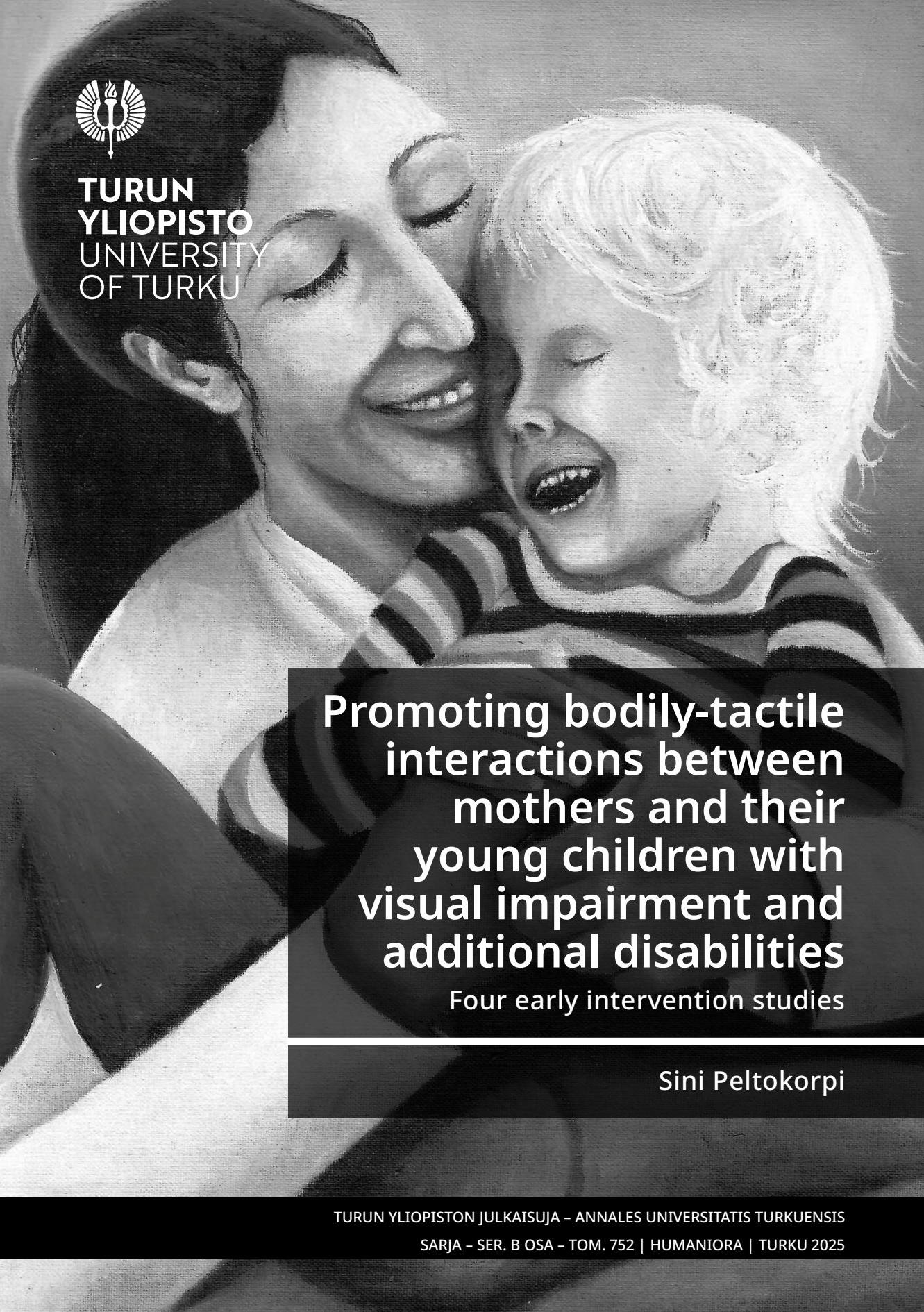

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Promoting bodily-tactile interactions between mothers and their young children with visual impairment and additional disabilities

Four early intervention studies

Sini Peltokorpi

TURUN YLIOPISTON JULKAISUJA – ANNALES UNIVERSITATIS TURKUENSIS
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To my brother Mikko

UNIVERSITY OF TURKU
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ABSTRACT

