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Sign language, visuospatial cognition, and deaf bilingual education: contributions from the extended mind and intermodal neuroplasticity

Língua de sinais, cognição visuoespacial e educação bilíngue de surdos: contribuições da mente estendida e da neuroplasticidade intermodal

Lengua de señas, cognición visoespacial y educación bilingüe de sordos: aportes de la mente extendida y de la neuroplasticidad intermodal

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Abstract: This article examines bilingual deaf education through the articulation of the neurobiology of language, embodied cognition, the extended mind, and deaf studies. Its aim is to discuss how visuospatial experience and early access to sign language support the linguistic, cognitive, and identity development of deaf students, as well as the implications of this articulation for the organization of bilingual schooling. Methodologically, the article takes the form of an interdisciplinary theoretical essay grounded in bibliographic research and guided by a non-exhaustive theoretical-analytical reading of works relevant to the articulation between the neuroscience of language, philosophy of mind, and deaf education. This analysis is mobilized to argue that Libras is not a compensatory resource, but a full-fledged language, a medium of meaning-making, and a matrix of cognitive organization. The literature examined indicates that sign language processing recruits classical language networks, especially the posterior Superior Temporal Sulcus and the Inferior Frontal Gyrus, while the spatiality of signing externalizes grammatical relations and supports working memory, reference tracking, and reasoning. It is further argued that the main risk to the development of deaf children does not stem from deafness itself, but from linguistic deprivation produced by delayed or restricted access to a natural language. The article concludes that ensuring Libras as a language of instruction and organizing visual didactic ecologies constitute central conditions for confronting linguistic deprivation and for strengthening bilingual education policies committed to learning, subjectivation, and recognition.

Palavras-chave: educação bilíngue de surdos; língua brasileira de sinais (libras); neuroplasticidade intermodal; mente estendida.

Resumo: Este artigo examina a educação bilíngue de surdos a partir da articulação entre neurobiologia da linguagem, cognição incorporada, mente estendida e estudos surdos. O objetivo é discutir de que modo a experiência visuoespacial e o acesso precoce à língua de sinais sustentam o desenvolvimento linguístico, cognitivo e identitário de estudantes surdos, bem como as implicações dessa articulação para a organização da escola bilíngue. Trata-se de um ensaio teórico interdisciplinar, de base bibliográfica, orientado por leitura teórico-analítica não exaustiva de obras relevantes para a articulação entre neurociência da linguagem, filosofia da mente e educação de surdos. Esta análise se mobiliza para sustentar que a Libras não constitui recurso compensatório, mas língua plena, meio de significação e matriz de organização cognitiva. A literatura examinada indica que o processamento das línguas de sinais recruta redes linguísticas clássicas, com destaque para o Sulco Temporal Superior posterior e o Giro Frontal Inferior, ao mesmo tempo em que a espacialidade da sinalização externaliza relações gramaticais e apoia operações de memória de trabalho,

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referenciação e raciocínio. Argumenta-se, ainda, que o principal risco ao desenvolvimento da criança surda não decorre da surdez em si, mas da privação linguística produzida pelo atraso ou pela restrição no acesso a uma língua natural. Conclui-se que a garantia da Libras como língua de instrução e a organização de ecologias didáticas visuais constituem condições centrais para o enfrentamento da privação linguística e para o fortalecimento de políticas de educação bilíngue comprometidas com aprendizagem, subjetivação e reconhecimento.

Keywords: Bilingual deaf education; Brazilian Sign Language (Libras); Intermodal neuroplasticity; Extended mind.

Resumen: Este artículo examina la educación bilingüe de sordos a partir de la articulación entre la neurobiología del lenguaje, la cognición corporizada, la mente extendida y los estudios sordos. Su objetivo es discutir de qué modo la experiencia visoespacial y el acceso temprano a la lengua de señas sostienen el desarrollo lingüístico, cognitivo e identitario de los estudiantes sordos, así como las implicaciones de esta articulación para la organización de la escuela bilingüe. Metodológicamente, se trata de un ensayo teórico interdisciplinario, de base bibliográfica, orientado por una lectura teórico-analítica no exhaustiva de obras relevantes para la articulación entre neurociencia del lenguaje, filosofía de la mente y educación de sordos. Este análisis se moviliza para sostener que la Libras no constituye un recurso compensatorio, sino una lengua plena, un medio de significación y una matriz de organización cognitiva. La literatura examinada indica que el procesamiento de las lenguas de señas recluta redes lingüísticas clásicas, con destaque para el Surco Temporal Superior posterior y el Giro Frontal Inferior, al mismo tiempo que la espacialidad de la señación exterioriza relaciones gramaticales y apoya operaciones de memoria de trabajo, referenciación y razonamiento. Se argumenta, además, que el principal riesgo para el desarrollo del niño sordo no deriva de la sordera en sí misma, sino de la privación lingüística producida por el retraso o la restricción en el acceso a una lengua natural. Se concluye que garantizar la Libras como lengua de instrucción y organizar ecologías didáticas visuales constituyen condiciones centrales para enfrentar la privación lingüística y para fortalecer políticas de educación bilingüe comprometidas con el aprendizaje, la subjetivación y el reconocimiento.

Palabras clave: Educación bilingüe de sordos; Lengua Brasileña de Señas (Libras); Neuroplasticidad intermodal; Mente extendida.

1 Introduction

The ontological and epistemological status of deafness has been the subject of intense debate in the field of education, oscillating between a clinical-therapeutic tradition grounded in deficit, rehabilitation, and normalization, and a socio-anthropological paradigm that foregrounds linguistic and cultural difference as the key to understanding Deaf experience (Skliar, 2005; Perlin, 2003). In light of advances in the neuroscience of language and in contemporary philosophy of mind, however, it has become increasingly necessary to develop a synthesis capable of articulating the biology of brain plasticity, the centrality of language in the constitution of the subject, and the phenomenology of Deaf existence, without collapsing into either biologizing reductionism or culturalist readings detached from the concrete conditions of linguistic and cognitive development (Emmorey, 2002; Skliar, 2005). It is within this horizon that the present article is situated. Its purpose is to examine, from an interdisciplinary perspective, how visuospatial experience challenges traditional conceptions of logos and language, thereby reframing the role of sign languages in the constitution of the Deaf subject and in the educational regimes historically imposed upon Deaf individuals.

