism and aphasia, (3) Flemish Sign Language and aphasia, and (4) general education regarding sign languages and aphasia. Full survey items are available in Appendix D. After collecting demographic information, the first part included primarily multiple-choice questions about participants' professional roles, years of experience, and primary region of employment.

Respondents were also asked whether they had completed relevant postgraduate programmes, for instance, to become a neurological speech-language pathologist (neurological SLP). The options consisted of the Postgraduate Neurological Communication Disorders⁶⁹, the Postgraduate Neurological Care⁷⁰, and the Postgraduate Neurological Language and Speech Disorders⁷¹. An open-ended question then inquired about the professionals' standard protocol for acute-phase aphasia.

The second part examined multilingualism and how professionals would treat or have treated a multilingual patient with acquired aphasia. The third focused on Flemish Sign Language (VGT) in particular, and whether professionals had ever diagnosed a patient who used VGT (L1/Lx) or how they would hypothetically diagnose.

In the last part, (para)medical experts were asked whether they had gained knowledge regarding the neural representation of sign languages, hard-of-hearing or deaf patients, or communication in Flemish Sign Language through training or studies (yes/no). Additionally, the questions circled back to the postgraduate degrees from the first section. An option was also provided to insert a specific course or programme (e.g., Postgraduate Interpreting of Flemish Sign Language). Finally, the survey assessed the personal need for medical professionals to gain knowledge about language disorders related to sign languages as part of their mandatory degree or in specific additional training or studies.

⁶⁹ Postgraduaat Neurogene Communicatiestoornissen (Postgraduate Neurological Communication Disorders), successor of the Postgraduaat Neurologische Taal-en-Spraakstoornissen (Postgraduate Neurological Language and Speech Disorders), active since 2016 (Arteveldehogeschool, 2026-a)

⁷⁰ Postgraduaat Neurologische Zorg (Postgraduate Neurological Care), a collaboration between Arteveldehogeschool, Odisee, Vives, and UCLL, is for healthcare professionals seeking specialisation in neurological care and is currently under revision. The programme will restart in 2027-2028 (Arteveldehogeschool, 2026-b)

⁷¹ Postgraduaat Neurologische Taal-en-Spraakstoornissen (Postgraduate Neurological Language and Speech Disorders), predecessor of Postgraduaat Neurogene Communicatiestoornissen, was active from 1995-2016 (Arteveldehogeschool, 1995-2016).

Participants were invited to submit their contact information to receive the study's results and to indicate their willingness to participate in a more in-depth follow-up interview if the information provided needed clarification. Unfortunately, answers requiring more contextualisation were submitted by participants who did not provide further personal details.

Quantitative results were analysed with Microsoft Excel, while qualitative responses were examined by a thematic analysis in MAXQDA. Incomplete or duplicate answers were removed from the data set. Personal information of respondents, such as primary region of employment and provided contact details, was redacted for privacy purposes. The anonymised responses can be consulted in Appendix E. As for the reported diagnostic instruments used for assessing acute-phase aphasia in the Flemish Community, a concise literature review was conducted. In April 2026, the most recent ScreeLing and a previous, incomplete version of the Dutch Naming Test could be consulted thanks to the speech pathology and audiology department of KULEUVEN. These tests and their relation to RQ2 will be described further in chapter 4.2.2.

4.2 Results

In total, 22 responses were collected. Following data cleaning and the exclusion of responses from participants who did not provide consent or were not medical professionals in aphasia diagnostics, 20 responses were deemed valid. In the following sections, demographics, standard protocols, aphasia in relation to multilingualism, aphasia and VGT, and education regarding aphasia and sign languages will be discussed.

4.2.1 Demographics

No respondents indicated Brussels-Capital or Limburg as their primary region of employment. Oost-Vlaanderen was selected the most ($n=8$), followed by Antwerpen ($n=7$), and Vlaams-Brabant ($n=3$). Lastly, West-Vlaanderen ($n=2$) was chosen the least. As shown in Figure 6, 35% of respondents were employed as speech-language pathologists (SLPs). 60% were active as neurological speech-language pathologists (nSLPs). 5% of respondents, equal to 1 person, was a neurologist, while no one chose the option 'other'. Regarding experience in acute-phase aphasia diagnostics, the following results were obtained (Figure 7): 20% of professionals reported 0 to 5 years, 25% indicated 5 to 10 years, and 15% selected 10 to 15 years. 20% of respondents had 15 to 20 years of experience, and 20% more than 20 years.

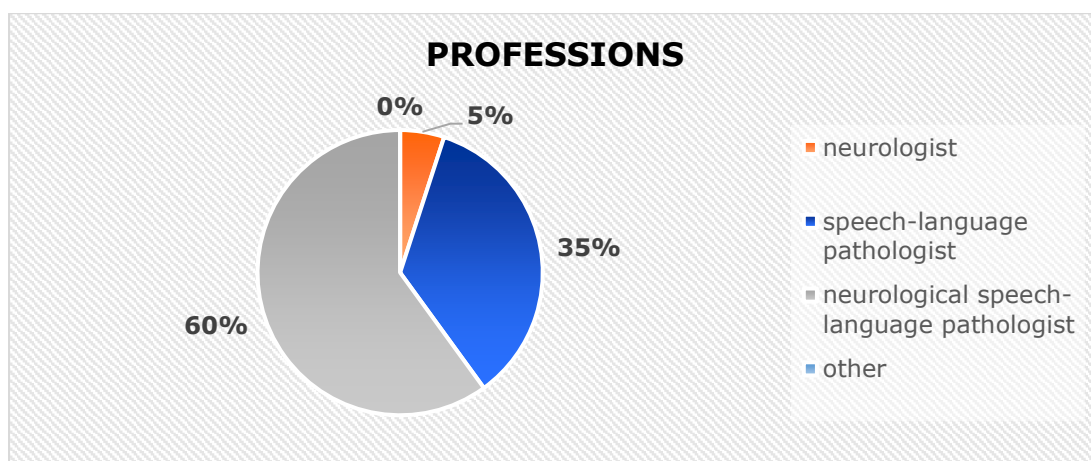


Figure 6: Professions of respondents

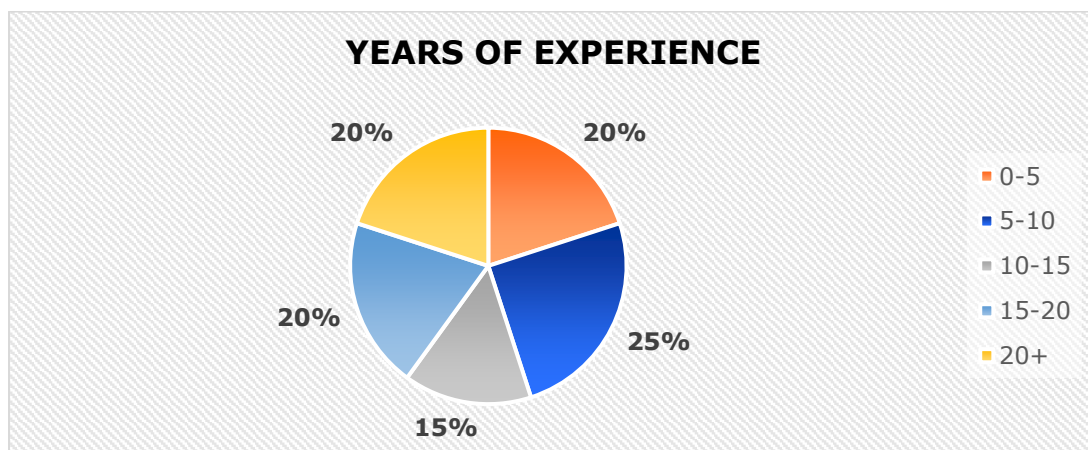


Figure 7: Years of experience of respondents

As is visualised in Figure 8, 40% indicated having completed the Postgraduate Neurological Communication Disorders and 25% the Postgraduate Neurological Language and Speech Disorders. Notably, SLP1 reported the Postgraduate Neurological Communication Disorders and SLP7 Postgraduate Neurological Language and Speech Disorders as additional degrees. Neither indicated being currently employed as nSLP. 35% of the respondents did not obtain any of the listed postgraduate degrees, the majority being SLPs. Nevertheless, one nSLP, namely 7, did not select a postgraduate degree, but reported being currently employed as nSLP. Lastly, no respondents chose the option Postgraduate Neurological Care.

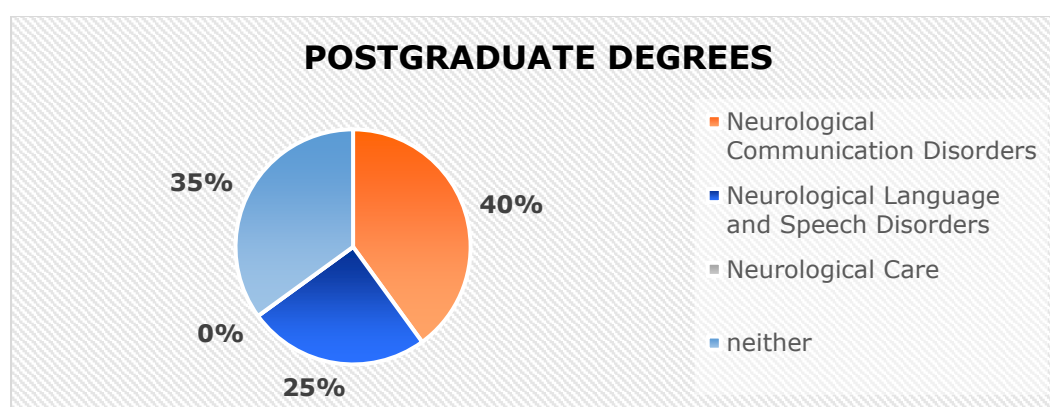


Figure 8: Postgraduate degrees of respondents

4.2.2 Standard Protocols

Through a thematic analysis in MAXQDA, the following results concerning diagnostic experts' standard protocols for acute-phase aphasia were obtained. Overall, ScreeLing and the Dutch Naming Test (NBT) were most frequently used to diagnose acute-phase aphasia. The Psycholinguistic Assessments of Language Processing in Aphasia (PALPA) is also part of several professionals' standard protocol concerning aphasia diagnostics. Lastly, multiple (para)medical experts responded that they use their own standard protocol, unspecified bedside screening, or the Token Test. Each diagnostic instrument will be elaborated on with the survey results and a brief theoretical review in mind. How many respondents included each diagnostic instrument in their answer is summarised in Table 3.

Diagnostic Instrument	Included in ... Responses
ScreeLing	15
Dutch Naming Test (Nederlandse Benoemtest [NBT])	13
unspecified self-developed screening	7
unspecified bedside screening	6
Psycholinguistic Assessments of Language Processing in Aphasia (PALPA)	4
Token Test (AAT ⁷² /unspecified)	4

Table 3: Overview of reported diagnostic instruments and prevalence

ScreeLing was the diagnostic tool most frequently mentioned by the experts (n= 15). It is part of the multidisciplinary approach recommended in current Dutch guidelines for aphasia (Berns et al., 2015). It can already be administered (at the bedside) within the first week post-onset of the acquired brain damage, most commonly due to a stroke, and takes approximately 30 minutes (Berns et al., 2015; Doesborgh et al., 2003). The tool screens three core linguistic domains, namely semantics, phonology, and syntax (Doesborgh et al., 2003). It is specifically designed to assess underlying linguistic impairments concerning these levels across modalities, rather than focusing exclusively on a single input or output channel (El Hachoui et al., 2010). This entails that it is not designed to generate detailed modality-specific profiles, such as producing comprehensive scores for speaking versus writing skills.

Before the test, information such as the patient's date of birth, education, and handedness, as well as the aetiology and location of the cerebral lesion, the date of onset and the test date, is noted down. Other factors are also clinically relevant, namely information regarding motor function or the presence of speech disorders (e.g., dysarthria, apraxia of speech). Attention/concentration, confusion, mood, and endurance are also documented.

⁷² The Aachen Aphasia Test (AAT) is used for diagnosing aphasia in German-speaking individuals. Refer to Graetz et al. (1987) for the Dutch version.