Children with visual impairment and additional disabilities (VIAD) may fail to perceive visual information from their parents' facial expressions and gestures. In cases of congenital deafblindness (CDB), auditory information may also be limited. The parents of such children may experience challenges in detecting their child's subtle bodily and gestural expressions. Such interactions indicate difficulties with accessibility, which may in turn compromise the child's developmental outcomes and even the emotional relationship between the parent and child. However, the systematic use of bodily-tactile modality (touch and movement) during interactions could help to compensate for the child's sensory loss. This thesis therefore investigates the effects of a bodily-tactile early intervention on the interactions between mothers and their children with VIAD or CDB, using a time-series design with a baseline, intervention, and follow-up; the follow-up spanned Studies II, III, and IV.

In Study I, a mother was guided in the use of a bodily-tactile modality in which she imitated her three-year-old child with CDB. The results show that the mother's tactile imitations increased during the intervention, that imitation exchanges became longer, and that the child began to respond more to her mother's imitations through smiling and placing her hands on her mother's face. Moreover, the child and her mother became more emotionally available to each other.

In Studies II, III, and IV, four mothers were guided in the use of the bodily-tactile modality in interactions with their one-year-old children with VIAD. In Study II, we observed that the mother increased her use of the bodily-tactile modality in early social play routines and in tactile signing during the intervention. Her child developed new gestural expressions and imitated signs based on his bodily-tactile experiences. Their emotional availability was already good at baseline, yet there was still an increase during the intervention in the mother's non-intrusiveness and the child's responsiveness. The results of Study III suggest that the intervention increased reciprocity in the mother-child interactions, which was itself based on changes in the mothers' interactional behavior. In Study IV, the mothers increased their use of bodily-tactile play routines, tactile anticipatory cues, tactile noticing responses, and tactile signs during the intervention. Moreover, the children and mothers were emotionally more available to each other during the intervention.

Together, the results suggest that the bodily-tactile early intervention aimed at the mothers had a positive impact on the embodied participation and gestural communication of their children with VIAD. Positive changes were also seen in the emotional availability and reciprocity between the children and their mothers.

KEYWORDS: Accessibility, bodily-tactile modality, early intervention, emotional availability, congenital deafblindness, multiple disabilities, visual impairment

TURUN YLIOPISTO
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TIIVISTELMÄ

Näkömonivammaisten lasten voi olla vaikea havaita heidän vanhempiensa kasvojen ilmeitä ja eleitä. Mikäli lapsi on syntymästään kuurosokea, hänen on lisäksi hankala vastaanottaa kuulonvaraista tietoa. Myös vanhempien voi olla vaikea tulkita näkömonivammaisten tai kuurosokeiden lastensa hienovaraisia kehollisia ilmaisuja ja eleitä. Ilmausten saavutettavuuteen liittyvät vaikeudet voivat heikentää lasten kehitysmahdollisuuksia ja lasten ja vanhempien välistä tunneviestintää. Kehollis-taktiilisen modaliteetin (kosketuksen ja liikkeen) systemaattinen käyttö vuorovaikutuksessa voi kompensoida näkö- ja kuuloinformaation puutetta. Tämä väitöskirjatutkimus selvittää kehollis-taktiilisen varhaiskuntoutuksen vaikutuksia näkömonivammaisten lasten ja heidän äitiensä väliseen vuorovaikutukseen. Aikasarja-asetelman mukaisesti aineistoa kerättiin ennen varhaiskuntoutusta, kuntoutuksen aikana ja sen jälkeen. Seurantavaihe sisältyi tutkimuksiin II, III ja IV.

Tutkimuksessa I äitiä ohjattiin käyttämään kehollis-taktiilista modaliteettia hänen kolmevuotiaan syntymästään kuurosokean lapsensa ilmausten jäljittelyssä. Ohjauksen aikana äiti alkoi käyttää enemmän kosketusta jäljittelyssä. Äidin ja lapsen väliset jäljittelydialogit pitenivät, ja lapsi alkoi vastata äidilleen enenevässä määrin hymyilemällä ja asettamalla kätensä äidin kasvoille. Lisäksi heidän emotionaalinen saatavillaolonsa vahvistui.