To support this investigation, the article adopts an interdisciplinary theoretical essay grounded in bibliographic research and guided by a non-exhaustive theoretical-analytical reading of the literature relevant to the problem under discussion, in dialogue with the fields of cognitive neuroscience, philosophy of mind, and deaf education. The bibliographic survey drew on databases

such as SciELO, PubMed, and PhilPapers, selected for their relevance to the fields of education, neuroscience, and philosophy. Search terms in Portuguese, English, and Spanish were employed to identify key works for the debate, including sign language, deaf education, intermodal neuroplasticity, extended mind, embodied cognition, and linguistic deprivation, as well as their equivalents in Portuguese and Spanish. Priority was given to peer-reviewed articles, book chapters, and seminal works whose conceptual density proved especially productive for the articulation between language, cognition, and deafness. Texts whose contribution did not directly address the relationship between linguistic experience, cognitive organization, and the schooling of deaf individuals were set aside. The analysis was conducted from a qualitative and interpretive standpoint, guided by conceptual analysis and theoretical synthesis, with a focus on intermodal plasticity, embodied cognition, and the extended mind hypothesis. It does not aim to exhaust the available literature, but rather to bring together contributions capable of critically illuminating the problem and highlighting relevant analytical convergences.

The central issue lies in the persistent gap between, on the one hand, neurobiological evidence that conceives language faculty as an abstract capacity not restricted to the oral-auditory modality and, on the other hand, pedagogical practices that continue to treat the auditory channel as if it were a necessary condition for full linguistic development (Petitto *et al.*, 2001; Emmorey, 2002; Neville; Bavelier, 2000). Research in the neurobiology of language has increasingly shown that the human brain responds to the structure, rhythm, and formal organization of language even when it is experienced in a visuospatial modality (Petitto *et al.*, 2001; Emmorey, 2015). What is at stake, therefore, is not the superiority of one sensory channel over another, but the availability of a sufficiently structured natural language capable of sustaining processes of signification, symbolization, and learning (Petitto *et al.*, 2001; Emmorey, 2015). It is precisely in this tension between linguistic capacity and pedagogical provision that the urgency of the problem emerges. From the outset, it is important to note that the literature on intermodal plasticity suggests significant implications for the design of visual learning ecologies, a point that will be further developed in light of neurocognitive studies and their consequences for Deaf bilingual education (Neville; Bavelier, 2000; Emmorey, 2015).

It is therefore necessary to ground bilingual education beyond a generic discourse of inclusion or mere methodological adaptation. In dialogue with Clark (2008), this article argues that Libras may be understood as an embodied cognitive support, a claim that will later be developed through the notion of the extended mind and its relation to the spatiality of signed language. At the same time, this discussion is not merely technical. When schools regulate deaf students' access to the language that structures their experience, they do not simply administer a method; they define the conditions under which these subjects may be recognized within the pedagogical scene. In terms that will be further elaborated in the final sections, the issue is whether or not one responds to the otherness that presents itself within the school environment, assuming responsibility before a form of presence that does not conform to the historically dominant phonocentric paradigm. It is within

this horizon that Skliar's (2005) pedagogy of difference becomes intelligible: not as a methodological concession, but as the recognition of a distinct way of being in the world, mediated by modes of intelligibility marked by the spatiality of language and by a language realized in the body, in gesture, and in shared space.

Accordingly, the argument unfolds in three complementary movements. First, the article discusses intermodal plasticity and its implications for language acquisition and for the organization of visually oriented pedagogical contexts. Second, it analyzes the spatiality of sign language in light of embodied cognition and the extended mind hypothesis, with a view to understanding Libras not as a compensatory resource, but as a full-fledged language and a means of cognitive organization. Third, it examines the ethical and political consequences of recognizing Deaf difference in the school setting, articulating identity, otherness, and bilingual education. The central problem, therefore, does not lie in deafness itself, but in the linguistic deprivation produced when early access to a natural language is denied or delayed, with significant consequences for linguistic, cognitive, and academic development (Quadros, 1997; Petitto *et al.*, 2001).

2 Biological nature and embodied perception: the rescaling of visual logos

A contemporary understanding of deaf education requires an epistemological shift away from the phonocentric tradition that largely shaped educational policies throughout the twentieth century. Such a shift entails recognizing that language is not a mere byproduct of hearing, but a biological capacity whose emergence and development depend, above all, on access to structured linguistic patterns, rhythmically organized and endowed with grammatical regularity, regardless of the sensory modality through which they are perceived. In this sense, the literature on language acquisition in children exposed early to sign language suggests that the decisive factor is not sound itself, but the availability of structured linguistic patterns that can be perceived and internalized in a visuospatial modality (Petitto *et al.*, 2001; Emmorey, 2002).

It is within this framework that the seminal studies by Petitto *et al.* (2001) provide important support for the critique of auditory reductionism. In examining hearing and deaf infants exposed early to sign language, the authors describe the phenomenon of *silent babbling*, that is, a set of manual movements that do not appear as random gestures, but instead display rhythmic, temporal, and “syllabic” characteristics functionally comparable to those of vocal babbling. As the authors observe, the discovery of *silent babbling* suggests that infants are sensitive to the rhythmic patterns of language and that this sensitivity plays a decisive role in triggering the process of language acquisition. The evidence thus supports the hypothesis that language development rests on sensitivity to structured patterns rather than on exclusive dependence on the auditory channel.

For education, this finding has decisive implications. The window of opportunity for language

development is not tied to hearing itself, but to early access to a natural language with a complete grammatical structure; in contexts of deafness, this means a sign language (Petitto *et al.*, 2001; Quadros, 1997). In other words, the central problem does not lie in deafness as an organic condition, but in the forms of restriction or delay in access to language. When such access is blocked or postponed, the result is not merely an immediate communicative difficulty, but also a restriction of the conditions for symbolization, learning, and school participation (Quadros, 1997). The gap between what the neurobiological literature recognizes as linguistic potential and what schools actually provide thus remains one of the critical issues in deaf education.

2.1 Intermodal plasticity and the reconfiguration of visuospatial experience

The discussion of intermodal plasticity requires conceptual caution. It is not a matter of assuming a simple biological compensation for the absence of hearing, nor of asserting a homogeneous and universal reorganization of the brain in all deaf individuals. What the neuroscientific literature suggests is that, in contexts of auditory deprivation and sustained visuospatial experience, certain neural networks may undergo functional reorganization, becoming more responsive to visual, spatial, and linguistic demands (Neville; Bavelier, 2000; Emmorey, 2015). More than a model of substitution between modalities, what is at stake is a dynamic of functional reconfiguration that is sensitive to developmental conditions and to the quality of access to language.

When auditory input is absent or significantly reduced, many studies describe a functional reorganization in which areas traditionally associated with auditory processing may be recruited for visuospatial demands, within a framework of intermodal plasticity (Neville; Bavelier, 2000). It is in this context that the concept of intermodal plasticity is employed: not as a simple functional substitution of one modality for another, but as a reorganization of networks and couplings among neural systems that come to operate under new conditions of input and task demand.

It is important, from the outset, to avoid a deficit-based interpretation of this process. Intermodal plasticity should not be understood as the correction of a deficiency, since such a framing tends to reinstate the pathologizing paradigm that critiques of phonocentrism seek to overcome (Neville; Bavelier, 2000; Emmorey, 2015). More precisely, what we suggest is that the absence of one sensory channel may foster alternative functional specializations, that is, distinct modes of organization and efficiency in tasks involving attention, spatial orientation, and environmental monitoring. The decisive issue, therefore, is not to functionally replace the auditory channel, but to understand how certain visuospatial capacities become central to cognitive and linguistic life in subjects whose experience is structured visually.