In order to administer a reliable test, participants are required to have been adequately proficient in Dutch before the onset of the linguistic deficits, have no history of significant language or speech disorders, and have sufficient hearing and visual function (with or without correction), with no signs of hemianopia⁷³ or neglect (*ibid.*).

According to El Hachoui et al. (2010), the ScreeLing consists of the following tasks. To evaluate semantics, the ScreeLing includes tasks targeting semantic field processing (word–picture matching within categories), selectional restrictions (judging the semantic plausibility of sentences), semantic associations (identifying the most closely related word), and semantic categorisation (detecting the item that does not belong within a semantic set).

For phonology, tasks include repetition without visual input, targeting word length, consonant clusters, vowel patterns, and phoneme–grapheme correspondence, as well as reading-aloud tasks assessing phoneme selection and sequencing. Auditory discrimination is evaluated through same–different judgments of word pairs, and phoneme analysis through the identification of initial phonemes. Patients are allowed to self-correct once per item, but responses must be entirely accurate, including stress patterns.

For syntax, assessment includes sentence–picture matching tasks targeting verb meaning, prepositions, reversible sentences, tense, subject–verb agreement, and reflexive constructions. Furthermore, comprehension of syntactic relations is examined through *wh*-questions, while grammatical judgement tasks assess metasyntactic awareness. Finally, sentence completion tasks evaluate the understanding of grammatical function and meaning. In addition to its use in the acute phase, ScreeLing is also used to chart recovery patterns and the effect of rehabilitation in the first three months post-onset

⁷³ Hemianopia refers to the loss of vision in one-half of the visual field in both eyes, caused by unilateral brain damage resulting from strokes, tumours, or traumatic injuries. Lesions involve the retrochiasmal visual pathways or the primary visual cortex (Thurtell & Tomsak, 2019).

The **Dutch Naming Test** (Nederlandse Benoemtest, NBT) was also frequently mentioned and is a part of the respondents' standard protocol (n=13), though it is not explicitly recommended in the current Dutch-language guidelines for aphasia (Berns et al., 2015). It can already be used in the acute phase of aphasia. The tool is designed to determine word-retrieval deficits in patients with acquired brain damage. The administration time varies from 5 to 30 minutes, depending on the severity of the aphasic syndrome (Van Ewijk et al., 2020). The NBT consists of 92 unambiguous images in colour, built up on the basis of acquisition age and word frequency (Storms et al., 2004). The patient is instructed to name the image they see (Van Ewijk et al., 2020). Test items ranged from high-frequency concrete words (e.g., bed) to lower-frequency abstract words, such as the nouns 'democracy', 'desperation', 'doubtfulness', etc. (Loon-Vervoorn & Stumpel, 1994; Van Ewijk et al., 2020).

Administration considers several relevant factors, similar to ScreeLing. These include the patient's date of birth, education, and handedness, the aetiology and location of the cerebral lesion, the date of onset and the test date, namely information regarding motor function or the presence of speech disorders, attention/concentration, confusion, mood, and endurance. Additionally, it is required that the patient had been adequately proficient in Dutch before the onset of the linguistic deficits, has no history of significant language or speech disorders, and has sufficient hearing and visual function with no signs of hemianopia or neglect, all of which could interfere with task performance (Van Ewijk et al., 2020).

Furthermore, several diagnostic experts stated that they utilise a **self-developed screening** (n=7) or some form of **bedside screening** (n=6). Neurological SLP1 and nSLP9 elaborate that their screening consists of several tasks, such as automatic word lists, semi-automatic language output, production on word- and sentence-level, repetition, reading of words, and writing high-frequency words and/or the patient's name or address. NSLP1 also asks the patients to describe an image of a daily situation, to assess both language comprehension and production.

A well-known example of such a task, visualised in Figure 9, is the 'Cookie Theft' card picture from the BDAE⁷⁴, which was also mentioned by nSLP6. Other respondents who reported using a self-developed screening stated that evaluating all language modalities is essential when charting the aphasic syndrome for a complete and accurate diagnosis.



Figure 9: Cookie Theft picture from the Boston Diagnostic Aphasia Examination. Patients are asked to describe everything they see, either orally or in writing, to assess speech and fluency. Adapted from Figure 3, p. 5 in Berube et al. (2019).

In addition to ScreeLing and the NBT, the Psycholinguistic Assessments of Language Processing in Aphasia (**PALPA**) was mentioned four times. It was originally designed for the English language. The Dutch version was adapted by Bastiaanse, Bosje & Visco-Brink (1992). 20% of respondents stated that they still rely on this assessment for more extensive testing. This is in line with the current Dutch guidelines for aphasia, as they recommend administering the PALPA as a follow-up examination to address the patient's specific health concerns (Berns et al., 2015). As SLP1 and nSLP5 note, the implementation of this diagnostic instrument in the acute phase is rather uncommon. For mild aphasic cases, it can be used to detect underlying morphological or phonological deficits, while specifically, the PALPA task 51 is used to assess oral-auditory naming tasks in severe cases (Berns et al., 2015).

⁷⁴ For the third edition, refer to Goodglass and Kaplan, 2001.

Finally, versions of the **Token Test** were also included in four answers, either unspecified or as part of the Aachen Aphasia Test. The Token Test is a comprehension task in which patients respond to verbally presented commands involving tokens of different shapes, colours, and sizes. It can be administered in both the acute and chronic phases of aphasia. It is most commonly applied after initial screening tests such as ScreeLing, from approximately three weeks post-onset onwards (Berns et al., 2015).

Though the survey specifically inquired about acute-phase diagnostic instruments, respondents also provided examples of chronic-phase tests. These include the Comprehensive Aphasia Test (Dutch version, CAT-NL), GLOBAMIX parts 1 & 2, the Semantic Association Test (SAT), and the Global Aphasic Neurological Battery (GANBA). These will not be elaborated on as they go beyond the scope of this study.

4.2.3 Aphasia and Multilingualism

In relation to how often the participants encounter multilingual patients with a suspected acute-phase aphasia, the following results were obtained. 25% of professionals reported that they seldom encounter multilinguals in need of diagnostic tests for acute-phase aphasia. However, the majority of respondents indicated that they often (50%) or very frequently (25%) interact with multilingual patients. All respondents who selected 'often' or 'frequently' also provided a ranking of the most encountered languages of multilingual patients. First place was worth 3 points, second place 2 points, and third place 1 point. It yielded the following results, as visualised in Figure 10. French (40%), Arabic (17%), English (14%), and Turkish (11%) were the most commonly named.

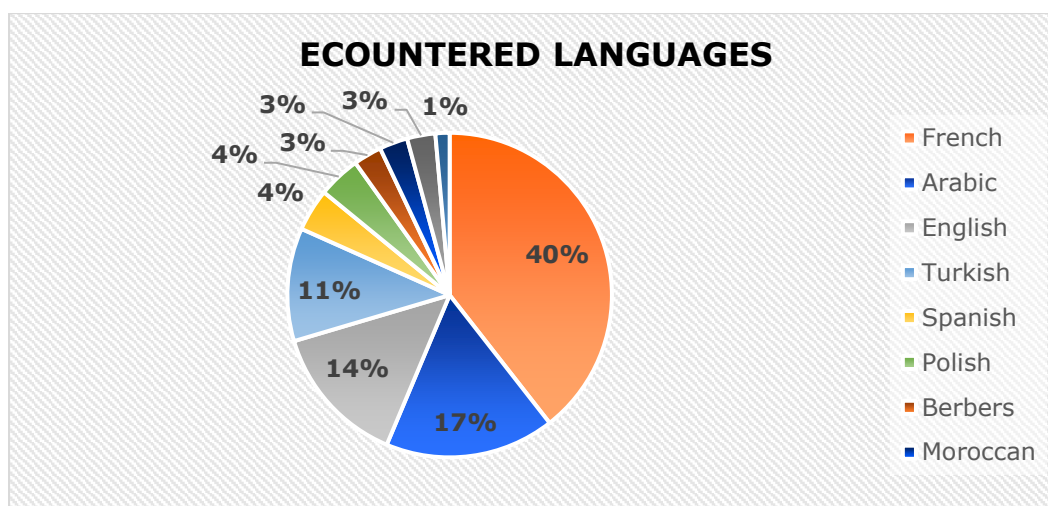


Figure 10: Encountered languages in multilingual patients

NSLP11 specified that thorough screening is often very challenging because they are not fluent in (all of) the languages the patients use, specifically mentioning Arabic and Berber in their response. This is also affirmed by SLP5, who says they most often do not have any knowledge of (all of) the patient's languages, providing examples such as Mandarin, Turkish or Ukrainian.

Only 20% of these respondents evaluated all languages when diagnosing acute-phase aphasia. SLP1 responded that they would need to hire an interpreter, while SLP7 stated that the language barrier requires filling in the blanks, resulting in professionals guiding the patient too heavily to the correct answers, lowering the spontaneity and validity of language output and thus introducing prompting bias. SLP7 and nSLP7 underline that they will inquire about language behaviour regarding the patient's other language(s) with family members or friends or seek the help of interpreters, but that this was not part of their standard protocol.

Most participants responded 'I do not know' or equivalent answers, stating they were not aware of which testing materials they could use in addition to their standard Dutch-language protocol for acute-phase aphasia. Only SLP 1, with 15-20 years of experience, mentioned the **Bilingual Aphasia Test (BAT)**.

This test is designed to be objective and equal across languages to assess and compare all the spoken languages a person uses. It also aids in identifying which language domains are impaired and is primarily used to observe which language is best suited for communication and to guide rehabilitation for aphasic patients. It is not only administered to diagnose aphasic syndromes but can also be employed for other conditions resulting in linguistic deficits, such as Alzheimer's disease (Paradis, 2011).

4.2.4 Aphasia and VGT

When respondents were asked how often they encountered hard-of-hearing or deaf patients with (a suspected) acute-phase aphasia, the following results were obtained. The majority reported that such encounters occurred rarely (75%). An additional 20% indicated that they encounter these patients often, while only 5% reported encountering them very frequently. Further, when asked whether they have ever treated (deaf or hearing) users of VGT with (a suspected) acute-phase aphasia, a large majority (95%) responded negatively. Only 5%, corresponding to a single respondent (SLP6; 0-5 years of experience), reported having treated such a patient.

In their follow-up question, they stated they had not tested VGT as part of their standard protocol, as they did not know this language. They had not deployed a professional VGT interpreter and were unaware of any additional tools or adaptations to the standard protocol that they could use to provide a (more) precise diagnosis. This participant did not elaborate on this case in the survey responses and did not provide their contact information for further elaboration.

The remaining 95% of respondents were given other follow-up questions based on their 'no' response. The diagnostic experts named a variety of potential difficulties. First and foremost, all professionals answered that they themselves do not know Flemish Sign Language. Thus, communication would be very challenging should they ever treat a VGT user with (a suspected) acquired aphasia.

NSLP 1 labelled it as 'a difficult client-clinician relationship' and mentioned that it would be difficult to psychoeducate the patient (i.e., inform them of their condition). NSLP9 stated that verbal communication would be nearly impossible and that they would need to find another way, for instance, through written language. If possible, they would call upon the patient's family and friends to assess their sign language(s).

Additionally, there are no standardised tests readily available to assess aphasic deficits in Flemish Sign Language, and current diagnostic instruments would require adaptation (nSLP9). SLP5 theorised that the most prevalent difficulties would lie in testing language comprehension and phoneme discrimination in VGT users, [since it works differently in sign languages]. NSLP7 stated that the combination of a language disorder and a hearing disorder is challenging when a diagnosis is required. Moreover, nSLP2 thought of potential comorbidities (e.g., apraxia), which could further complicate diagnosis. NSLP 12 also had the additional reservation that hospital environments are not really organised in a way fully accessible for people who use a sign language (e.g., planning, availability of experts, etc.).

Several diagnostic experts mentioned hiring a professional interpreter. Nevertheless, nSLP11 raised the concern that this interpreter would most likely not know what acquired aphasia entails and would require basic training. When the same respondents were asked whether they could access a VGT interpreter in future instances, the majority of respondents (69%) admitted they did not know. 26% selected yes, while 5% selected no.