Tutkimuksissa II, III ja IV ohjattiin neljää äitiä käyttämään kehollis-taktiilista modaliteettia vuorovaikutuksessa heidän yksivuotiaiden näkömonivammaisten lastensa kanssa. Tutkimuksessa II havaitsimme, että varhaiskuntoutuksen aikana äiti alkoi käyttää enemmän kehollis-taktiilisia vuorovaikutusleikkejä lapsensa kanssa. Lisäksi äiti otti käyttöön taktiileja viittomia. Hänen lapsensa alkoi tuottaa kehollis-taktiilisten kokemustensa pohjalta uusia eleilmaisuja ja jäljitellä viittomia. Sekä äiti että lapsi olivat emotionaalisesti saatavilla jo lähtötilanteessa. Kuntoutuksen aikana tapahtui vahvistumista äidin ei-tunkeilevuudessa ja lapsen responsiivisuudessa. Tutkimuksen III tulokset viittasivat siihen, että kehollis-taktiilinen varhaiskuntoutus lisäsi vastavuoroisuutta äitien ja heidän näkömonivammaisten lastensa välisessä vuorovaikutuksessa, mikä puolestaan johtui muutoksista äitien vuorovaikutus-käyttäytymisessä. Tutkimuksessa IV havaittiin, että kuntoutuksen aikana äidit lisäsivät kehollis-taktiilisten vuorovaikutusleikkien ja taktiilien viittomien käyttöä. He alkoivat myös ennakoida tapahtumia ja vastata lapsilleen kosketuksen ja liik-

keiden avulla. Lisäksi näkömonivammaisten lasten ja heidän äitiensä välinen emotionaalinen saatavillaolo vahvistui.

Väitöskirjatutkimuksen johtopäätöksenä voidaan todeta, että äideille suunnattu kehollis-taktiilinen varhaiskuntoutus vaikutti myönteisesti näkömonivammaisten lasten kehollisen osallistumiseen ja kommunikointiin eleiden avulla. Positiivisia muutoksia havaittiin myös lasten ja äitien välisessä vastavuoroisuudessa ja emotionaalisessa saatavillaolossa.

ASIASANAT: Saavutettavuus, kehollis-taktiilinen modaliteetti, varhaiskuntoutus, emotionaalinen saatavillaolo, synnynnäinen kuurosokeus, monivammaisuus, näkövamma

Acknowledgements

I became interested in communication using the tactile modality when I studied Finnish Sign Language at Rovala Folk High School in Rovaniemi. During that time, I had the chance to provide assistance to a man with acquired deafblindness during a weekend course. When I observed ongoing interactions, I was overwhelmed by the beauty and fluency of the Finnish Tactile Sign Language and by the fact that complex conversations can be realized through the sense of touch. Later, I wrote my master's thesis in logopedics on interactions between children with CHARGE syndrome and their mothers. That study raised the question of how early interactions between parents and their children with sensory impairments and additional disabilities can be enhanced. My doctoral thesis is an attempt to answer this question.

This study was conducted at the Department of Psychology and Speech-Language Pathology, Faculty of Social Sciences, University of Turku. I warmly thank all the children and their families who participated in the study. You are the heart of this research! The financial support from the Eino Jutikkala Fund of the Finnish Academy of Science and Letters, the Emil Aaltonen Foundation, the Finnish Cultural Foundation, the University of Turku, the Otto A. Malm Foundation, the Pediatric Research Center, the Turku University Foundation, and the TOP Foundation is gratefully acknowledged.

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My deepest gratitude belongs to my Heavenly Father, who gave me everything I needed on this journey. Thank you for your faithfulness. *Proverbs 8:14*

October 2025
Sini Peltokorpi

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List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

I Peltokorpi, S., Daelman, M., Salo, S., & Laakso, M. (2020). Effect of tactile imitation guidance on imitation and emotional availability. A case report of a mother and her child with congenital deafblindness. *Frontiers in Psychology, 11,* Article 540355. doi: 10.3389/fpsyg.2020.540355

II Peltokorpi, S., Salo, S., Nafstad, A., Hart, P., Tuomikoski, E., & Laakso, M. (2023). Bodily-tactile early intervention for a mother and her child with visual impairment and additional disabilities: A case study. *Disability and Rehabilitation, 45*(12), 2057–2072. doi: 10.1080/09638288.2022.2082563