Across the studies examined in the field of cognitive neuroscience, there is significant convergence around the hypothesis of intermodal neuroplasticity. Neville and Bavelier (2000) describe this dynamic by noting that deaf individuals may show enhanced visual processing,

especially in the periphery of the visual field, and suggest that, under certain conditions, auditory areas may be recruited for visual and spatial processing within a framework of intermodal plasticity. In the authors' words, "deaf individuals show an enhancement in the processing of visual information at the periphery [...] suggesting that the auditory cortex, in the absence of auditory input, can be recruited for visual and spatial processing, reflecting a specific intermodal plasticity" (Neville & Bavelier, 2000, p. 89).

Although Neville and Bavelier's (2000) studies on plasticity were pioneering, contemporary neurobiology of language indicates that the cortical organization of Deaf individuals is not merely a form of sensory compensation, but rather a deeper functional specialization. As Emmorey (2015, p. 476) points out, in signers, "the processing of visual phonology is associated with the posterior Superior Temporal Sulcus (STS)". Neuroimaging reviews have reinforced this picture by describing the involvement of posterior temporal and inferior frontal circuits in the comprehension and production of sign language, indicating that the visuospatial modality recruits specialized linguistic networks rather than a merely gestural or compensatory system (MacSweeney *et al.*, 2008).

In addition to reception, the neuroanatomical organization of linguistic production in Libras, as indicated by the studies examined here, reaffirms the preservation of language centers. The evidence that "sign production recruits the left inferior frontal gyrus (IFG)" (Emmorey, 2015, p. 477) supports the claim that the brain relies on the same executive areas for lexical retrieval, regardless of whether the language is spoken or signed. The linguistic architecture therefore suggests a central amodality², in which supporting circuits extend into the parietal and posterior temporal cortex in order to manage the visuospatial nature of language, while preserving the predominant recruitment of classical language networks in the left hemisphere.

A methodological caveat is nevertheless necessary in order to preserve the rigor of the argument: gains in peripheral attention and visual monitoring do not justify the inference of a generalized "visual superiority", since intermodal plasticity depends on multiple factors, including duration of exposure to natural language, conditions of schooling, effective use of sign language, and individual heterogeneity (Neville; Bavelier, 2000). The argument advanced here does not consist in attributing a visual essence to the deaf subject, but rather in recognizing the central role that visuospatial strategies may assume under certain developmental and educational conditions.

In this sense, it is more precise to speak of a functional reorganization oriented toward visuality and of a refinement of visuospatial attentional strategies. Functionally, this means that attention may operate in a more distributed manner and become more sensitive to peripheral cues, a characteristic particularly relevant in signing contexts, where linguistic and pragmatic information is presented simultaneously across multiple channels (Neville; Bavelier, 2000; Emmorey, 2002),

² The concept of amodality in the neurobiology of language postulates that the brain possesses neural systems dedicated to processing grammatical and lexical rules that operate independently of the sensory modality of input. Thus, the networks of the left hemisphere are activated by the structure of the language (whether Libras or Portuguese), and not by the motor or sensory properties of production.

such as the hands, the face, the torso, gaze direction, and the use of space.

In dialogue with these findings, and not as a mechanical deduction from them, the pedagogical implication goes beyond the mere use of images and points instead to the need to conceive of the classroom as a visual ecology, in which visibility, spatiality, and the circulation of sign language become structural conditions of intelligibility and participation (Skliar, 2005; Quadros, 1997). This means that the school must attend to spatial layout, lighting, contrast, the rhythm of alternation between presenter and students, the reduction of competing visual clutter, and the simultaneous organization of information as structuring didactic variables. In other words, it is not enough simply to incorporate visual resources; the pedagogical experience must be designed so that visuality functions as a condition of intelligibility rather than as mere ornament.

To illustrate, in a classroom activity involving the reading and discussion of a short story in Libras, the teacher may assign character referents to fixed points in the signing space, for example, character A on the left and character B on the right. When revisiting a plot point or a line of dialogue, the teacher points to the corresponding location, creating a spatial anchor that reduces the load on working memory and allows students to follow the narrative structure visually. Similarly, in a science lesson on the food chain, elements may be arranged from left to right in the frontal plane, sun, plant, herbivore, carnivore, and the relations among them may be signaled through directional movement between points, making the conceptual organization directly manipulable within the shared space.

These examples show that, in the context of bilingual education, visuality is not merely a support resource, but may function as an organizing principle of pedagogical work itself. It is precisely at this point that the discussion of intermodal plasticity acquires broader educational relevance. Moreover, intermodal plasticity allows us to reinterpret the status of sign language within the educational process. When the school environment insists on exclusively oral methodologies, it not only disregards a complete natural language; it imposes a communicative architecture that may be ill-suited to the student's predominant forms of linguistic and perceptual organization. From this perspective, the case for bilingual education derives not only from cultural or legal arguments, but also from convergent neurocognitive evidence, although the interpretation of that evidence still requires theoretical mediation at the educational level (Neville; Bavelier, 2000; Emmorey, 2015; Skliar, 2005).

The educational implications of this discussion are significant, but they must be formulated with caution. If visuospatial experience occupies a central place in the linguistic and perceptual development of many deaf individuals, then schools can no longer remain organized exclusively according to auditory and linear parameters. The most immediate consequence is the need to conceive of pedagogical contexts in which visibility, spatiality, and the circulation of sign language cease to be ancillary elements and instead become integral to the very structure of teaching (Skliar, 2005; Quadros, 1997). This implies recognizing that pedagogical intelligibility, for deaf students, depends not only on the content being presented, but also on the material and

interactional conditions through which that content becomes visually accessible. From this perspective, classroom organization, the management of instructional time, and mediation in Libras cease to be supplementary resources and become central dimensions of the learning experience itself.

2.2 The phenomenology of flesh and the signing body

Based on the findings of the literature examined, the transition from neurobiology to lived experience requires a shift in theoretical register: whereas neuroscience describes mechanisms and functional reorganizations, phenomenology asks how the subject inhabits the world and constitutes meaning through the body. It is at this point that the work of Maurice Merleau-Ponty (1999) offers a decisive philosophical framework for understanding Deaf experience beyond the deficit/compensation dichotomy. The aim here is not to “psychologize” deafness, but to make explicit that all language is rooted in a situated corporeality and that, in the case of the Deaf subject, visibility and gesture are not mere accessories of communication, but structuring dimensions of presence and intelligibility.

In line with the philosophical studies examined, Merleau-Ponty subverts mind-body dualism by rejecting the idea that the body is a mere object or instrument used by a separate consciousness. In his classic formulation, “the body is the vehicle of being in the world, and to have a body is, for a living being, to be united with a defined environment, to merge with certain projects, and to engage continuously in them” (Merleau-Ponty, 1999, p. 122). This thesis has direct consequences for education: learning is not merely a matter of processing information, but of engaging in a perceptual and practical field in which meaning and action are constituted simultaneously. Within this horizon, language does not hover above the body; it emerges from a way of perceiving, orienting oneself, and interacting.