When finally asked which tools or adaptations to their standard protocol they could provide, should they ever encounter a VGT patient (with a suspected) acute-phase aphasia. Nearly half of the respondents (45%) indicated that they did not know which tools or adaptations they could provide in such a situation. The other half provided a range of possible solutions. Once more, hiring an interpreter was mentioned three times (15%).

NSLP1 elaborated that this professional should be readily available, know the standard diagnostic tests, and translate correctly and precisely. This, in return, could be made possible if more budget is allocated to this endeavour. NSLP5 would deploy an interpreter via video call so that their translation services could be called upon more quickly. NSLP 9 would videotape [versus audiotape] the VGT users for diagnostic purposes. NSLP8 added that the room where the tests take place should be well-lit and that a clear view of the patient's mouth would be essential to administer the tests [to speechread]. Moreover, according to the respondents, an adapted standardised protocol would alleviate the issues by a large margin. nSLP6 and SLP6 both suggested a brief screening involving images, for instance, of highly frequent signs that could be linked to the correct image or action and vice versa. SLP1 would assess in an orthographic manner, as would nSLP8.

4.2.5 Education Aphasia and Sign Languages

The online survey concluded with a section for all respondents concerning general sign language knowledge and acute-phase aphasia. It followed a similar format to previous questions, starting with whether the professionals had ever completed a specific programme or training on communication with hard-of-hearing or deaf people.

Training exposure was generally limited among respondents: 80% reported no training, 20% reported limited training, and none reported thorough training. Those within the limited training group indicated that this was obtained through different programmes and courses: a bachelor-after-bachelor in audiology, (an elective in) the speech-language pathology master's degree, or a course in Flemish Sign Language. No one selected that the postgraduate degrees, mentioned in the first section of this online survey, provided training. Regarding communication with VGT users, respondents were also asked about (additional) programmes or training. 90% answered 'no'. Only 10% received limited training, and no one indicated having obtained thorough knowledge through education.

Once more, respondents specified that they had gained this information through either a course in Flemish Sign Language or an elective during their master's degree in speech-language pathology. No respondents attributed training to postgraduate degrees mentioned in the first section of the survey. A question in this section also asked whether respondents had completed a specific training or programme regarding communication in and the neural representation of sign languages in general. Once more, the majority (80%) selected no, while 20% responded that they had been trained, but that it was limited. No one indicated the 'yes (thorough)' option. Respondents did not specify further how they had obtained this knowledge.

Participants were also questioned about which challenges or difficulties they foresaw concerning damaged (connections between) language-specialised brain areas in relation to sign languages, more specifically, in contrast to spoken languages. The majority admitted they did not know, for instance, due to insufficient knowledge. NSLP6 and nSLP9 alerted to comorbidities such as hemianopia, which could hinder communication in sign languages. Moreover, they responded that they would find it difficult to assess cognitive abilities for this population as well.

Other respondents interpreted this question more in relation to which difficulties they would encounter during diagnosis and how they would act accordingly. SLP7 specified that they would involve the patient's family members more throughout the entire process. Neurologist 1 answered that they would encounter difficulties with timely and correct diagnosis and that they would not know which referral options would be best. SLP6 appointed the language barrier as the most challenging. NSLP9 mentioned that these patients would have fewer options to mitigate the aphasia once their ability to sign has been damaged, more so than patients who employ a spoken language. They stated that sign language users already undergo debilitating difficulties with communication and that, due to a lack of interpreter availability and [sign language] knowledge, they would experience even more barriers.

To conclude the survey, the respondents were asked to indicate how high their need was to obtain more knowledge about language disorders, such as aphasia, in relation to sign languages through additional training. This question was scaled from 0 (very little need) to 5 (high need). The majority of respondents selected the lower end of the spectrum, with 15% indicating 0, 30% choosing 1, and 25% answering 2 (Refer to Figure 11).

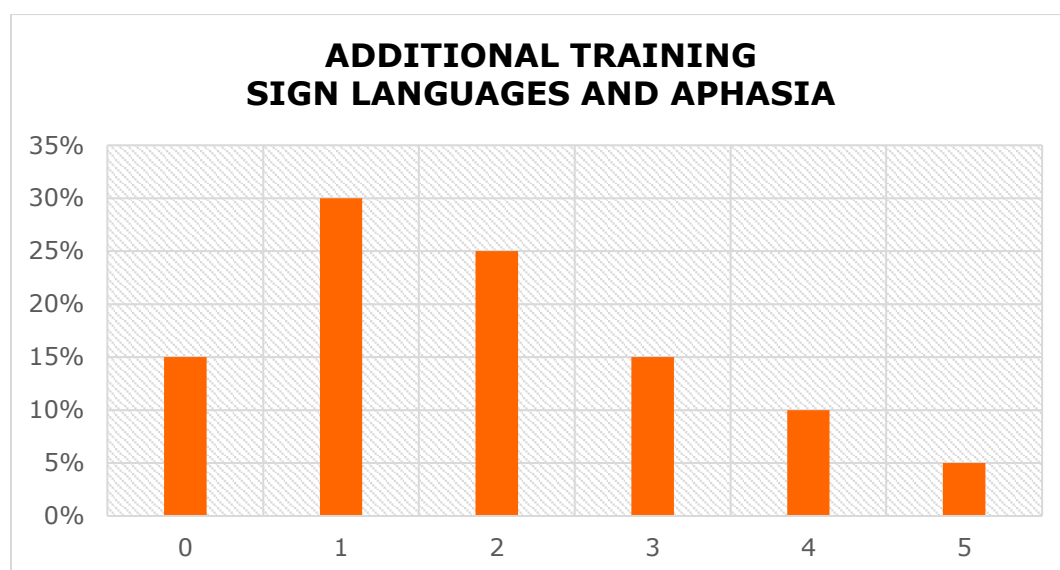


Figure 11: How high is the need of respondents to obtain more knowledge concerning aphasia in relation to sign languages through additional training?

Similarly, the last question assessed whether professionals would find it valuable to learn about aphasia and other language disorders in relation to sign languages, as shown in Figure 12. This question was scaled from 0 (not valuable at all) to 5 (very valuable). The majority of respondents selected lower numbers on the scale, with 5% selecting 0, 45% choosing 1, and 20% indicating 3. Thus, the majority of professionals did not see the value in adding it to the general programme.

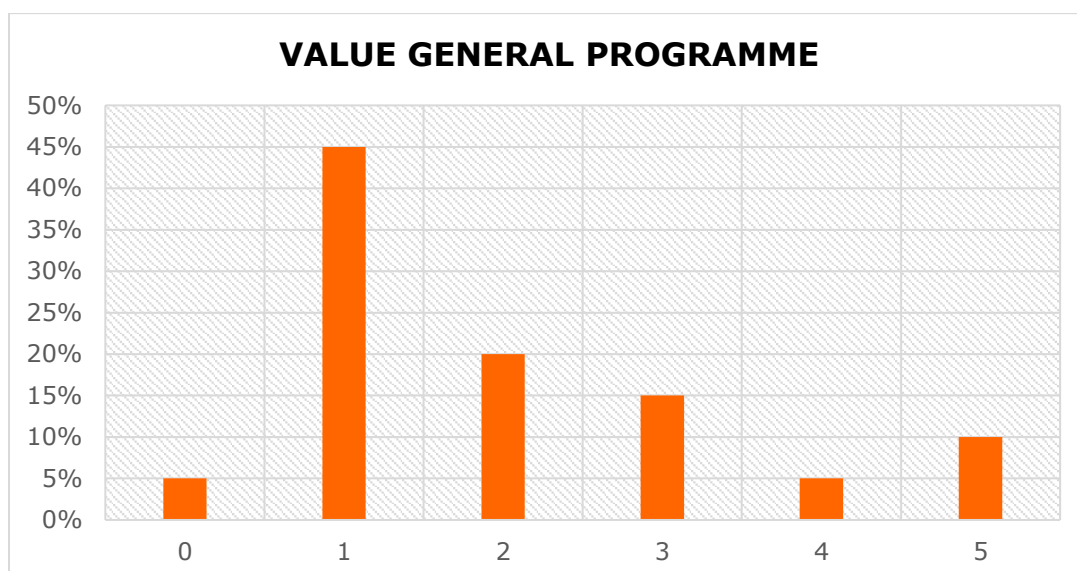


Figure 12: How valuable would the respondents find including aphasia in relation to sign languages in their general programmes?

Regarding the higher spectrum of the two previous survey questions, the following information can be linked to earlier responses. NSLP 1 (5-10 years of experience) selected 5 on both questions and thus indicated a high need for additional training regarding sign languages and aphasia. Moreover, they responded that it would be a valuable addition to the general programme. Although they had never treated a VGT patient, they did respond that they very frequently interacted with deaf or hard-of-hearing patients. NSLP3 (20+ years of experience) only saw value in receiving additional training, having reported participating in none regarding the topic. Lastly, neurologist 1 (10-15 years of experience) and SLP6 (0-6 years of experience) would like to see aphasia in relation to sign languages in the general programme's curriculum or additional training (4/5). All three had seldom diagnosed a hard-of-hearing or deaf patient and had never treated a VGT-user.

None had followed a specific training or programme regarding aphasia and sign languages prior to filling in this survey. One respondent, SLP9 (10-15 years of experience), indicated having followed a course on Flemish Sign Language in previous questions. However, they seldom encountered deaf or hard-of-hearing patients, had never treated a VGT-user, and had very little need to obtain more knowledge through additional training or the general programme.

4.3 Discussion

Through thematic analysis in MAXQDA and quantitative analysis in Microsoft Excel, this survey aimed to explore which diagnostic protocols are currently used to assess acute-phase aphasia in the Flemish Community (RQ2) and to what extent Flemish speech-language pathologists consider the needs of VGT users (RQ3). In the following sections, results will be discussed. This concerns remarks on demographics, current diagnostic protocols, aphasia in relation to multilingualism, aphasia in relation to VGT, and the education of (para)medics regarding aphasia and sign languages in the broader context.

4.3.1 Demographics

As regards the specific profiles of the respondents, who were neurologists or (neurological) speech-language pathologists, years of experience in aphasia diagnostics varied from 0-5 to 20+ years. This highlights the diverse backgrounds of respondents in terms of knowledge and skills, representing the broader population. Conversely, the regional distribution could be more balanced as no respondents indicated Brussels-Capital or Limburg as their primary region of employment. As Flemish Sign Language is being used in both Brussels-Capital and Flanders as an L1, certain perspectives might have been overlooked in the survey's sample.

4.3.2 Standard Protocols

As for standard protocols currently used in acute-phase aphasia diagnostics (RQ2), ScreeLing and the Dutch Naming Test were most frequently used by respondents. It is also relevant to note that several (para)medics reported the use of a self-developed screening or did not further name the type of bedside screening they administer.

As responses were anonymous and the consultation of blank test forms is, in any case, protected by professional confidentiality and copyright laws, further information concerning these self-developed or unnamed bedside screenings could not be accessed beyond what the respondents provided in their answers. Based on the geographical information of respondents and other mentioned diagnostic instruments (ScreeLing, NBT), it is highly likely that these also assess the Dutch language.

4.3.3 Aphasia and Multilingualism

As regards to what extent Flemish speech-language pathologists consider the needs of VGT users during acute-phase aphasia diagnostics (RQ3), the survey investigated several closely interrelated domains. These include questions in relation to multilingualism, Flemish Sign Language, and education on aphasia and sign languages.

As sign language users are largely multilingual, it was relevant to assess how often (para)medics treated multilingual patients and in which ways they accommodated them in the broader context. Overall, the majority reported regularly administering diagnostic tests for aphasia on multilingual patients. This finding is unsurprising given Belgium's linguistic context, which is strongly shaped by migration. Significant inflows from EU countries such as Romania and France have been documented, as well as third-country nationals from Morocco, Turkey, and the Democratic Republic of Congo. Arrivals from Ukraine, since 2022, are also notable, although labour migration remains dominant (European Commission, 2025; International Organisation for Migration, n.d.). In addition to Belgium's three official languages, English also serves as a global lingua franca across domains such as education, commerce, and science (Crystal, 2003).

All factors are reflected in the survey results. French likely appears, among other influences, due to both its official status and migration, while Arabic and Turkish reflect migrant communities, and English relates to its international role.