III Peltokorpi, S., Salo, S., Hart, P., Nafstad, A., Kajamies, A., & Laakso, M. (2024). Developing reciprocity between one-year-old children with visual impairment and additional disabilities and their mothers: The effects of bodily-tactile early intervention. *Learning, Culture and Social Interaction, 48*, Article 100849. doi: 10.1016/j.lcsi.2024.100849

IV Peltokorpi, S., Salo, S., Nafstad, A., Hart, P., Biringen, Z., & Laakso, M. (2024). Bodily-tactile early intervention: A pilot study of the role of maternal touch and emotional availability in interactions between three children with visual impairment and additional disabilities and their mothers. *Frontiers in Psychology, 15,* Article 1439605. doi: 10.3389/fpsyg.2024.1439605

1 Introduction

Children with visual impairment (VI) are a heterogeneous population. The majority of them have additional disabilities such as an intellectual disability (ID) or a motor impairment. The type and degree of VI and the combination of additional disabilities vary between children. Children with congenital deafblindness (CDB) form a specific subgroup of children with visual impairment and additional disabilities (VIAD) due to their dual sensory loss and dependence on the sense of touch. Typically, all children with VIAD have difficulties in accessing the visual information connected to their parents' facial expressions, gestures, and actions. Similarly, it may be hard for their parents to read their children's subtle and atypical expressions. These challenges can easily compromise interactional *reciprocity* (Rowland, 1984), which consists of turn-taking and mutual emotional responsiveness (see Stevanovic & Peräkylä, 2015). Further, compromised reciprocity in early interactions may prevent children with VIAD from developing their full potential.

Reciprocity in interactions between children with VIAD and their parents may increase if *the bodily-tactile modality* is used to compensate for the children's lack of vision. Although modality is not a clearly defined term, it typically refers to the communicative modalities of the body such as gestures, gaze, or speech and the senses associated with these communicative modalities (Deppermann & Streeck, 2018). In this regard, the term bodily-tactile modality refers to interaction and communication through touch and movements (Nafstad & Rødbroe, 2015). *Interaction* can be understood as reciprocal action or influence between persons in which the participants exchange behaviors and emotions with each other (Trevarthen, 1980). *Communication* specifies a dynamic and interactive process of shared meaning through verbal and nonverbal signals (Bullowa, 1979).

In this study, children's language development is understood as a process which has its basis in early social interactions (e.g., Bruner, 1975; Trevarthen, 1980). Although the focus of the analysis is on the mothers' bodily-tactile actions and their children's embodied participation, interaction is regarded as a multimodal and integrated system. *Multimodality* is understood as meaning-making (making sense of life events) through different modalities, which often appear together (Jewitt et

al., 2025). However, due to children's VI, their ability to perceive multimodal information in interactions is easily compromised without compensatory strategies. Moreover, for some children with VIAD, the bodily-tactile modality may be a primary resource for meaning-making. This is a challenge because typically there is not a shared cultural sense within the hearing-sighted community of how bodily-tactile resources can realize meaning. A mismatch in parent-child interactions can be avoided if parents are familiarized with the bodily-tactile modality as a resource for meaning-making from the outset (see Bezemer & Jewitt, 2010).

Early intervention provides a great opportunity to support parent-child interactions in families with children with VIAD (see Guralnick, 2011). As parents play a key role in their child's development, it is essential that professionals work in close collaboration with them and involve them in activities that strengthen their existing competencies (e.g., Breemer, 2025; Dunst & Dempsey, 2007). Early intervention is most effective when it is started within the first two years of children's lives (e.g., Bailey et al., 2005; Launonen, 1998). However, currently, systematic support for parent-child interactions in families with children with VIAD may not be available at this age, and it is not self-evident that parents will be closely involved in the interventions. There has also been very limited scientific interest in investigating the effects of early interventions for children with VIAD and their families. Therefore, there is a fundamental need to gain more knowledge about the principles that foster reciprocal interactions between children with VIAD and their parents.