For the Deaf subject, this “defined environment” is, in a privileged sense, the three-dimensional visuospatial field. It is important, however, to avoid a simplistic reading that reduces Deaf experience to a kind of “natural visualism”. Visibility and gesture do not function as communicative accessories, but as constitutive conditions of the Deaf subject’s presence and intelligibility, in line with Merleau-Ponty’s (1999) phenomenology of the body and with the understanding of sign language as a full-fledged language endowed with its own grammar (Emmorey, 2002; Perlin, 2003).

It is here that Merleau-Ponty’s concept of *flesh* becomes philosophically fruitful. “This is why we say that in perception the thing is given to us ‘in person’ or ‘in flesh and blood’” (Merleau-Ponty, 1999, p. 428). *Flesh* is neither raw matter nor an isolated physiological body, but the relational fabric in which subject and world are intertwined: seeing and being seen, touching and being touched, expressing and being affected are dimensions of one and the same experience.

Applied to sign language, this means that signification is not reducible to a “mental content” formed in advance and only later “translated” into gesture; rather, it is constituted in the body’s own expressive dynamics, in the rhythm of movement, the direction of the gaze, the orientation of the torso, and the spatial configuration of referents. In phenomenological terms, language takes place as meaningful gesture within a shared world.

At this point, a conceptual clarification is needed in order to strengthen the rigor of the argument: to claim, without qualification, that gesture constitutes a form of expressive realization of thought may seem too strong a thesis and may invite intellectualist objections. Thought cannot be reduced to movement, but “is traversed by a movement toward the world itself” (Merleau-Ponty, 1999, p. 438). What must be maintained, with Merleau-Ponty, is something more precise: gesture is not a mere shell of thought, but a form of thought in action, a mode of intelligibility realized in embodied expression. In other words, there is continuity between perceiving, signifying, and acting; language is not posterior to the body, but one of its most elaborate ways of inhabiting and organizing the world.

This perspective has direct implications for understanding what occurs in the bilingual classroom. Phonocentric pedagogy tends to conceive of language as a linear sequence of sound units and learning as the auditory reception of information. From a phenomenological perspective, however, learning is a situated event, dependent on conditions of visibility, spatial orientation, and intersubjective reciprocity. For Deaf students, the intelligibility of an utterance often involves the simultaneous coordination of hands, facial expressions, gaze direction, body, and signing space, which reinforces the need for adequate visual conditions for teaching and pedagogical interaction (Emmorey, 2002; Merleau-Ponty, 1999; Skliar, 2005). Teaching, therefore, is not merely a matter of “transmitting content”, but of creating a field of presence within which the body can signify.

Phenomenology also helps us understand why the recognition of sign language is simultaneously a recognition of subjectivity. When schools prohibit Libras or reduce it to an auxiliary resource, they do not merely restrict a communicative technique; they affect the way in which the subject presents and constitutes themselves in the public sphere. Sign language is, in this sense, a way of appearing, of inhabiting the world, and of being recognized within it (Perlin, 2003; Merleau-Ponty, 1999). An ethical dimension that will be developed later is already foreshadowed here: the pedagogical relationship is never neutral, since it always involves ways of seeing and welcoming the other, that is, ways of recognizing (or disavowing) a singular form of presence.

If intermodal plasticity describes possible reorganizations and phenomenology elucidates language as meaningful gesture and lived world, then Deaf identity may be understood as a historical and relational construction mediated by language, visibility, and community belonging (Perlin, 2003; Skliar, 2005). In this sense, the process of subject formation for the Deaf subject does not occur in isolation, but within practices of coexistence, recognition, and linguistic sharing. The next step, therefore, is to examine how otherness and recognition, especially in encounters with peers and with Deaf culture, operate as conditions for the constitution of “being Deaf” beyond

narratives of lack.

2.3 Being and Becoming: Identity, Otherness, and Visuality

At the intersection of the plasticity described by neuroscience and the lived experience elucidated by phenomenology, a decisive issue for education emerges: Deaf identity cannot be reduced to a clinical marker (“not hearing”), nor can it be understood as an automatic effect of a biological condition. Rather, it is a historical, relational, and linguistic construction traversed by practices of recognition and regimes of visibility (Perlin, 2003; Skliar, 2005). In other words, deafness is not reducible to the absence of hearing; it may be understood as a way of being-in-the-world in which visuality, sign language, and community belonging operate as conditions of subject formation.

This distinction is crucial for avoiding two recurring risks in educational discourse: first, the risk of simplistic biologization, which derives identity directly from neural plasticity; and second, the risk of ungrounded sociologization, which treats language merely as a cultural symbol without considering its constitutive role in cognitive development and perceptual experience. The argument advanced in this article is that Deaf identity is formed precisely through the intertwining of these dimensions: sign language functions simultaneously as a cognitive environment, a bodily practice, and a matrix of recognition (Perlin, 2003; Skliar, 2005; Emmorey, 2002).

In this context, Perlin’s (2003) contributions provide an important framework for understanding Deaf identity as an ongoing process mediated by otherness and visuality. In discussing the constitution of the Deaf “self”, Perlin emphasizes that identity is not a fixed or given datum, but a construction that is continually reorganized through experience and through encounters with other Deaf subjects. She argues that Deaf identity is constituted by a subject who perceives themselves through visual experience, such that “being Deaf” (Perlin, 2003, p. 23) takes shape through contact with others who share the same linguistic difference. The strength of this formulation lies in shifting identity away from the axis of lack and toward the axis of shared experience: it is not a matter of “accepting a limitation”, but of recognizing a linguistic and cultural positivity actualized in social interaction.

In this case, otherness is not merely a social backdrop; it is a constitutive condition. The “other Deaf person” functions as a mirror and as a horizon of intelligibility: it is in encounters with peers that linguistic repertoires, signing styles, narratives of belonging, and ways of naming one’s own experience are stabilized (Perlin, 2003; Quadros, 1997). This has direct consequences for schooling: when educational institutions organize the Deaf student’s trajectory in linguistic isolation, without systematic access to Libras, without meaningful interaction with peers, and without the presence of Deaf adults or an effective linguistic community, they do more than hinder learning; they impoverish the very conditions of identity formation and recognition.

It is at this point that the educational debate becomes most incisive. Hearing-centered

policies and practices often define inclusion as the integration of the Deaf student into the communicative norm of the majority, insisting on methods that prioritize oral language and lip-reading as the central means of participation. The problem is that such a model tends to produce formal inclusion alongside experiential exclusion: the student is present, but not fully recognized; participates, but under asymmetrical conditions of intelligibility. If identity is linguistic and visual, the school cannot demand that the subject “translate” their existence into a norm that undermines them. Rather, it must reorganize the environment so that difference can function as a legitimate condition of learning and coexistence (Skliar, 2005; Perlin, 2003).