The exclusive mention of oral-auditory languages is expected, as visual-gestural languages are considered minority languages (cfr. Emmorey, 2023), with VGT specifically only having 6,000 L1 users in Flanders and Brussels-Capital (cfr. Loots et al., 2003).

Furthermore, though professionals frequently treated multilingual patients, only 20% evaluated all languages during diagnosis. The core issue is two-fold; on the one hand, participants are not fluent in the languages their patients use for communication, and on the other hand, they are unaware of which standardised tests are available. Although answers on encountered languages in multilingual patients other than Dutch varied, respondents primarily listed non-EU languages as examples when asked why they do not assess all the languages a multilingual patient with a suspected aphasia uses. It is important to note that a (para)medic will experience similar difficulties with communicating in an Arabic variety as in English if they have no prior knowledge of the language, let alone administering diagnostic tests.

In relation to diagnostic protocols, respondents report being unaware of which standardised tests can be used to evaluate all the languages a patient uses. This suggests that knowledge regarding non-Dutch diagnostic instruments is limited and that such standardised tests are not readily available. As SLP1 noted, the Bilingual Aphasia Test (BAT) may be a valuable tool. However, the BAT cannot provide a definitive or universal diagnosis of the aphasia subtype, as the results depend on the clinician's taxonomy and interpretation. Moreover, it is a very complex and time-consuming test to administer, and it is also relevant to note that this diagnostic battery is designed for spoken languages (Paradis, 2011). It is therefore not inclusive of sign language users, who are equally part of the multilingual population. Though the Bilingual Aphasia Test is certainly a step in the right direction in accurately diagnosing oral-auditory multilingual patients, it is unsurprising that it is not widely known or used in Flemish hospitals.

As for when communication barriers occur, respondents report a strong reliance on the patient's family members and friends. Though there is considerable goodwill in diagnostic experts to adapt to the needs of their multilingual patients, several issues arise when family and friends double as interpreters. Firstly, research by Meeuwesen et al. (2010) shows that informal interpreters are active participants in the interaction between medical professionals and patients, potentially influencing the accuracy of results. Interpretation bias may (subconsciously) arise when family and friends insert their own opinions and views into the translation, share minimal details with the patient themselves, or provide more information than what the patient is truly communicating. Moreover, Meeuwesen et al. (2010) found that family and friends could not be impartial due to their close relation to the patient, as they might distort, filter, or show discomfort with the situation, introducing emotional bias. Therefore, family members and friends cannot act as neutral parties for translation services. Furthermore, the effectiveness of informal interpreting in Meeuwesen et al. (2010) was found to be inconsistent, as role performance varied significantly between individuals.

Potential risks of informal interpreting were also investigated by Kilian et al. (2014), in which ad hoc interpreting in mental health settings was found to contribute to diagnostic inaccuracies. This especially occurred when communication was mediated by untrained interpreters. The most documented errors in such cases were omissions, additions, and selective transmission of information. In a study by Maletsky et al. (2023), family and caregivers themselves report similar concerns, as they showed awareness of the fact that they cannot provide the same level of interpreter quality as a professional. Moreover, participants stated that (para)medics often do not allocate sufficient time for complete interpretation, speak too fast, and use too much medical jargon. Suggestions for improvement included speaking more slowly, using more everyday language, or hiring specialised medical interpreters (in person or through videocall).

However, as Jaeger et al. (2019) rightly point out, most healthcare institutions do not have sufficient access to professional interpreters. Moreover, the provision of interpreter services may entail a considerable financial burden. Such services are also expected to be timely available, responsive to patients' expressed needs, and organised in a straightforward and accessible manner, which is not always feasible. Aphasic patients could also become disoriented, or even aggressive in more severe cases, during the administration of diagnostic tests (Cfr. Modirrousta et al., 2013). This could be heightened due to involvement of strangers (i.e., the professional interpreter) or screens (i.e. a videocall).

Overall, though they are aware of the multilingual composition of their patient population, it is evident that most respondents are not properly equipped to accommodate to the diagnostic and communicative needs of multilingual patients in the context of comprehensive aphasia assessment. When resources and tools are limited, professionals appear to default to the dominant institutional language (i.e., Dutch), because it is the most operationally easy option, even if it is not the most representative one. If Dutch is mutually intelligible to both the clinician and the patient, though it is merely one of the languages the patient uses, it may suffice to support a diagnosis with ScreeLing and/or the Dutch Naming Test in the acute phase.

In the other cases, reliance on Dutch standardised tools alone becomes insufficient, as multilingualism is disregarded, potentially influencing the accuracy of the diagnosis. The strong reliance on informal interpretation of the patient's family and friends further complicates and risks the accuracy of the assessment. Notably, even professional interpreters would not be able to resolve all issues, as they can only provide translation services and cannot guide diagnosis and rehabilitation without extensive aphasia training in relation to multilingualism.

4.3.4 Aphasia and VGT

Naturally, multilingualism only represents one unique characteristic associated with sign language users. Therefore, as regards to what extent Flemish speech-language pathologists consider the needs of VGT users during acute-phase aphasia diagnostics (RQ3), the survey also investigated other aspects of Flemish Sign Language users in relation to aphasia. The core challenges for diagnosing multilingual patients – communication barriers and lack of standardised tests – are also present for VGT users but are even more pronounced according to the survey responses. These arise not only from the multilingual nature of sign language users but also from their hearing status and modality.

As for hearing status, the core population of sign language users are not only multilingual, but also profoundly deaf. Although it falls beyond the scope of the present study to investigate deafness in relation to aphasia without a focus on sign languages, it is reasonable to assume that a hearing impairment alone may already pose considerable challenges for diagnostic practices. For instance, it would be difficult for paramedics to differentiate between prior sensory deficits (i.e., hearing impairment) and acquired linguistic deficits (i.e., aphasia). Though survey respondents frequently treated multilingual patients, deaf/hard-of-hearing individuals were seldom encountered. As only 5% of the world population has a disabling hearing loss, this result is not surprising (Cfr. WHO, 2025b). Notably, it already foreshadows the survey results in relation to VGT users, as only one respondent reported ever treating such an individual with a suspected aphasia. Additionally, the VGT L1 population is already relatively small (cfr. Loots et al., 2003).

Most importantly, the core challenges are exacerbated for VGT users due to the difference in modality, as sign languages are structured entirely differently from spoken languages. This has implications for both communication, practical organisation of the hospital, and diagnostic instruments, which will be discussed separately.

As respondents indicated, they would be unable to communicate with their patients, as they themselves are not fluent in Flemish Sign Language. Reported solutions included calling upon the patient's family and friends to translate, hiring a professional interpreter, or using written communication. Though these could certainly alleviate certain communication barriers, there are also several caveats.

As discussed in relation to multilingualism, research consistently shows that informal interpreting may compromise diagnostic accuracy due to bias, inconsistent interpretation quality, and limited medical knowledge of caregivers. Additionally, the context is far more complex for deaf signing individuals, as their direct environment is not always fluent in the sign language they themselves use. As reported by Van Herreweghe and Vermeerbergen (2022), 90-95% of deaf children are born into hearing families. Furthermore, those who learn a sign language as an additional language (Lx) represent the minority in the general sign language population (Cfr. Schönström, 2021; United Nations, n.d.). Thus, even interpretation by the patient's family members and friends might not be possible.

Furthermore, access to professional interpreter services remains structurally and financially restricted (Cfr. Jaeger et al., 2019). Several survey respondents admitted to these constraints, stating that they did not know whether they could (quickly) access an interpreter and if there could be a budget allocated to this endeavour.

Additionally, research by Doof Vlaanderen (2023) indicates that only a very small group is active as professional interpreter of Flemish Sign Language on a full-time basis, limiting the general availability of translation services. Nevertheless, even when a professional VGT interpreter could be easily accessed, it is still the clinician who needs to administer the diagnostic tests. Even with extensive training on what aphasia entails and how it manifests in sign languages such as VGT, which in itself is already highly impractical, diagnostic barriers would still occur.

Moreover, though it is a natural response to shift to written communication when oral communication is not possible, one cannot assume that this patient was fluent in (written) Dutch before the onset of the aphasic syndrome. This is especially true for older VGT users who most likely have not received a cochlear implant from a very young age, in contrast to the younger generation (Cfr. Mertens et al., 2021). Additionally, though sign language users are almost always multilingual, they are not necessarily equally proficient in all languages across all language skills (Cfr. Paradis, 2023; Sanches de Oliveira & Bullock Oliveira, 2022). As a result, their proficiency may not reach the level of a typical user (Mayberry & Lock, 2003). To illustrate, research on deaf users of American Sign Language (ASL) found lower average proficiency in written English (Traxler, 2000). Written communication, therefore, could already be affected before the onset of their aphasia. This makes it challenging to distinguish between aphasic deficits and pre-existing differences in language proficiency.

In addition to the communication issues, respondents also raised other concerns, such as a strained clinician-patient relationship and a lack of psychoeducation. In the medical context, the latter refers to providing insight into symptoms, causes, and treatment options of the condition to the patient, primarily used in mental health settings (Manjunatha & Ram, 2022), which is closely related to the concept of health literacy. As previously discussed, health literacy refers to the ability to access, understand, evaluate, and utilise information to maintain good health (Cfr. WHO, 2025a).

Research confirms that people with profound hearing impairment experience increased healthcare use and communication barriers in healthcare settings (Cfr. Okuba et al., 2023), as well as poorer health outcomes (Cfr. McKee et al., 2015). Based on the survey results, certain respondents do show awareness of lower health literacy in the VGT population, though in a more implicit manner.

Furthermore, respondents also reported other clinical and practical barriers. Diagnostic processes may be complicated by comorbidities such as apraxia, which can affect motor execution of signs and obscure the distinction between language and motor impairments. Moreover, the co-occurrence of hearing loss and language disorders adds another layer of complexity. Organisational constraints within healthcare settings, such as adapting the clinical environment, were also mentioned. Though these are not the primary concerns, they need to be equally addressed.

In addition, there are no standardised tests readily available to diagnose a user of Flemish Sign Language, as is also highlighted by respondents. The Bilinugal Aphasia Test, though a highly valuable diagnostic test, only applies to spoken languages (Cfr. Paradis, 2011). ScreeLing and the NBT, though highly valuable for Dutch, can serve only as complementary tests for VGT users at best. ScreeLing, for instance, relies partly on auditory input and spoken Dutch (e.g., repetition tasks), which is problematic for individuals with hearing loss, and even visually presented tasks require knowledge of written Dutch. Although ScreeLing aims to assess language independently of the input channel, modality remains highly relevant for sign language users. The phonology tasks are based on the oral-auditory modality and are therefore not applicable. Additionally, the semantic and syntactic tasks also depend on Dutch vocabulary and grammar rather than VGT (Berns et al., 2015; El Hachoui et al., 2010). In the Dutch Naming Test, lexical items pose a problem. To illustrate, in Flemish Sign Language, the meaning of a single word is distributed across multiple phonological parameters, unlike in Dutch (Van Ewijk et al., 2020).

It is notable that Dutch can be assessed to some degree as an additional language for VGT users, as most are multilingual and bimodal. Particularly, the younger generation, namely those with high-functioning cochlear implants from a very young age (Cfr. Mertens et al., 2021), would be able to achieve an adequate level of Dutch proficiency pre-onset of the acquired aphasia.

Lastly, it is worth investigating how respondents would consider the needs of patients who use VGT as an additional language, either for professional (e.g., interpreters) or personal (e.g., CODAs) reasons. In cases where an older deaf signer is admitted to hospital with suspected aphasia, the need to assess VGT is more readily apparent. However, for a hearing adolescent or adult who uses Dutch (or any other oral-auditory language) as an L1/Lx, other languages, such as VGT, might not be evaluated due to previously discussed challenges. In the hypothetical case that a professional interpreter, a CODA, or anyone with knowledge of VGT were to require diagnostic assessment, reliance on Dutch-based screening tools would fail to capture their full linguistic repertoire.