This doctoral study explores the effects of two interventions that utilize the bodily-tactile modality as a resource in interactions between mothers and their children with VIAD. The first intervention, "Tactile imitation guidance," focuses on fostering mother-child interactions through guiding a mother of a child with CDB to add tactility in her (vocal) imitations. The second intervention, "Bodily-tactile early intervention," guides mothers of children with VIAD to utilize the bodily-tactile modality for several purposes, including in the context of interaction and communication. Both interventions aimed to increase accessibility to interactions between children with VIAD and their mothers. By increasing accessibility and guiding the mothers to respond to their children's bodily expressions, the interventions aimed to promote reciprocity in mother-child interactions.

2 Review of the literature

2.1 Children with visual impairment and additional disabilities

More than half (60–70%) of children with VI in Western societies have additional disabilities (Hatton et al., 2013; Sonksen & Dale, 2002). Because these additional disabilities have a major impact on their development, children with isolated VI and children with VIAD should be considered as two separate populations (Rahi & Gilbert, 2013; Sonksen & Dale, 2002). However, even when regarded as a separate population, children with VIAD form a remarkably heterogeneous group considering their abilities and disabilities. For instance, it is common for a child with VIAD to have more than one additional disability and other medical problems such as epilepsy (Rudanko, 2007). In this chapter, VI and the typically associated disabilities are described so as to obtain an understanding of each impairment and their impact on children's development. Lastly, special attention is given to a subgroup of children with CDB to recognize their specific and vulnerable conditions for communication and language development.

2.1.1 Visual impairment

The term "visual impairment" refers to a moderate or severe VI or blindness (World Health Organization [WHO], 2013a). Children who have normal sight in one eye or normal corrected vision are not classified as having VI (Näkövammaisten liitto, n.d.). Currently, the definitions of VI are based on assessments of visual acuity and visual field. A far acuity refers to a person's ability to recognize small details from a long distance. The WHO defines blindness as a presenting visual acuity of worse than 3/60 or a corresponding visual field loss to less than 10° in the better eye. Severe VI is defined as a presenting visual acuity of worse than 6/60 and equal to or better than 3/60. Moderate VI is defined as a presenting visual acuity in the range from worse than 6/18 to 6/60 (WHO, 2013a, p. 7). Alternatively, visual acuity can be expressed as a decimal number. The prevalence of VI in children varies between countries (Rahi & Gilbert, 2013). In a Finnish study, Rudanko (2007) found VI in 556

individuals from a population of 1 138 326 children aged 0–17 years, which gives a prevalence of 49/100 000.

Kran et al. (2019) calls for a re-evaluation of the current criteria used to define VI, as they do not account for cerebral/cortical visual impairment (CVI). CVI can be defined as "a verifiable visual dysfunction, which cannot be attributed to disorders of the anterior visual pathways or any potentially co-occurring ocular impairment" (Sakki et al., 2018). CVI has become the leading cause of pediatric VI in developed countries due to improved neonatal intensive care (Chang & Borchert, 2020; Kran et al., 2019). The most common cause of CVI is perinatal hypoxia-ischemia (İdil et al., 2021). Typically, CVI is associated with other disabilities (Hatton et al., 2013; Huo et al., 1999; Rudanko, 2007) and it also affects most of the children in this study. CVI negatively impacts children's functional vision. Huo et al. (1999) found that 43% of the children with CVI had only light perception, 28% of them could occasionally fixate on large objects, faces, or movement, while only 14% of the children could occasionally fixate on small objects or reliably fixate on faces. However, in most children with CVI, visual acuity improves over time while their functional vision may stay invariable (Chang & Borchert, 2020). Despite the growing knowledge concerning CVI, its diagnostic criteria and assessments are not well-defined (Boster et al., 2021). Moreover, early visual habilitation and communication interventions for children with CVI have received very limited attention (Boster et al., 2021).

VI affects children's development. Children with VI can experience difficulties in pragmatic language skills (use of language in a socially appropriate way; Tadić et al., 2010) and emotion recognition according to vocal qualities (Dyck et al., 2004; Minter et al., 1991). Negative consequences accumulate when children with VI also have additional disabilities. Boulton et al. (2006) found that children with VIAD had a remarkably lower health-rated quality of life and poorer general health than children with VI.