In this sense, bilingualism should not be understood as the mere provision of “two languages” in additive form, but as the guarantee of an effective first language (Libras) capable of structuring symbolic experience and supporting subsequent access to the written form of the majority language. The literature on linguistic deprivation and cognitive development consistently indicates that the decisive issue is not simply to “expose” the student to codes, but to ensure that they have access to a complete linguistic medium through which memory, attention, categorization, and discursive participation can be organized. In the case of the Deaf subject, Libras is not a supplementary pedagogical resource; it is the medium through which the subject can constitute themselves discursively and thereby expand their cultural and academic repertoire (Quadros, 1997; Perlin, 2003).

This thesis ultimately connects to the ethical-political axis running throughout the article. If Deaf identity is constituted through visibility and through encounters with others, then the school cannot remain neutral: it functions either as a mechanism of recognition or as a mechanism of disavowal. Access to sign language, the presence of peers, and the valuing of Deaf culture are not merely “teaching strategies”; they are institutional conditions that define who may appear as a full subject within the school setting. Here, the “biological nature” discussed at the outset does not function as determinism, but as a condition of possibility: it lends empirical and conceptual support to the argument that denying Libras and community experience is to restrict the very conditions of the subject’s development and recognition (Perlin, 2003; Skliar, 2005; Quadros, 1997).

3. Spatial cognition and the extended mind: the body as an interface of thought

Building on the phenomenological understanding of the signing body, this section examines a more specific problem: how signing space functions as an external support for memory, reference, and reasoning. Within contemporary philosophy of mind, the extended mind hypothesis, formulated by Clark and Chalmers (1998) and further developed by Clark (2008), provides a useful framework for understanding Libras as a form of visuospatial cognitive coupling. It should be emphasized, however, that the extended mind hypothesis does not constitute neuroscientific evidence in the strict sense, but rather a heuristic philosophical model whose value lies in offering a conceptual lens

through which empirical evidence may be reinterpreted, rather than replaced. Understood here in this analytical sense, and not as experimental proof in the strict sense, the hypothesis helps illuminate how the spatiality of Libras externalizes and stabilizes cognitive operations. From this perspective, the externalization of operations through gesture and space reduces the load on working memory, stabilizes relations, and renders complex linguistic structures manipulable (Clark, 2008; Emmorey, 2002).

In dialogue with Deaf experience, this hypothesis allows us to understand Libras as an embodied linguistic technology that, beyond its immediate communicative function, extends the mind into signing space, making gesture a constitutive dimension of reasoning and conceptual organization. In the case of the Deaf subject, the three-dimensional space around the body ceases to be a mere physical setting and begins to function as an active grammatical space. The hands, gaze, torso orientation, and facial microexpressions operate as interfaces within a processing system that externalizes relations, reference, and logical operations (Emmorey, 2002; Clark, 2008).

When a signer uses space to establish anaphoric referents, for example, by positioning two characters at distinct points in signing space in order to organize a dialogue, they create an external cognitive support that stabilizes relations and alleviates the burden on working memory, thereby facilitating mental computation and discursive continuity. This spatial manipulation may be interpreted, in analytical terms, as a particularly fruitful expression of the extended mind hypothesis: physical space becomes integrated into linguistic-cognitive functioning (Emmorey, 2002; Clark, 2008), becoming part of the syntax of thought and paving the way for the subsequent discussion of the neural specialization of grammatical space and the simultaneity characteristic of sign languages.

3.1 The neural specialization of grammatical space and simultaneity

The extended cognitive system described in the previous section is not merely a philosophical metaphor; it is supported by neuroscientific and neuropsycholinguistic evidence that challenges the idea that language is intrinsically auditory. In the field of sign language neuroscience, Emmorey (2002; 2015) shows that the lateralization and recruitment of classical language networks remain intact even when language is realized in a visuospatial modality. Thus, what defines the linguistic character of a language is not the sensory channel through which it is processed, but its capacity to organize form and meaning through grammatical principles. With regard to production, neuroimaging studies have likewise demonstrated convergences between sign language production and spoken language production, including the recruitment of inferior frontal and temporal regions associated with linguistic planning and lexical retrieval (Emmorey; Mehta; Grabowski, 2007).

In this vein, Emmorey (2002) argues that the left hemisphere, traditionally associated with linguistic processing, may function as the neural basis of language regardless of whether language is spoken or signed, while also highlighting a decisive difference: the use of space as a grammatical component. As she summarizes:

The left hemisphere is specialized for language, regardless of whether that language is spoken or signed [...] sign language uses grammatical space to encode linguistic relations in a way that spoken languages cannot (Emmorey, 2002, p. 280).

This formulation allows us to refine the often oversimplified opposition between linearity and simultaneity. It is correct to say that speech is organized predominantly in a temporal-sequential manner, with one segment following another, but this does not mean that spoken languages are cognitively “linear” in any strict sense: they also rely on pragmatic, prosodic, and contextual overlap. The point, however, is that sign languages possess a particularly powerful structural resource: the ability to encode multiple relations within the same utterance through space, integrating manual and non-manual parameters in a combinatorial and simultaneous fashion. What is at stake, then, is a rescaling of grammatical architecture: spatiality does not appear as an external support, but as a formal element that participates directly in the construction of meaning.

This is why Emmorey (2002, p. 61) insists that “unlike spoken languages, verbal morphology in sign languages is inherently topographical, using movement between specific points in the signing space to encode agent-object relations”. The location of referents and the direction of movement do not function merely as expressive strategies; they encode syntactic-semantic relations, anaphoric relations, and thematic roles, allowing the utterance to be organized into a manipulable visuospatial matrix. From a cognitive perspective, this spatial anchoring has important implications for working memory and for the organization of reasoning. By distributing referents in space and preserving their positions as “grammatical addresses”, the signer creates an external support that stabilizes relations and reduces the need to maintain dependencies solely in an internal and transitory format. In pedagogical terms, this means that the student can follow and produce argumentative sequences with the aid of a visible structure: in signing, they do not merely “express” a pre-formed thought, but construct and sustain the architecture of the argument within a shared space, thereby enhancing clarity, anaphoric tracking, and control over discursive coherence.

This feature requires high-level visuospatial cognition and a form of organization that operates less through a single sequence than through a networked articulation in which different linguistic parameters combine and synchronize. A single signed morpheme may simultaneously integrate information about subject, action, manner of action, and object, mobilizing parameters such as handshape, place of articulation, movement direction, and non-manual markers. The result is a linguistic system that demands distributed attention, visual monitoring, and the capacity to integrate multiple layers of meaning in real time (Emmorey, 2002; MacSweeney *et al.*, 2008).