4.3.5 Education Aphasia and Sign Languages

As regards education in relation to aphasia and sign languages, knowledge is very limited. Those who did follow a course, such as a course in Flemish Sign Language or an elective in their master's degree, did not necessarily obtain more information on the topic. When asked which challenges or difficulties they foresaw concerning damaged (connections between) language-specialised brain areas in relation to sign languages, most of them did not know. They were, nevertheless, troubled about which residual options for communication their patients would have as a VGT user's options before the aphasia, according to their opinion, was already severely limited. This is a valid concern, as users of sign languages already face considerable barriers in their day-to-day lives because of their minority status. It is already extremely difficult to navigate audiocentric environments while using a sign language, let alone when that sign language becomes impaired.

Perhaps due to the rare chance of (para)medics ever encountering a VGT user who requires an aphasia diagnosis, they did not see the value in obtaining more knowledge either in the general programme or through additional training. However, they acknowledged limited knowledge of aphasia in relation to sign languages, implicitly indicating a need for further understanding in this area.

Based on survey responses, (para)medics show significant goodwill, but severely lack of profound knowledge of (deaf) signing patients. This not only involves the language barrier itself but also insights into the aspects of sign languages that make them unique and different from spoken languages, which requires a modality-specific approach to both communication and diagnostic practices. In addition, respondents report that a professional aphasia-specialised interpreter would alleviate certain issues, but fail to show awareness of the fact that they themselves could also increase their knowledge.

5 General Discussion

Research on acquired language disorders, such as aphasia, remains predominantly Westernised and audiocentric, with diagnostic protocols adapted or created for sign language users being extremely rare. Though sign language users represent a minority, it is equally important that acute-phase aphasia assessments are also adapted to their (linguistic) needs. Unsuitable assessments increase the risk of underdiagnosis/misdiagnosis and exclusion from care. Therefore, this study investigated the general neural representation of healthy sign language processing versus sign language aphasia (RQ1), which acute-phase aphasia diagnostic protocols are currently used in the Flemish Community (RQ2), and to what extent Flemish speech-language therapists consider the needs of VGT users when assessing acute-phase aphasia (RQ3). These sub-questions were selected to answer the overarching research question 'How can acute-phase aphasia diagnostic practices be evaluated and improved to better accommodate sign language users in the Flemish Community?'

5.1 RQ1

Through the rapid review, the following results were obtained for RQ1, namely 'How does current neuroimaging and neuropsychological evidence characterise the neural representation of sign languages in relation to aphasia?'. Evidence shows that sign languages rely on a core left-lateralised perisylvian network, similar to spoken languages. Nevertheless, additional recruitment was found in the parietal regions in relation to spatial and grammatical processing, predominantly in the left hemisphere. Moreover, right-hemispheric contributions were found in relation to spatial and classifier processing. Thus, certain brain areas are more strongly activated (e.g., left IPL and left SPL) while some are more consistently recruited for sign language processing (e.g., right-hemispheric homologues of language-specialised brain areas).

This indicates that the neural representation of sign languages relies on a modality-independent core network, shared with spoken languages, but with certain modality-specific adaptations. Moreover, signs and gestures diverged in neural representation, as signs consistently activate left perisylvian regions, whereas gestures rely more on bilateral or right-hemispheric networks. This underscores that signs (e.g. BRUSHING TEETH) are inherently linguistic, while gestures (e.g. 'do as if you are brushing your teeth') are non-linguistic. This implies that the distinction between language deficits (signs) and intact gestures is clinically relevant and that they should be assessed separately.

As regards acute-phase aphasia in relation to sign languages, results demonstrated that left-hemispheric damage was associated with classic aphasic deficits. Conversely, right-hemispheric damage was associated with subtle but clinically relevant impairments, for instance, in spatial and classifier processing. The increased activation in the left parietal cortex from the results of healthy sign language processing implies that sign language users might experience more (severe) impairments when this area is damaged, for instance, in topographic structuring or verb agreement.

Therefore, diagnostic protocols should not only assess the core linguistic functions (e.g., lexical retrieval) but also incorporate modality-specific features such as spatial processing, classifier constructions, and visuospatial abilities, while distinguishing linguistic deficits from motor or gestural impairments. Although hearing status, handedness, and multilingualism/bimodality did not appear to alter activation patterns significantly, further research is required to detect subtle, but important, differences. Only then can clinical practices consider the full context of sign language users and potentially increase the accuracy of diagnosis and rehabilitation options.

5.2 RQ2

Through the survey and the additional literature review, the following results were obtained for RQ2, namely 'Which diagnostic protocols are currently used for assessing acute-phase aphasia in the Flemish Community?'. Results show that acute-phase aphasia diagnostic protocols in the Flemish Community strongly rely on ScreeLing and the Dutch Naming Test (NBT). However, these are designed to evaluate Dutch, an oral-auditory language, and are heavily focused on verbal output. As of conducting this research, there are no validated tools available to assess Flemish Sign Language users.

5.3 RQ3

The following results were also obtained through the survey and additional literature review, investigating to what extent Flemish speech-language therapists consider the needs of sign language users when assessing acute-phase aphasia. This involved aspects such as multilingualism, hearing status, and the visual-gestural modality. Diagnostic experts frequently encounter multilingual patients but rarely assess all languages or language modalities due to practical constraints or limited knowledge. There is little awareness of tools that could be deployed to diagnose multilingual patients. Existing tools, such as the Bilingual Aphasia Test, are not widely known or applied in Flemish hospitals.

When communication barriers arise, clinicians often rely on interpretation by family members or friends, despite research demonstrating that untrained interpreters may introduce inaccuracies that can compromise diagnostic reliability. While professional interpreter services may partially alleviate communication barriers, their availability remains structurally and financially constrained, and interpreters themselves cannot compensate for the absence of specialised clinical expertise in multilingual aphasia assessment.

Without proper knowledge of all the languages a patient uses and related diagnostic protocols, the risk of underdiagnosis or misdiagnosis increases. In a country as linguistically diverse as Belgium, this cannot be ignored.

For users of sign languages, particularly VGT users, the issues are far more problematic. Not only do they experience the same barriers as multilingual patients, but they also face further complications due to the added complexity of the visual-gestural modality, hearing status, and relatively small and underrepresented population. Respondents reported major barriers: a lack of proficiency in VGT among diagnostic experts, the absence of standardised assessment tools for sign languages, and difficulties distinguishing pre-existing sensory or language differences from aphasic impairments. Commonly proposed communication strategies included written communication, relying on family members or friends for interpretation, or engaging professional interpreters. However, written Dutch proficiency cannot be assumed for all sign language users, particularly older generations. Translation services display the same risks as previously discussed in relation to multilingualism, with the added difficulty that professional VGT interpreters are rare. Additionally, it is important to assess Lx users of VGT as well (e.g., professional interpreters, CODAs), as evaluating Dutch only would fail to capture their full linguistic repertoire.

Overall, professionals report limited training in sign languages and aphasia in signers and a general uncertainty in handling such cases should they occur. The low exposure to Flemish Sign Language users in need of an aphasia diagnosis leads to a low perceived need for professionals to follow (additional) training to gain more knowledge. This leads to a continued lack of awareness and knowledge and reflects a vicious cycle of consistent underrepresentation for this population. Given the limited knowledge of diagnostic experts, it would be beneficial to receive, at a minimum, basic training regarding sign languages and language disorders such as acquired aphasia. Only then can health literacy for Flemish Sign Language users be improved, and a reliable diagnosis be provided.

A collaboration among (para)medics, universities and colleges, sign language users, and the deaf communities could be highly valuable for improving knowledge and awareness through (additional) training, not only for VGT, but for sign language users worldwide.

The question then remains which recommendations can be made to accommodate the needs of sign language users, particularly VGT users, in acute-phase aphasia diagnostics. To alleviate communication and psychoeducational barriers, the use of a professional interpreter would be beneficial when readily available, ideally with at least basic training in aphasia. This, however, requires adequate budget allocation and effective organisational structure within healthcare institutions. More broadly, the professional status and accessibility of (full-time) VGT interpreters should be strengthened. Given the already limited number of active interpreters, those with specific experience or training in aphasia are likely to be even more scarce. Should the VGT user be sufficiently proficient in Dutch, written communication could be an option if the linguistic deficits are minor (e.g. anomic aphasia).

However, assessing in an orthographic manner or hiring a professional, aphasia-trained interpreter cannot fully address diagnostic challenges associated with the visual-gestural modality. Although professional translation is recommended, indirect testing may reduce diagnostic reliability. Furthermore, including only one test (i.e., involving highly frequent signs), as suggested by respondents, fails to assess all the unique structural possibilities of sign languages such as VGT.

Rather than adapting protocols such as ScreeLing to assess VGT, it would be more beneficial to follow the examples of already existing aphasia test batteries for other sign languages. Though each sign language is distinct, they all share the visual-gestural modality. Consequently, tests in other sign languages are far more inclusive of VGT users than those for oral-auditory languages, such as Dutch.

Generally, sign language research and aphasia test batteries appear to focus on American Sign Language (Lillo-Martin & Henner, 2021), a trend that is also reflected in this study's rapid review, in which 17 of the 29 included studies involved ASL. The ASL-adapted version of the BDAE, for instance, was administered in studies by Hickok et al. (1999) and Rogalsky et al. (2013).

Currently, efforts are being made to develop aphasia test batteries for other sign languages as well. The British Sign Language Adult Language Impairment and Aphasia Battery (BSL-ALIAB) represents a relevant diagnostic instrument (DCAL Portal, n.d). This is a clinical battery to address suspected language impairments, such as aphasia, for British Sign Language and gesture ability. It can be implemented for both acquired and developmental language disorders and also has implications for BSL teaching or for exploring the concept of visual iconicity (e.g. Noun Comprehension Test). Similar to ScreeLing, the administration takes approximately 30 minutes and considers several factors (i.e., visual neglect, hemianopia, prior speech or language disorders). The BSL-ALIAB involves tasks that assess locatives, classifiers, negations, question judgement, noun comprehension, and sentence and verb comprehension. Notably, gestures are also assessed in a separate task. Clinicians without BSL skills are advised to use the services of a BSL interpreter to ensure good clinical rapport (ibid.).

Moreover, a study in progress by Parini et al. (2026) aspires to develop the first assessment tools for Aphasia in French and Italian Sign Languages, with preliminary data presented at the Conference of the Student Organisation of Linguistics in Europe (ConSOLE34) in January 2026. In relation to VGT, a study by Wille et al. (2020) adapted and piloted a version of the Visual Communication and Sign Language Checklist (VCSL) to assess early sign language and visual communication development in deaf children under 24 months. Although not a screening tool for adults with acute-phase aphasia, it shows that VGT tests are emerging. To increase health literacy and accuracy of diagnosis for VGT users, this trend needs to continue.

5.4 Limitations and Future Directions

Although this study provided valuable insights into acute-phase aphasia diagnostics in relation to Flemish Sign Language users, several limitations should be acknowledged. This includes the methodological choices for the rapid review and the surveys, as well as general critical remarks and recommendations for improvement in light of future research.

Firstly, the rapid review operated within a limited timeframe and relied on predefined inclusion and exclusion criteria, limiting opportunities for more extensive, in-depth exploration. Nevertheless, search terms were purposefully chosen to provide a focused, rapid search and to cover the aspects most representative of the overarching theme, namely sign language processing in relation to acquired aphasia. All stages, namely identification, evaluation, selection, and analysis, were administered by a single reviewer. Single reviewer bias can therefore not be fully excluded. To mitigate this limitation, each step was repeated multiple times, minimising inconsistencies. Furthermore, the rapid review was supported by established frameworks (PRISMA and GRADE) and tools (Mendeley and Microsoft Excel).

Unfortunately, the available literature presented several limitations as well. Many articles, particularly lesion-based studies, involved small samples and showed substantial variability in imaging methods, tasks, and participant characteristics. Inconsistent formal assessment and reporting of multilingualism, age of acquisition, handedness, and hearing status further constrain interpretability. Despite these issues, cross-study consistency increases the reliability and generalisability of results, and the GRADE assessment ultimately indicates a moderate level of certainty.

As for theoretical limitations, one could argue that evidence from the healthy sign language processing studies is more correlational than causative, making it difficult to infer direct relationships between brain areas and sign language processing or aphasic outcomes. Generalisability, therefore, might be reduced.