2.1.2 Motor, intellectual, and hearing impairments

Motor impairment. "Motor impairment is the partial or total loss of function of a body part, usually a limb or limbs. This may result in muscle weakness, poor stamina, lack of muscle control, or total paralysis" (International Neuromodulation Society, n.d.). In the study by Rudanko (2007), motor impairments were found in a third (33%) of Finnish children with VI.

Cerebral palsy (CP) is a typical cause of a motor impairment in children with VI (Flanagan et al., 2003; Hatton et al., 2013). "CP describes a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain. The motor disorders of CP are often accompanied by

disturbances of sensation, perception, cognition, communication, and behavior, by epilepsy, and by secondary musculoskeletal problems" (Rosenbaum et al., 2007, p. 9). CP categorization includes information on the affected body parts (Rosenbaum & Rosenbloom, 2012). Hemiplegia describes a condition in which one side of the body is affected and diplegia refers to a functional limitation affecting either the arms or the legs. Quadriplegia (or tetraplegia) refers to a condition in which the legs, hands, pelvis and trunk are affected (Rosenbaum & Rosenbloom, 2012). The CP categorization also includes information concerning motor impairment, which comprises four sub-types: spastic CP, ataxic CP, dyskinetic CP (including dystonic CP and choreo-athetotic CP) and non-classifiable CP (Cans, 2000).

Coleman et al. (2013) found that nearly two thirds of two-year-old children with CP had difficulties in their communication development. Children who had more severe gross motor functional impairment also had lower communication skills. CP often hampers expressions with face and body movements and gestures (Pennington, 2008). CP can also cause deterioration in speech intelligibility, which can vary from mild disorders to an inability to utter recognizable words (Pennington, 2008). These challenges can compromise reciprocity in parent-child interactions and lead to conversations in which children with CP become passive communicators. The passive role may persist later when the children have access to augmentative and alternative communication (AAC; Pennington & McConachie, 2001).

Intellectual disability. ID, also called learning disability, is diagnosed when a person has impairment in cognitive functioning and adaptive skills during his or her developmental period (Harris, 2006). ID has multiple prenatal (e.g., chromosomal and syndrome disorders), perinatal (e.g., neonatal disorders), and postnatal (e.g., infections; Harris, 2006) causes. In a Finnish study, cognitive impairment was found in more than a third (39%) of children with VI (Rudanko, 2007). In persons with CDB, the prevalence of ID has been found to be even higher. Dalby et al. (2019) found cognitive impairment in most people with CDB (87.5%). However, sometimes a developmental delay in a person can be a consequence of CDB instead of ID (Deuce & Rose, 2019). Moreover, challenges in the diagnostic processes of persons with sensory and multiple disabilities may lower the reliability of assessment. First, their cognitive assessment requires special attention from the assessor to apply competent partner strategies, individuality, and time for the person being assessed to show their potential (Tuomi et al., 2021). Without these adjustments, their cognitive assessment may not be valid. Second, the typical assessment protocols may not address tactile cognition, which could demonstrate most of the abilities in persons with CDB (Damen & Ask Larsen, 2014). Tactile cognition refers to "the higher order processing and integration of tactile information through active touch that includes the mental processes of attention and memory" (Nicholas, 2013). Third, family knowledge needs attention in the diagnostic process. Only parents have contextual

everyday knowledge of the cognitive capacities of their children with CDB (Breemer, 2025).

The Tenth Revision of the International Classification of Diseases (ICD-10) divides ID into six different types: mild, moderate, severe, profound, other, and unspecified ID (Terveyden ja hyvinvoinnin laitos, 2011, pp. 272–273). Approximately 85% of people with ID have mild ID. In early childhood, mild ID may not be identifiable and it can be found later, at preschool or school age (Harris, 2006). Typically, children with mild ID can participate in conversations and learn to read, but they have difficulties in more demanding academic performance (Harris, 2006). Moderate ID affects approximately 10% of individuals with ID. Some of these individuals may be able to join simple spoken conversations, while others may express themselves through AAC (Harris, 2006). Around 3%–4% of individuals with ID have severe ID, and 1%–2% are affected by profound ID (Harris, 2006). Almost all individuals with severe or profound ID have other neurodevelopmental, motor, or sensory comorbidities (Rensfeldt Flink et al., 2021). Danker et al. (2023) found that some adults with severe or profound ID did not have any functional communication and some of them communicated through aided AAC (e.g., a communication book), signing, gestures, facial expressions, vocalization, or speech. Limited communication increases dependence on others. Williams et al. (2020) found that 5–18-year-old children with ID who had higher dependency on others had a poorer quality of life. Moreover, higher-level functioning was connected to more frequent participation, which was associated with an increased quality of life. The researchers concluded that a poorer quality of life in children with ID can be partly explained by their less-frequent participation in community activities. These findings indicate that participation is key to enhancing the quality of life in children with ID from the start. The first contexts to support their participation can be early interactions with their parents (see Sameroff & MacKenzie, 2003a; Våpenstad & Bakkenget, 2021).