It is worth underscoring here the connection to the extended mind hypothesis: by treating space as a formal component of grammar, sign language shows how the immediate environment, namely, signing space itself, may become integrated into linguistic processing. In this sense, the simultaneity characteristic of sign languages is not merely an expressive feature, but a form of linguistic-cognitive organization in which the immediate environment participates in the construction and maintenance of the utterance (Emmorey, 2002; Clark; Chalmers, 1998). This discussion sets

the stage for the following section, in which linguistic deprivation will be examined as a disruption of these very conditions of coupling and development.

3.2 Linguistic deprivation as a structural constraint on development

The gravity of denying sign language in childhood becomes even more evident when the extended mind hypothesis is brought into dialogue with studies on language acquisition in contexts of deafness. If, as Clark (2008) proposes, human cognition expands through couplings with external supports, and if language is one of the primary devices through which this expansion takes place, then early access to a natural language is not a mere pedagogical detail, but a structuring condition for the development of symbolic operations, categorization, and complex forms of thought. From this perspective, the central problem is not deafness itself, but linguistic deprivation: the absence of, or significant delay in access to, a full language during critical periods of development. In the international literature, this problem has been described as particularly severe when educational policies or practices delay a Deaf child's access to a fully accessible language, thereby producing cumulative effects on linguistic development, schooling, and social participation (Humphries *et al.*, 2012).

Quadros's (1997) studies on language acquisition also provide an important basis for addressing this issue within the Brazilian educational context. In discussing the effects of delayed exposure to sign language, the author warns:

Considering the psychosocial aspect, a deaf child will integrate satisfactorily into the hearing community only if they have a sufficiently strong identification with their group; otherwise, they will face difficulties in both communities, exhibiting social and linguistic limitations that are sometimes irreversible (Quadros, 1997, p. 28).

The literature on language acquisition in contexts of deafness has consistently indicated that the principal risk to the development of the Deaf child does not stem from deafness itself, but from delayed or restricted access to a natural language, with consequences for symbolization, linguistic working memory, and discursive participation (Quadros, 1997; Petitto *et al.*, 2001). The force of this claim lies in shifting the debate away from hearing loss and toward the status of language as a developmental environment: the issue is not the absence of sound, but the failure to provide a linguistic structure capable of organizing experience, memory, and discursive participation.

To avoid biologizing simplifications, it is important to clarify what it means to say that development is "compromised". The point is not to assume an irreversible neurodevelopmental determinism, but to recognize that language, as a social practice and symbolic system, plays an organizing role in networks of attention, working memory, executive control, and conceptual construction. When a child lacks a natural language through which to structure experience, opportunities to stabilize categories, narrate events, form generalizations, and operate with

hypotheses tend to be restricted, capacities that are crucial to schooling and metalinguistic reflection (Quadros, 1997). Linguistic deprivation, therefore, is not merely communicative: it limits access to the cultural and cognitive tools through which the mind expands and regulates itself. In a more recent formulation, Hall, Levin, and Anderson (2017) argue that prolonged linguistic deprivation may produce profound neurodevelopmental and sociocultural effects, thereby reinforcing the need for early access to a fully accessible natural language. From a philosophical perspective, the extended mind hypothesis helps explain why denying a deaf child access to sign language does not merely mean denying a means of communication, but also restricting a cognitive mechanism for the externalization and stabilization of abstract relations (Clark, 2008).

Put differently, without effective access to Libras, the Deaf subject may face restricted possibilities, especially in prolonged contexts of linguistic deprivation, for more complex forms of symbolic systematization and discursive participation, with detrimental effects on the development of metalinguistic and metacognitive operations that depend on a structured language. It is important to stress that this is not a matter of developmental determinism, but rather of recognizing that the absence of a natural language during critical periods tends to constrain fundamental conditions of symbolization and cognitive regulation. This does not mean that there is no thought without language, but rather that certain forms of thought, such as hypothetical-deductive, argumentative, and reflective thinking, require symbolic tools that expand and reorganize cognition. From this perspective, bilingual education does not function as a late intervention that simply adds a new skill; it provides the necessary support for language to operate as a driver of development and as an interface for access to the curriculum.

In this sense, the defense of bilingualism takes on a dual status: it is simultaneously a linguistic claim and a condition for cognitive development. This argument is supported by studies linking delayed access to sign language to cumulative disadvantages in the educational and communicative trajectories of Deaf children (Humphries *et al.*, 2012). Thus, by offering Libras as a language of instruction and interaction from an early age, the school not only ensures communication, but also creates an environment in which the student can construct concepts, monitor their own thinking, organize narratives, compare perspectives, and stabilize referential relations, operations that, within the extended mind framework, depend on external supports and shared practices. This discussion sets the stage for the following section, in which the critique of normalization and the “pedagogy of difference” will be revisited in light of what has been established here: sign language is not an auxiliary resource, but a constitutive condition of cognition, identity, and schooling (Skliar, 2005; Perlin, 2003; Quadros, 1997).

3.3 From Modern Discourse to the Pedagogy of Difference

In light of the foregoing discussion on plasticity, embodied cognition, and the extended mind, it becomes possible to critically reinterpret the persistence of pedagogical models oriented toward

normalization. If visuospatial language constitutes a full environment for acquisition, abstract thought, and conceptual organization, then approaches that subordinate the education of Deaf students to an ideal of orality cease to be merely “methodological choices”; they begin to function as mechanisms that restrict conditions of intelligibility, participation, and development. The critique of oralism advanced here is not reducible to a methodological dispute, but points instead to a regime of normalization that subordinates Deaf experience to the hearing paradigm and marginalizes sign language as a language of instruction (Skliar, 2005; Lulkin, 2005). The decisive point, therefore, is not to oppose “orality” and “signing” as if they were simply cultural preferences, but to examine how particular educational regimes define what counts as legitimate language and which forms of subjectivity may emerge within the pedagogical space.

This diagnosis sheds light on historical practices of controlling the Deaf body which, under the pretext of “inclusion” or “rehabilitation”, have produced the marginalization of sign language. The prohibition of the hands, or their reduction to a mere auxiliary resource, may be understood as a form of bodily governance in which the school regulates gesture, expressiveness, and modes of interaction in order to approximate them to the hearing norm. When bilingualism is implemented merely as a transposition from Portuguese into Libras, there is a risk of leaving the phonocentric architecture of teaching intact, to the detriment of forms of intelligibility more compatible with Deaf linguistic experience (Skliar, 2005; Quadros, 1997). From the standpoint of the extended mind hypothesis, such control affects not only communication; it also acts upon the very supports through which thought expands and stabilizes, transforming what should function as a cognitive interface into an object of discipline.

In this light, the “pedagogy of difference” cannot be presented as an ornamental proposal or as a mere adaptation of teaching materials. It must be understood as a reorganization of the school environment grounded in a stronger principle: sign language must occupy the status of a language of instruction, rather than the peripheral role of “translation” for a curriculum originally designed for hearing students. The consequence is that visuospatial experience, instead of structuring knowledge, remains subordinated to a pedagogical rationality that is fundamentally auditory and linear.