Nevertheless, given the underrepresentation of sign language users in academic research and their small population size, these findings remain valuable. The same applies to the eight lesion-based studies, which provided direct causative evidence.

As regards the survey, this method operated on a limited timeframe for data collection, and access relied heavily on email communications and voluntary participation. Due to these factors, (self-)selection bias cannot be fully excluded. Nevertheless, years of experience were balanced (i.e., ranging from 0-20+ years). Additionally, geographical distribution (i.e., 4/6 regions) as well as medical profession of the respondents (i.e., SLP, nSLP, neurologist) varied to a degree that is sufficiently representative of the broader population. Moreover, respondents were asked to provide their contact information for a follow-up interview should their answers require further elaboration. Unfortunately, very few respondents were willing to participate, especially those who provided less detailed or ambiguous answers. In future research, it may be useful to expand the timeframe of data collection and directly involve respondents who are motivated to participate in an interview from the start. Respondents could, for instance, be contacted through other strategies, such as social media, flyers, or in-person communication and collaboration with hospitals. With an expanded timeframe, interviews could also be added as a required methodological step to provide a more in-depth exploration.

Lastly, concerning the diagnostic instruments used by (para)medics in the Flemish Community, only ScreeLing could be accessed for more detailed research. Although a concise literary review regarding other diagnostic instruments, such as the Token Test, was sufficient for this study, it may be valuable to purchase or loan these tests from (other) universities, hospitals, and publishers. Nevertheless, these diagnostic instruments were primarily discussed in an explorative manner, namely, to investigate current diagnostic practices in the Flemish Community. Pending the development of diagnostic instruments for VGT, recommendations and inspiration should be drawn from aphasia test batteries applicable to other sign languages, such as the BSL-ALIAB.

6 Conclusion

In sum, the persistent invisibility of sign languages has created a profound mismatch between neuroscientific evidence and clinical practice. While research consistently demonstrates that sign languages are natural, complex, modality-sensitive language systems, clinical practice continues to be dominated by Westernised, monolingual, and audiocentric perspectives. This gap impacts diagnostic accuracy, quality of care, and rehabilitation outcomes for sign language users.

Neuroimaging evidence shows that sign languages rely on a left-lateralised perisylvian network shared with spoken languages, with additional modality-specific involvement of parietal and right-hemispheric regions for spatial and classifier processing. In aphasic patients, left-hemispheric damage led to deficits in core linguistic aspects, while right-hemispheric damage selectively impaired spatial, classifier, or visuospatial processing. This indicates a partly modality-independent but adapted neural system, relevant to consider in diagnostic practices (RQ1).

Acute-phase aphasia assessment reportedly relies on Dutch-based tools such as ScreeLing and the Dutch Naming Test (NBT). These instruments, however, are designed to assess monolingual patients in Dutch. As of conducting this research, no validated standardised tools exist for assessing Flemish Sign Language users (RQ2). Flemish medical professionals frequently encounter multilingual patients but rarely assess all languages or modalities due to limited tools, training, and time. Sign language users are largely unaccommodated, and assessments often default to Dutch or informal translation methods, leading to limited consideration of multilingual and visual-gestural needs (RQ3).

Key implications for clinical practice include developing validated aphasia assessments for VGT following the example of other sign language aphasia test batteries (e.g., BSL-ALIAB). Moreover, it is important to assess each language (modality) separately, rather than assuming overarching linguistic deficits. Clinicians and professional interpreters should receive, at a minimum, basic training to raise awareness of acquired acute-phase aphasia in relation to sign languages such as VGT. Collaboration between (para)medics, Flemish Sign Language users, universities and colleges, and deaf communities could make significant progress in this endeavour. Without addressing these required adaptations, the risk of misdiagnosis persists, and inequalities in healthcare remain. Addressing this is essential for clinical accuracy, equitable healthcare, and improved quality of life, not only for VGT users but also for sign language users worldwide.

7 References

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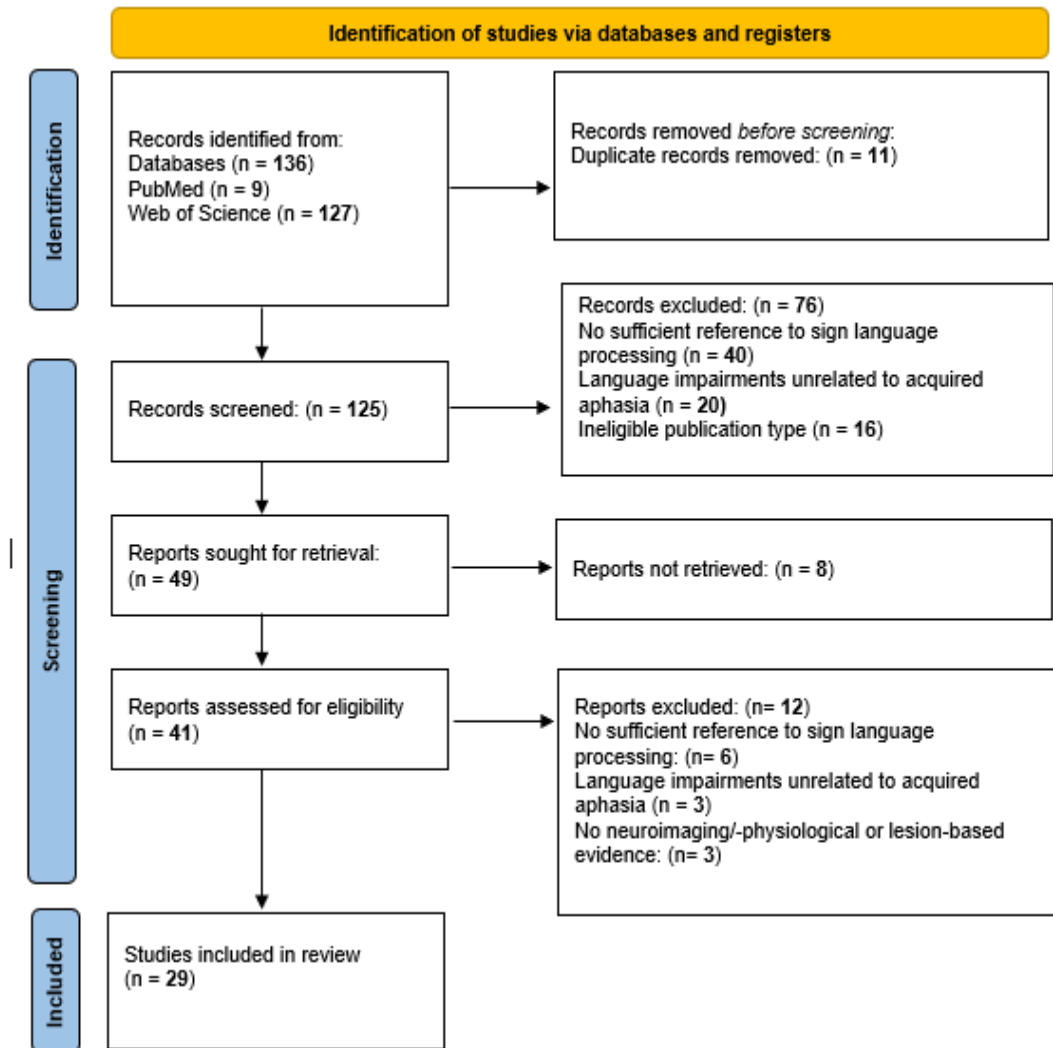
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8 Appendices

APPENDIX A: PRISMA Flowchart



APPENDIX B: Rapid Review Selected Studies

STUDY: AUTHOR & YEAR	APHASIA	STUDY TYPE	LANGUAGE(S)	DEAF/ HEARING	HANDED- NESS
Alotaibi et al., 2024	No	Experimental	ASL	24 deaf signers	23 r 1 l
Atkinson et al., 2003	Yes	Lesion-based	BSL	5 deaf signers, 1 hearing signer	5 r 1 l
Capek et al., 2009	No	Comparative	BSL vs English	13 deaf signers vs 13 hearing non- signers	26 r
Corina et al., 2003	No	Experimental	ASL	16 deaf signers	16 r
Corina et al., 2007	No	Comparative	ASL vs English	10 deaf signers vs 10 hearing non- signers	20 r
Emmorey et al., 2009	No	Comparative	ASL vs English	14 deaf signers vs 14 hearing non- signers	28 r
Haluts et al., 2024	Yes	Lesion-based	1 multilingual: Hebrew, Romanian, English, Israeli Sign language (ISL)	1 Hearing signer	l + r
Hickok et al., 1998	Yes	Lesion-based	ASL	20 deaf	20 r
Hickok et al., 2002	Yes	Lesion-based	18 ASL 1 multilingual: ASL + English	18 deaf 1 hearing bilingual	19 r
Hickok et al., 2009	Yes	Lesion-based	ASL	20 deaf 1 hearing	21 r

Horwitz et al., 2003	No	Comparative	11 multilinguals: ASL + English vs 20 monolinguals: English	11 hearing signers vs 20 hearing non-signers	31 r
Husain et al., 2009	No	Comparative	ASL (vs gestures)	12 deaf signers	Not specified
Kassubek et al., 2004	No	Comparative	ASL vs English	7 deaf signers vs 15 hearing non-signers	All r
Kovelman et al., 2008	No	Comparative	5 multilinguals: ASL + English vs 27 monolinguals: English	5 hearing signers, 20 hearing non-signers, 7 deaf non-signers	32 r
Kumar et al., 2024b	No	Comparative	Multilinguals: Indian Sign Language (ISL) + Hindi Monolinguals: Hindi	35 deaf signers vs 35 hearing non-signers	70 r
Lee et al., 2025	No	Comparative	24 multilinguals: BSL + English (vs fingerspelling)	24 deaf signers	23 r 1 l
Li et al., 2014	No	Comparative	Chinese Sign Language (CSL) (proficiency levels)	14 deaf 36 hearing	50 r
Liu et al., 2020	No	Comparative	14 multilinguals: Chinese Sign Language (CSL) + Chinese Mandarin	Not specified	29 r

			vs 15 monolinguals: Chinese Mandarin		
MacSweeney et al. 2002	No	Comparative	BSL (topographic vs. nontopographic)	18 deaf signers	18 r
MacSweeney et al., 2008b	No	Comparative	Multilinguals: BSL + English	23 deaf vs 24 hearing signers	47 r
Malaia et al., 2012	No	Comparative	ASL vs English	17 deaf signers vs 13 hearing non-signers	30 r
Newman et al., 2010a	No	Experimental	ASL	14 deaf signers	14 r
Newman et al., 2010b	No	Experimental	ASL	17 deaf signers	17 r
Okada et al., 2016	No	Experimental	ASL	16 deaf signers	16 r
Pickell et al., 2005	Yes	Lesion-based	ASL	1 deaf	1 l
Rogalsky et al., 2013	Yes	Lesion-based	ASL	34 deaf signers	34 r
Saito et al., 2005	Yes	Lesion-based	Japanese Sign Language (JSL)	1 deaf signer	1 r
San José-Robertson et al., 2004	No	Experimental	ASL	16 deaf signers	16 r
Twomey et al., 2017	No	Comparative	BSL (acquisition time)	60 deaf signers	60 r

APPENDIX C: Survey ICF



Geïnformeerde toestemming

U wordt uitgenodigd deel te nemen aan een masterproefonderzoek van Nina Driesmans aan de Vrije Universiteit Brussel, gericht op het voltooien van het diploma Taal-en Letterkunde, profiel neuro-en psycholinguïstiek. Dit onderzoek focust zich op diagnostische protocollen voor afasie in de acute fase bij gebruikers van de Vlaamse Gebarentaal.

Uw deelname is volledig vrijwillig en u kunt deze op elk moment stopzetten. IP adres en locatiegegevens worden niet verzameld tijdens het invullen van deze enquête. Gegevens zoals functie, aantal jaren ervaring en observaties worden vertrouwelijk verwerkt en uitsluitend gebruikt voor wetenschappelijk onderzoek, in overeenstemming met GDPR. Uw gegevens worden maximaal 1 jaar bewaard en kunnen worden gedeeld in publicaties of conferenties. Deelname brengt geen risico's met zich mee en er zijn geen persoonlijke voordelen aan verbonden. U hebt het recht uw gegevens in te kijken, te corrigeren of te laten verwijderen. Voor vragen of klachten kunt u contact opnemen met de onderzoeker (nina.driesmans@vub.be), promotor (beatrj.wille@vub.be) of de gegevensbescherming van de Vrije Universiteit Brussel (dpo@vub.be).