Hearing impairment. Hearing impairment is caused by damage in any parts of the auditory system, which is responsible for hearing (Zeng & Djalilian, 2010). The damage can be in the outer and/or middle ears (conductive loss), in the inner ear (cochlear loss), in the auditory nerve (neural loss), in the backward-feed pathway (feedback loss) or in the brainstem and cortex (central loss; Zeng & Djalilian, 2010). The prevalence of hearing impairment in children with VI differs in studies. In a Finnish study (Rudanko, 2007), hearing impairment was found in 6% of children with VI, whereas in a British study the prevalence was 13% (Teoh et al., 2021). The etiology of childhood hearing impairment can be congenital or acquired (Liddle, 2022). Congenital etiologies are most common, and they include genetic (e.g., Trisomy 21), structural (e.g., hypoplastic or absent VIII nerve), and prenatal (e.g., cytomegalovirus; Liddle, 2022) factors. Acquired etiologies include perinatal (e.g.,

asphyxia) and postnatal (e.g., meningitis; Liddle, 2022) causes. Approximately a third of children have an unknown etiology of their hearing impairment and almost 40% of them have one or more additional disabilities (Häkli et al., 2014).

The degree of hearing impairment is defined by the better ear hearing level. The severity of the hearing impairment is indicated in decibels (dB), which describe the loudness of sounds for a person to hear them (American Speech-Language-Hearing Association, n.d.). In the revised grading system of the WHO (2021), hearing impairment can be mild (20 to < 35 dB), moderate (35 to < 50 dB), moderately severe (50 to < 65 dB), severe (65 to < 80 dB), profound (80 to < 95 dB), or complete hearing impairment/deafness (95 dB or greater). Most children with hearing impairment and additional disabilities who have mild, moderate, or severe hearing impairment use hearing aids whereas the majority of children with a profound hearing impairment use cochlear implants (Cupples et al., 2018). As hearing is pivotal for language learning in the auditory modality, the degree of hearing impairment influences speech and language development. Cupples et al. (2018) found that milder hearing impairment, higher level of nonverbal cognitive ability and use of oral communication were associated with better language outcomes in children with hearing impairment and additional disabilities.

2.1.3 Congenital deafblindness

Children with CDB form a specific subgroup of children with VIAD due to the combined effect of dual sensory impairment. The dual sensory impairment can affect the social participation of children with CDB to a greater extent than for children with VIAD in general, therefore children with CDB need special attention. The severe hearing and vision impairment of children with CDB is present at birth or before language has been developed (Dammeyer, 2012a). However, many of them have some residual hearing and/or vision. It is also typical that children with CDB have additional motor or cognitive impairments or complex medical conditions. In acquired deafblindness, the dual sensory impairment occurs later in life when the person has developed language (Dammeyer, 2012a). CDB is an uncommon condition. In the study by Dammeyer (2010), the prevalence of CDB in children was 1:19 000. Moreover, CDB has various etiologies, which makes it challenging to link it to a specific cause. Even the most common etiologies, CHARGE syndrome and perinatal asphyxia, do not cause CDB in every child (Dammeyer, 2010). Moreover, several rare syndromes such as Trisomy 13 can cause CDB (Andersen & Rødbroe, 2005).