A visual pedagogy, in the strict sense of the term, entails conceiving knowledge in forms compatible with the visuospatial grammar and cognitive economy of the Deaf student (Skliar, 2005; Perlin, 2003): concept maps, spatial diagrams, the three-dimensional organization of relations, visual resources with an argumentative rather than merely illustrative function, and signing practices that allow concepts to be constructed directly in Libras. In this scenario, the Deaf student does not learn “despite” not hearing, nor do they learn “because they are visual” as though visuality were a naturalized essence; rather, they learn insofar as they are provided with the linguistic and environmental conditions necessary to mobilize operations of categorization, inference, comparison, and argumentation within a framework of intelligibility that recognizes their language as a matrix of thought.

It is also important to emphasize that this reorientation has immediate ethical and political consequences. If the school insists on models that privilege orality as a normative ideal, it does more than hinder learning: it establishes a hierarchy of ways of life in which Deaf presence appears as insufficient and in need of “correction”. By contrast, embracing the pedagogy of difference means recognizing that Deaf otherness is not an obstacle to be removed, but an organizing principle of a more just pedagogical practice, a practice that responds to the student as a subject of language rather than as a body to be normalized.

4 The pedagogy of difference and the ethics of otherness: beyond normalization

The convergence between intermodal brain plasticity and the extended mind hypothesis demands more than a change in teaching strategies; it requires a normative reconfiguration of how schools conceive language, cognition, and recognition. If, as argued above, visuospatial experience may constitute a central organizing axis of linguistic and cognitive development in Deaf individuals, then education cannot treat sign language as an auxiliary resource or as a mere means of access to a curriculum designed according to hearing parameters. From an ethical perspective, deaf education requires recognizing that the pedagogical relationship cannot reduce the other to a pre-existing norm, but must respond to their linguistic and visual otherness as a legitimate condition of presence and learning (Lévinas, 2004; Skliar, 2005). The problem thus shifts from the technical to the ethical-political plane: what is at stake are the conditions that the institution secures for the student to emerge as a subject of language and thought.

In this context, it is necessary to refine the language of the argument so as to avoid biologizing interpretations: to say that the Deaf brain may organize itself in a manner more responsive to visuospatial demands must be understood as a reference to possible functional specializations and to spatially oriented attentional and linguistic strategies, rather than to any natural essence or perceptual superiority. When school practices insist on auditory normalization as the normative horizon, institutional restrictions are imposed on the conditions of development and participation of the deaf student, thereby transforming difference into a deviation to be corrected rather than a legitimate form of presence (Skliar, 2005; Lulkin, 2005). In educational terms, normalization ceases to be “therapeutic” and begins to operate as a mechanism for delegitimizing a visually mediated way of being-in-the-world.

It is precisely this shift that Skliar (2005, pp. 8–9) articulates when proposing that the focus of education move from a set of binary oppositions centered on “deafness as a problem” to an understanding of “normality as a problem”. For Skliar (2005), modern discourse in deaf education was constructed under a logic of control and correction, in which difference was interpreted as a pathology to be cured. He challenges this paradigm by asserting that “deafness is a visual

experience” (Skliar, 2005, p. 11), rather than a lack of hearing. The flaw, in his view, lies in the gaze that seeks normalization rather than difference, since normality is a political construct that serves to exclude those who do not fit the auditory norm. The critique here is not merely descriptive: it reveals that, by defining a standard of legitimate language, the school simultaneously defines who may be recognized as a full subject within the pedagogical arena.

This shift in perspective resonates with the ethics of Emmanuel Lévinas, for whom the relation with the other is not grounded in knowledge that reduces difference to sameness, but in the responsibility that opens itself before the transcendence of the other’s face. In *Entre Nous*, Lévinas states that “in my philosophical studies, I have spoken at length of the face of the other person as an original locus of meaning” (Lévinas, 2004, p. 193). The face of the other is the place where truth begins, for it confronts us and prevents us from reducing the other to our own world. Applied to education, this means that the Deaf student is not an object to be deciphered through clinical-normative categories, but a face that addresses the educator and demands an ethical response: the recognition of their linguistic and visual otherness, rather than their assimilation to the ideal of auditory normality.

In this sense, the pedagogy of difference does not seek to “integrate” the Deaf student into a curriculum designed for hearing subjects, but to create conditions for visibility and sign language to function as organizing centers of knowledge production. The ethics of otherness manifests itself here in the recognition that the “other” (the Deaf person) is not an incomplete version of the “self” (the hearing person). On the contrary, Deaf otherness destabilizes the purported universality of phonetic logos and places the school before a philosophical and political task: to build an educational space in which different regimes of language and perception are not merely tolerated as exceptions, but recognized as legitimate forms of rationality and life. In this way, the ethics of otherness takes concrete form in the creation of a school environment in which sign language, visibility, and community belonging are recognized as conditions of rationality, learning, and recognition (Lévinas, 2004; Perlin, 2003; Skliar, 2005).

4.1 Being Deaf and becoming Deaf: the construction of identity

The discussion of Deaf identity gains theoretical depth in Perlin’s work (2003), especially in her distinction between “being Deaf” and “becoming Deaf” as categories that move away from fixed and essentialist definitions. In doing so, Perlin shifts identity from a biomedical register to a phenomenological and social perspective: identity is not something with which the individual is simply “born ready-made”, but is historically constituted through relations with other subjects, with sign language, and with modes of belonging that render Deaf experience intelligible. In this context, the school ceases to be merely a place of instruction and begins to function as a mechanism of recognition, or disavowal, of the subject.

Perlin (2003) argues that the constitution of the Deaf “self” depends on mirroring in the Deaf “other” and on full participation in sign language. In her words, “Deaf culture is the place where the Deaf subject constructs their subjectivity in order to ensure survival and maintain their status quo within multiple cultures and multiple identities” (Perlin, 2003, p. 130). This formulation is decisive because it repositions sign language: it is not merely a means of transmission, but a condition for stabilizing narratives of selfhood, belonging, and participation. Identity and language, therefore, are not added later in development; they are co-implicated in the constitution of the subject and in the way the subject inhabits social and educational space.

In this sense, “visual experience” should not be understood as a passive biological faculty, but as a way of inhabiting the world and producing culture. Perlin makes this point explicit when she states that “the experience of being deaf, or visual experience, means more than the use of vision as a means of communication. From this visual experience emerges Deaf culture, represented by sign language” (Perlin, 2003, p. 94). Conceiving visual experience in these terms allows us to critique forms of inclusion based on mere physical presence: when the school fails to offer an environment that is effectively visual, sign-based, and communally meaningful, it not only hinders learning, but also restricts the conditions for the student’s identity formation and recognition (Perlin, 2003; Skliar, 2005).