Uw deelname wordt zeer op prijs gesteld!

* Bij deelname aan dit onderzoek geeft u concreet toestemming voor:

- ✓ het verzamelen en verwerken van uw functie, aantal jaren ervaring en observaties, in overeenstemming met GDPR.
- ✓ het openbaar maken van de resultaten in publicaties en conferenties, in overeenstemming met GDPR.

- ☐ Ik bevestig dat ik de bovenstaande informatie volledig heb doorgenomen en ga AKKOORD om deel te nemen aan dit onderzoek. ✓
- ☐ Ik bevestig dat ik de bovenstaande informatie volledig heb doorgenomen en ga NIET AKKOORD om deel te nemen aan dit onderzoek. ✗

* Deelname aan dit onderzoek vereist een specifiek profiel.

Bent u een medisch expert die betrokken is bij acute afasiediagnostiek (neuroloog, neurologopedist, logopedist, etc.)?

- ☐ Ja, ik ben een medisch expert die betrokken is bij acute afasiediagnostiek. ✓
- ☐ Nee, ik ben geen medisch expert die betrokken is bij acute afasiediagnostiek. ✗

APPENDIX D: Survey Questions

DEMOGRAPHICS

1. Wat is uw rol/functie?
 - Neuroloog
 - Neurologopedist
 - Logopedist
 - Andere, namelijk: _____
2. In welke regio bent u voornamelijk werkzaam?
 - Antwerpen
 - Oost-Vlaanderen
 - West-Vlaanderen
 - Limburg
 - Vlaams-Brabant
 - Brussel-Hoofdstad
3. Hoeveel jaren ervaring heeft u in de acute afasiediagnostiek?
 - 0-5
 - 5-10
 - 10-15
 - 15-20
 - 20+
4. Heeft u één van deze opleidingen gevolgd? U kunt meerdere antwoorden selecteren, indien nodig.
 - Postgraduaat Neurogene Communicatiestoornissen
 - Postgraduaat Neurologische Taal-en-Spraakstoornissen
 - Postgraduaat Neurologische Zorg
 - Geen van allen
5. Welke diagnostische test(s) voert u uit? Beschrijf in het kort uw standaardprotocol in verband met acute afasie.

APHASIA AND MULTILINGUALISM

6. Hoe vaak komt u in contact met meertalige personen met een vermoeden van acute afasie?
 - Zelden
 - Regelmatig
 - Zeer vaak
7. Welke talen, volgens uw ervaring, gebruiken deze personen het vaakst om te communiceren? Stel een top 3 op.
8. Test u alle talen die een persoon met een vermoeden van acute afasie gebruikt om te communiceren?
 - Ja
 - Nee
9. Zo ja, beschrijf kort welke diagnostische tests u uitvoert bij meertalige personen (i.e. wat afwijkt van uw standaardprotocol in vraag 5).
10. Zo nee, beschrijf kort waarom u geen (extra) diagnostische tests uitvoert bij meertalige personen.

11. Zo nee, beschrijf kort van welke diagnostische tests u op de hoogte bent die u kan uitvoeren bij meertalige personen (i.e. wat afwijkt van uw standaardprotocol in vraag 5).

APHASIA AND VGT

12. Hoe vaak bent u in uw loopbaan al in contact gekomen met dove of slechthorende personen met een vermoeden van acute afasie?
- Zelden
 - Regelmatig
 - Zeer vaak
13. Heeft u al eerder acute afasie diagnostische tests afgenomen bij gebruikers van de Vlaamse Gebarentaal (VGT)?
- Ja
 - Nee
14. Zo ja, heeft u de Vlaamse Gebarentaal meegenomen in de diagnose?
- Ja
 - Nee
15. Zo ja (13), welke uitdagingen heeft u hierbij ervaren?
16. Zo ja (13), heeft u beroep gedaan op een tolk in de Vlaamse Gebarentaal?
- Ja
 - Nee
17. Zo ja (13), zijn er nog specifieke aanpassingen of hulpmiddelen die u gebruikt om gebruikers van de Vlaamse Gebarentaal een accurate acute afasiediagnose te geven? Beschrijf kort.
18. Zo nee (13), welke uitdagingen voorziet u hierbij?
19. Zo nee (13), zou u in de toekomst beroep kunnen doen op een tolk in de Vlaamse gebarentaal?
- Ja
 - Nee
 - Ik weet het niet zeker.
20. Zo nee (13) welke specifieke aanpassingen of hulpmiddelen zou u kunnen gebruiken om gebruikers van de Vlaamse Gebarentaal een accurate acute afasiediagnose te geven? Beschrijf kort.

EDUCATION APHASIA AND SIGN LANGUAGES

21. Heeft u een specifieke opleiding/training gevolgd in verband met communicatie met dove of slechthorende personen?
- Nee, geen training
 - Ja, beperkte training
 - Ja, uitgebreide training
22. Zo ja, verkreeg u deze kennis in één van deze opleidingen? U kunt meerdere opties selecteren.
- Postgraduaat Neurogene Communicatiestoornissen
 - Postgraduaat Neurologische Taal-en-Spraakstoornissen
 - Postgraduaat Neurologische Zorg
 - Cursus Vlaamse Gebarentaal
 - Andere, namelijk: _____

23. Heeft u een specifieke opleiding/training gevolgd in verband met communicatie in de Vlaamse Gebarentaal?
- Nee, geen training
 - Ja, beperkte training
 - Ja, uitgebreide training
24. Zo ja, verkreeg u deze kennis in één van deze opleidingen? U kunt meerdere opties selecteren.
- Postgraduaat Neurogene Communicatiestoornissen
 - Postgraduaat Neurologische Taal-en-Spraakstoornissen
 - Postgraduaat Neurologische Zorg
 - Cursus Vlaamse Gebarentaal
 - Andere, namelijk: _____
25. Heeft u een specifieke opleiding/training gevolgd omtrent taalorganisatie in de hersenen bij gebarentalige communicatie?
- Nee, geen training
 - Ja, beperkte training
 - Ja, uitgebreide training
26. Zo ja, verkreeg u deze kennis in één van deze opleidingen? U kunt meerdere opties selecteren.
- Postgraduaat Neurogene Communicatiestoornissen
 - Postgraduaat Neurologische Taal-en-Spraakstoornissen
 - Postgraduaat Neurologische Zorg
 - Cursus Vlaamse Gebarentaal
 - Andere, namelijk: _____
27. Welke uitdagingen heeft u opgemerkt of voorziet u bij het vaststellen van beschadigde (connecties tussen) taalgebieden in de hersenen in verband met gebarentalen (in tegenstelling tot gesproken talen)? Beschrijf kort.
28. Hoeveel nood heeft u op dit moment om een specifieke opleiding te volgen om uw kennis omtrent taalstoornissen zoals afasie in verband met gebarentalen te verhogen? Duid aan op een schaal van 0 (zeer weinig nood) tot 5 (zeer veel nood).
29. Zou u het een meerwaarde vinden, mocht afasie in verband met gebarentalen behandeld worden in de basisopleiding? Duid aan op een schaal van 0 (helemaal geen meerwaarde) tot 5 (zeer veel meerwaarde).

INTERVIEW AND CONTACT

30. Indien ik nog verdere opmerkingen/vragen heb bij uw antwoorden, mag ik u dan uitnodigen voor een kort, verdiepend gesprek? Dit interview kunt u afleggen op een tijdstip en plaats naar keuze (ook online). Afspraken en geïnformeerde toestemming zullen hierop voorafgaan.
31. Zou u een e-mailadres kunnen opgeven waarop ik u zou kunnen contacteren, indien ik een gesprek wens?
32. Indien u interesse zou hebben in het raadplegen van de resultaten, kunt u een e-mailadres opgeven waarop ik u kan contacteren. U krijgt dan inzage in het masterproefonderzoek.

APPENDIX E: Survey Responses

RESPONDENT	PROFESSION	YEARS OF EXPERIENCE	POSTGRADUATE DEGREES
1	neurologopedist	5-10	Postgraduaat Neurogene Communicatiestoornissen
2	neurologopedist	20+	Postgraduaat Neurogene Communicatiestoornissen
3	logopedist	15-20	Postgraduaat Neurogene Communicatiestoornissen
4	neurologopedist	20+	Postgraduaat Neurologische Taal-en Spraakstoornissen
5	logopedist	0-5	geen van allen
6	neurologopedist	5-10	Postgraduaat Neurogene Communicatiestoornissen
7	neurologopedist	15-20	Postgraduaat Neurologische Taal-en Spraakstoornissen
8	neurologopedist	10-15	Postgraduaat Neurogene Communicatiestoornissen
9	neurologopedist	20+	geen van allen
10	logopedist	0-5	geen van allen
11	logopedist	0-5	Postgraduaat Neurologische Taal-en Spraakstoornissen
12	neurologopedist	15-20	Postgraduaat Neurogene Communicatiestoornissen
13	neurologopedist	10-15	Postgraduaat Neurologische Taal-en Spraakstoornissen
14	neurologopedist	5-10	Postgraduaat Neurogene Communicatiestoornissen
15	logopedist	0-5	Postgraduaat Neurogene Communicatiestoornissen
16	logopedist	0-5	geen van allen
17	neuroloog	10-15	geen van allen
18	logopedist	20+	geen van allen
19	neurologopedist	15-20	geen van allen
20	logopedist	5-10	Postgraduaat Neurologische Taal-en Spraakstoornissen

RESPONDENT	STANDARD PROTOCOL APHASIA	ENCOUNTERS WITH MULTILINGUAL PATIENTS	TOP 3 ENCOUNTERED LANGUAGES IN PATIENTS
1	Spraak en taalscreening Anamnese gesprek met patiënt en eventueel omgeving	regelmatig	Arabisch, Spaans, Turks
2	NBT, zelfgemaakte screening, Screeling, PALPA, BBT...	regelmatig	Nederlands - Frans - Arabisch
3	intakegesprek, auto/hetero bedsidescreening ScreeLing; NBT Globamix indien ernstig fatisch beeld Afhankelijk van resultaten diepgaander met testen bv PALPA taken; CAT-NL. Maar dan zijn we meestal voorbij de echte acute fase	zelden	
4	voornamelijk Screeling	zelden	
5	- Nederlandse benoemtest - Screeling - CAT-NL	regelmatig	- Nederlands - Frans - Spaans
6	Eigen ontwikkelde taalscreening Screeling Nederlandse BenoemTest	regelmatig	Nederlands Frans Engels
7	Bedside screening, ScreeLing, Globacom bij ernstige afasie, eventueel CAT-NL of PALPA (eerder uitzonderlijk in de acute fase), Nederlandse Benoemtest	vaak	Nederlands, Frans, Engels
8	Screeling + indien zinvol Nederlandse Benoemtest Bij ernstige afasie: eigen taalscreening, Globamix, Globacom, behandelend onderzoeken	vaak	Nederlands, Frans, Engels
9	eigen bedsidescreening die kort screent op vlak van automatische taal, auditief woord- en zinsbegrip, leesinhoudelijk woord- en zinsbegrip, schrijven, benoemen en nazeggen.	regelmatig	nederlands, frans, turks
10	Spraak-en taalscreening die opgebouwd werd binnen het ziekenhuis Screeling NBT Token test (app op tablet)	vaak	- Frans - Arabisch/Berbers - Engels
11	eigen bedsidescreening die alle taalmodaliteiten nagaat	regelmatig	Turks-Frans- Slowaaks