4.2 The practice of bodily control and the muzzling of expression

A key point in the argument advanced by Skliar (2005) and his collaborators concerns the biopolitical control exercised over the Deaf body. Historically, the use of the hands in education was prohibited, discouraged, or marginalized in favor of oralist practices that sought to subordinate schooling to the ideal of speech. This pedagogical policy may be described as a form of cultural “muzzling”, not only because it restricts a mode of communication, but also because it regulates the body as a site of language, suppressing gesture, expressiveness, and presence. In light of Clark’s (2008) account of the extended mind, the gravity of this control becomes even more pronounced: if human cognition expands through couplings with embodied and environmental supports, and if, in the case of the Deaf subject, sign language is integrated into this system as an embodied cognitive technology, then prohibiting signing does not merely mean denying “a method”; it means restricting one of the primary means through which thought is organized, stabilized, and rendered communicable.

At this point, the discussion acquires a distinctly ethical dimension. For Lévinas, responsibility for the other precedes any social contract, clinical classification, or methodological choice. He argues that to be a subject is to be responsible for the other, for “the proximity of the neighbor is the responsibility of the self toward another” (Lévinas, 2004, p. 238). In the context of the bilingual classroom, this responsibility takes the form of an institutional and pedagogical commitment to guaranteeing Deaf students the effective means for full expression and participation. To deny Libras,

in Lévinasian terms, is to refuse to answer the appeal of the other; that is, to dehumanize the pedagogical relationship by privileging oralist techniques over the concrete conditions of the subject's life, language, and recognition.

Lulkin (2005) sharpens this point by analyzing the discourses of power that permeate the school, showing that this is not an isolated episode, but part of a historical rationality aimed at domesticating difference:

As the wave of Puritanism spread through European societies in the early decades of the nineteenth century, the body of the deaf person, their primary means of communication, was progressively constrained by the strict organization of the school institution, where the use of time and space was conceived with an emphasis on control and physical and moral discipline (Lulkin, 2005, p. 35).

The challenge for contemporary schools, therefore, is to transform spaces of control into spaces of encounter. If the history of deaf education has been marked by the prohibition of gesture, bilingual practice must become the site of its liberation. Ensuring access to sign language is, ultimately, a concrete gesture of responsibility toward the other, one that removes the student from the status of an object of clinical intervention and recognizes them instead as a subject of knowledge and rights.

4.3 Otherness as ethical responsibility

The conclusion of this section requires that teacher and institutional responsibility be reframed in terms that go beyond methodological efficacy. Drawing on Lévinas's (2004) ethics, frequently mobilized within Skliar's (2005) critical framework, deaf education cannot be reduced to a problem of technical adaptation or of managing "special needs". Rather, it must be understood as a relation in which the educator is addressed by the face of the other, that is, by an otherness that must not be absorbed into normalizing classifications. From this perspective, the teacher does not seek to "know" the deaf person in order to adjust them to a norm, but instead adopts a stance of ethical openness that recognizes linguistic difference as a legitimate condition of presence, participation, and learning.

The dialogue between neuroscience and Deaf studies allows us to argue that plasticity and identity are not disconnected dimensions; they are intertwined insofar as cognitive organization and social experience depend on concrete conditions of language, interaction, and recognition (Neville; Bavelier, 2000; Emmorey, 2002; Perlin, 2003; Skliar, 2005). When schools recognize Libras as a full-fledged language and organize the environment around visibility, they do more than improve educational outcomes: they fulfill an ethical obligation not to restrict the conditions under which subjects may exist and learn in their singularity. Thus, ensuring access to sign language, peers, visibility, and belonging is not a "concession", but an institutional response to the appeal of the other, a response that becomes even more urgent when one considers the potential harm caused by

linguistic deprivation and disciplinary control of the body (Hall; Levin; Anderson, 2017; Lulkin, 2005).

In this sense, the ethics of otherness assumes a concrete form: it is realized in the creation of a school environment in which visual difference is not merely tolerated as an exception, but recognized as a legitimate matrix of rationality and knowledge production (Lévinas, 2004; Skliar, 2005; Perlin, 2003). The pedagogy of difference, therefore, emerges as the normative horizon of the argument developed here: if visibility and sign language constitute cognition, identity, and presence, then an ethically responsible education is one that protects and cultivates these conditions rather than subjecting them to the ideal of normalization.

5 Concluding Remarks

The bibliographic and theoretical-interpretive analysis developed in this essay allows us to argue, with consistency, that sign language plays a constitutive role in the cognitive organization and subjective experience of Deaf individuals. The argument developed throughout this article has articulated three fundamental dimensions of Deaf existence, the neurobiological, the cognitive, and the ethical-political, in order to show that deaf education cannot remain anchored in a deficit-based rationality. Rather than reproducing a logic of compensation, the analysis has emphasized the recognition of modes of organization and experience oriented toward the visuospatial, in which sign language functions as a structuring axis of learning and subject formation. Within this horizon, Deafness is not treated as a flaw to be corrected, but as a condition that renders intelligible a form of cognitive organization with a strong visuospatial grounding, as well as a distinctive way of being-in-the-world, with direct consequences for how schools conceive language, participation, and development.

The evidence examined reinforces that sign language should not be reduced to a mere communicative accessory. The discussion of intermodal plasticity indicates that the processing of Libras recruits temporofrontal networks and the posterior Superior Temporal Sulcus (STS), thereby underscoring the amodality of the human language faculty. This neurofunctional organization allows Libras to operate as a constitutive cognitive technology: by using grammatical space to stabilize referents and organize inferential sequences, the signer creates an external support that aids working memory and reasoning. In this context, bilingualism ceases to appear as a merely methodological option and instead emerges as a structuring condition for confronting linguistic deprivation and ensuring that cognitive development is not constrained by institutional barriers.

Within the framework of the extended mind hypothesis, this argument gains further precision by clarifying classical criteria of functional coupling. From an analytical standpoint, Libras, as an embodied visuospatial linguistic practice, may be understood as satisfying such criteria insofar as it functions as an interface of thought: it externalizes relations and supports logical operations in conjunction with the body and the environment, without depending on auditory mediation as a

normative requirement for intelligibility.

Ultimately, the articulation between neurobiology and philosophy culminates in an ethics of otherness that rejects institutional indifference. As Lévinas (2004) argues, subjectivity is inseparable from an inalienable responsibility toward the other. Bilingual education must inhabit the *between-us* as a space of recognition, rejecting the assimilation of the Deaf student to the ideal of auditory normality. Ensuring early access to Libras and the right to interaction with peers is not merely a pedagogical choice; it is an ethical and political commitment to the conditions under which the subject's linguistic, cognitive, and existential capacities may fully flourish.

It follows, therefore, that a consistent bilingual education requires a pedagogy of difference that recognizes Libras as a language of instruction and of thought. By freeing the signing body from the constraints of phonocentrism, the school may reconfigure its own criteria of pedagogical intelligibility, recognizing that development depends on guaranteeing the linguistic and communal conditions necessary for the Deaf subject to learn, belong, and produce knowledge in full.

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