	Screeling NBT Soms onderdelen cat-NL Globacom		
12	Screeling of bedside screening (zelf opgesteld met allerlei taken zoals automatische reeksen, semi-automatische taal, begrip op woord- en zinsniveau, productie op woord- en zinsniveau, beschrijven van situatieplaat, lezen woorden en schrijven van naam/adres en hoogfrequente woorden). Naargelang hoe ernstige afasie is. Daarnaast kunnen ook bepaalde restmogelijkheden bekeken worden via evaluatieformulieren van globamix	regelmatig	Pools, Engels, Frans
13	Afhankelijk van niveau patiënt en wat hij/zij aankan: - CAT_NL - AAT of soms alleen Tokentest - Nederlandse Benoemtest - PALPA 52, soms 51 - Globamix - TMT van GANBA	regelmatig	Frans
14	Screeling vaak als eerste screening. Vaak ook eigen (niet-gestandaardiseerde) screening die alle taalmodaliteiten nagaat. CAT-NL voor grondigere diagnostiek. Eventueel NBT of SAT als woordvinding voornaamste/enige klacht is.	zelden	
15	-Bedside screening -Taalonderzoek adhv testmateriaal (NBT, Screeling, Globamix...) -Vragenlijsten	vaak	Turks, Bulgaars, Engels
16	een UZLEUVEN basisevaluatie	vaak	frans, engels, arabisch
17	Basisevaluatie Screening, screeling, CAT-nl, NBT	zelden	
18	Screeling Bij uitval CAT-NL	regelmatig	1) Frans 2) Arabisch 3) Engels
19	Cookie theft card picture; Boston naming test	regelmatig	Arabisch, Marokkaans, Frans

20	Wij nemen vertaling van LAST af (=Language Screening Test) (op 15 punten), als pt. stabiel is (bv na 2 of 3 weken) vaak ook de Nederlandse Benoem Test/CAT-NL/Screeling. Welke test hangt af van het profiel van de pt.		zelden
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RESPONDENT	DO YOU TEST ALL LANGUAGES?	STANDARD PROTOCOL & MULTILINGUALISM 'YES'	WHY DO YOU NOT TEST ALL LANGUAGES?
3	nee		Niet voor handen Geen beheersing van de taal en niet altijd toegang tot een tolk
4	nee		geen beschikbaar testmateriaal
14	ja	Grondige testing is vaak moeilijk. Ik kom op mijn werk in het ziekenhuis het vaakst in contact met mensen die Assyrisch, Arabisch, Berbers of Aramees spreken. Talen die ik zelf niet spreek. Ik probeer dan met familie de (veranderde) taal in kaart te brengen. Maar dit is heel moeilijk en ik heb hier nog niet echt een standaardprotocol voor.	
17	nee		Het niet eigen zijn van de taal bv. Mandarijn, Turks, Oekraïens,...

20			Wij nemen geen tests af in een andere taal dan Nederlands. Wij laten soms wel eens met een tolk (bv familielid of een zorgverlener in het ziekenhuis die de taal spreekt) onze screening vertalen en mee afnemen, maar merken dan dat de onderzoeker toch te veel 'helpt' bij de patiënt, waardoor de resultaten toch niet echt valide zijn. Wij zullen eerder aan bv familieleden vragen stellen over het soort taalgedrag van de pt.in de andere taal. Dit is echter geen standaard protocol, dat gesprek met de familie.
	nee		

RESPONDENT	STANDARD PROTOCOL & MULTILINGUALISM 'NO'	ENCOUNTERS WITH DEAF PATIENTS	ENCOUNTERS WITH VGT USERS
1		regelmatig	nee
2		zelden	nee
3	BAT	zelden	nee
4	Engelse afasietest	zelden	nee
5		vaak	nee
6		zelden	nee
7		regelmatig	nee
8		zelden	nee
9		zelden	nee
10		regelmatig	nee
11		zelden	nee
12		zelden	nee
13		zelden	nee
14		zelden	nee
15		zelden	nee
16		zelden	nee
17	Ik weet het niet.	zelden	nee
18		zelden	ja
19		zelden	nee
20	Ik weet het niet.	regelmatig	nee

RESPONDENT	DID YOU TEST VGT?	CHALLENGES?	ADAPTATIONS OR TOOLS?	INTEPRETER?
18	nee	Ik kan geen Vlaamse Gebarentaal	nee	nee

RESPONDENT	POTENTIAL CHALLENGES?	FUTURE ACCESS TO INTERPRETER?	FUTURE ADAPTATIONS OR TOOL?
1	Geen gestandaardiseerde test, automatische taal / gesprek uitlokken is zeer moeilijk, psycho-educatie geven in een andere taal is zeer lastig, moeilijkere therapeut-cliëntrelatie, ...	Ik weet het niet zeker.	Tolk die steeds en snel beschikbaar is, die ook kennis hebben van testing, die juist en exact vertalen, makkelijk en snel inzetbaar zijn (meer budget...)
2	Zelf de gebaren niet kennen. Geen test voorhanden die hiervoor aangepast is. Comorbiditeit (hemiplegie, apraxie).	Ik weet het niet zeker.	Ik weet het niet.
3	Kennis over gebarentaal en slechthorendheid; toegang tot tolk	Ik weet het niet zeker.	Vooraf orthografisch te werk gaan Ik zou wel eens op zoek gaan wat er allemaal bestaat; misschien zijn er applicaties waar ik kan op terugvallen? Maar geen kennis over en nog nooit tegengekomen; dus zou me moeten verdiepen hierin, maar heb vriendinnen die gebarentolk zijn dus zou wel ergens terecht kunnen voor input :-)
4	de algemene communicatie	Ik weet het niet zeker.	goed testmateriaal
5	/	Ik weet het niet zeker.	Ik weet het niet.
6	Geen kennis van VGT bij logopedist	Ik weet het niet zeker.	Geen direct idee. Eventueel een tolk op afstand, die een interpretatie/vertaling kan maken via video?
7	Zelf onvoldoende kennis	ja	ik weet het niet

8	Screenings worden minder bruikbaar, weinig aanknopingspunten naar communicatie toe	Ik weet het niet zeker.	Een korte screening met een aantal hoogfrequente gebaren die kunnen gelinkt worden aan de correcte foto/handeling? En omgekeerd.
9	dubbele combinatie van afasie - talig probleem en gehoorstoornis, wat de zaak bemoeilijkt en een tolk noodzakelijk maakt.	Ik weet het niet zeker.	ik weet het niet
10	/	Ik weet het niet zeker.	ik weet het niet
11	Tolk nodig	Ik weet het niet zeker.	Schriftelijk ondersteunde screening Duidelijk mondbeeld, goed verlichte kamer, ...
12	Ze zullen mij niet begrijpen als ik verbaal met hen communiceer. Ik zal via een alternatieve route moeten werken (via geschreven communicatie) en indien mogelijk omgeving betrekken om te kijken hoe communicatie verloopt in hun eigen taal (gebarentaal). Kijken op welk vlak er een uitval is bij het gebruik van gebaren. Daarnaast kijken of het mogelijk tolk in te schakelen of persoon die gebarentaal kan hanteren.	ja	Moeilijke vraag. Eventueel via video kijken of korte screening kan afgenomen worden bij gebruikers van Vlaamse Gebarentaal. Natuurlijk wordt het weer moeilijker om dit te interpreteren. Interpretatie zal dan moeten gebeuren met tolk of eventueel familie...
13	Ik beheers zelf de Vlaamse Gebarentaal niet.	Ik weet het niet zeker.	Ik weet het niet.
14	Tolk in de Vlaamse Gebarentaal moet goed op de hoogte zijn van wat afasie is en hoe zich dit uit in de gebarentaal.	ja	ik weet het niet
15	-Moeilijkheden bij praktische organisatie in een ziekenhuisomgeving	Ik weet het niet zeker.	-Inzetten van naaste omgeving (exploratieve testing)

	(planning, beschikbaarheid van instanties...) -Onvoldoende kennis beschikbaar		Geen ervaring hiermee.
16	zelf geen kennis van vlaamse gebarentaal, noch bij ander zorgpersoneel algemeen	ja	/
17	Het testen van begrip, foneemdiscriminatie,..	ja	Een ondersteunende test/stappenplan
19	Beschikbaarheid in de acute context, beschikbaarheid.	Ik weet het niet zeker.	Specifieke kaarten
20	Als het gaat over taaltesting of -sceening bij personen die slechthorend zijn: Auditief taalbegrip kan verkeerd ingeschat worden. Bij deze personen of dove personen is visueel taalbegrip interessanter om te evalueren.	nee	Ik weet het niet..

RESPONDENT	TRAINING DEAF PATIENTS?	WRITTEN RESPONSE: MCQ OR OTHER		TRAINING VGT?
1	nee, geen training			nee, geen training
2	nee, geen training			nee, geen training
3	nee, geen training			nee, geen training
4	nee, geen training			nee, geen training
5	ja, beperkte training	andere, namelijk:	Logopedische opleiding UGent	ja, beperkte training
6	nee, geen training			nee, geen training
7	nee, geen training			nee, geen training
8	nee, geen training			nee, geen training
9	nee, geen training			nee, geen training
10	nee, geen training			nee, geen training

11	ja, beperkte training	andere, namelijk:	Keuzevak tijdens universitaire opleiding logopedie	ja, beperkte training
12	ja, beperkte training	Cursus Vlaamse Gebarentaal		ja, beperkte training
13	ja, beperkte training	andere, namelijk:	Banaba audiologie	nee, geen training
14	nee, geen training			nee, geen training
15	nee, geen training			nee, geen training
16	nee, geen training			nee, geen training
17	nee, geen training			nee, geen training
19	nee, geen training			nee, geen training
20	nee, geen training			nee, geen training

RESPONDENT	WRITTEN RESPONSE: MCQ OR OTHER	TRAINING COMMUNICATION IN SIGN LANGUAGES?	WRITTEN RESPONSE: MCQ OR OTHER	
1		nee, geen training		
2		nee, geen training		
3		nee, geen training		
4		nee, geen training		
5	Logopedische opleiding UGent	nee, geen training		
6		nee, geen training		
7		nee, geen training		
8		nee, geen training		
9		nee, geen training		
10		ja, beperkte training		
11	keuzevak universiteit	nee, geen training		
12		ja, beperkte training		
13		nee, geen training		
14		nee, geen training		
15		nee, geen training		
16		nee, geen training		
17		nee, geen training		
19		nee, geen training		

20		nee, geen training		
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RESPONDENT	CHALLENGES APHASIA & SIGN LANGUAGES	NEED FOR ADDITIONAL TRAINING APHASIA & SIGN LANGUAGES	ADDED VALUE IN GENERAL PROGRAMME?
1	geen ervaring	5	5
2	/	1	2
3	geen idee; nog niet mee in aanraking gekomen	1	1
4	ik heb hier onvoldoende kennis over	4	1
5	/	2	2
6	Problemen met aansturen van fijne motoriek dominante (communicatie)hand. Vermoedelijk vnl problemen wanneer semantische regio's aangetast zijn + begripsproblemen.	3	1
7	geen kennis hieromtrent Wat met hemibeeld? cognitieve moeilijkheden?	3	3
8	Hoe patiënten te testen gezien geen kennis van gebarentaal Geen materiaal voor voorzien Testing zal sowieso moeizaam verlopen door comorbide stoornissen zoals bvb visueel neglect, hemianospie, gestoord begrip	2	1
9	ik weet het niet, geen ervaring	0	1
10	/	2	3

11	Extra bemoeilijkt door comorbiditeit (motorisch hemibeeld! neglect), impact mimiek die mogelijks veranderd is door centrale facialisparesse	0	0
12	Dat ze minder restmogelijkheden zullen hebben als hun gebarentaal is aangetast. Mensen die communiceren via gesproken taal kunnen vaak nog beroep doen op gebaren, aanduiden, .. Bij gebruikers van Vlaamse gebarentaal zullen ze misschien nog meer uitvallen.	1	2
13	Geen idee.	0	1
14	Geen ervaring mee, dus heel moeilijke vraag.	2	3
15	Geen kennis hierover.	2	1
16	/	1	1
17	Ik weet het niet.	1	2
19	Ik kan geen gebarentaal aanbieden dus ik kan moeilijk vaststellen of de persoon de gebaren begrijpt. Ik kan ook niet beoordelen of de persoon de gebaren correct gebruikt.	3	5
20	Tijdig stellen van de diagnose, juiste testen voor diagnose. Verwijsmogelijkheden.	4	4