CDB can be defined in different ways. The Nordic definition of deafblindness is as follows: “Deafblindness is a combined vision and hearing impairment of such severity that it is hard for the impaired senses to compensate for each other. Thus,

deafblindness is a distinct disability. To varying degrees, deafblindness limits activities and restricts full participation in society. It affects social life, communication, access to information, orientation and the ability to move around freely and safely. To help compensate for the combined vision and hearing impairment, especially the tactile sense becomes important" (Nordic Welfare Centre, n.d.). Ask Larsen and Damen (2014) argue that the heterogeneity of CDB definitions makes it difficult to define the population and compare the results of different studies. A diagnosis could facilitate this process, but currently there is no diagnosis code for deafblindness in ICD-10. However, identifying CDB in a child is essential, because identification can give access to appropriate services and interventions for the families. Without the right kind of support and systematic interactions through the bodily-tactile modality, the learning potentials of children with CDB may be missed, and the CDB may result in secondary consequences such as emotional and social disorders and social isolation (Andersen & Rødbroe, 2005). The International Classification of Functioning, Disability, and Health (ICF) framework can help to evaluate the functioning of individuals with CDB (WHO, 2013b). For clinical practice, a smaller set of ICF codes (Core Set) is currently being developed for deafblindness (Jaiswal et al., 2024).

Nordic countries such as Denmark, Norway, and Sweden have established national state-funded resource centers for deafblindness that apply the Nordic definition to identify cases of CDB in need of specialized service (Anderzén-Carlsson, 2017; Dammeyer, 2010). The assessment procedures include medical examinations, functional assessment of vision, hearing and tactile modality, and assessment of the functional use of senses in social interaction and communication (Dammeyer, 2012a). However, there appears to be no similar process for identifying CDB in Finland. Thus, in many cases Finnish families with children with CDB may lack appropriate services and support.

2.2 Early interactions between children with VIAD and their parents

Reciprocal parent-infant interactions are the basis for children's social-emotional and language development. The first signs of reciprocity can be observed in the responsiveness of infants and their parents to each other's visual attention (Brazelton et al., 1974). Later, infants use multimodal resources including gaze, facial expressions, vocalizations, movements, and gestures to engage in reciprocal exchanges with their parents (Paz & Frenkel, 2024). When infants produce their first words at around one year old, verbal communication simply becomes part of their existing interpersonal exchanges (Trevarthen, 1979).

Long periods of hospitalization after birth easily challenge reciprocity between parents and their infants with VIAD. Being separated allows limited time for parent-infant togetherness. It may also complicate the parent-infant emotional relationship. However, only a small amount of scientific information is available on the quality of these interactions. The findings of the few studies conducted indicate compromised reciprocity in interactions (Rogers & Puchalski, 1984; Rowland, 1984). Further, compromised reciprocity in early interactions creates a risk of compromising broader *emotional availability* (EA; Biringen, 2008) later in childhood. To prevent problems arising, attention must be directed to the quality of early interactions. High-quality interactions will provide infants with VIAD access to the same reciprocal processes that advance the development of typically developing infants. For this, parents may need to learn strategies to compensate for their infants' lack of vision and challenges in reciprocity.

2.2.1 Primary and secondary intersubjectivity

Intersubjectivity can be defined as "awareness of self and other's intentions and feelings in the dynamic sharing of minds acting in companionship, exchanging self-conscious intentions and emotional evaluations" (Kokkinaki et al., 2023). Infants are already equipped with readiness, interest, and capacity for social interactions with other persons at birth (Trevarthen, 1979, 1980). During their first months, they engage in face-to-face interactions with their parents through gaze, facial expressions, movements, and vocalizations. Trevarthen (1979, 1980) called this interpersonal activity *primary intersubjectivity.* Dyadic interactions have a structure resembling a conversation (Bateson, 1979; Trevarthen, 1974). That is, parents address their infants as conversational partners and treat their expressions as meaningful actions in conversations (e.g., Filipi, 2009). By acting in this way, the parents create the cultural norms of conversation, which are characterized by turn-taking and sequence organization (Filipi, 2009, p. 23). However, Damen et al. (2015b) found that the intersubjective development of children with sensory disabilities is easily delayed.

Turn-taking is the basic structure for conversation (Sacks et al., 1974). Thus, acquiring turn-taking skills through nonverbal and vocal actions is a major accomplishment of children in learning to communicate (Papoušek, 1995). Turn-taking involves temporally organized turns, responsiveness to a partner's prior expression, and avoidance of long periods of silence and overlap (Filipi, 2009, p. 24). However, simultaneous actions are typical in parent-infant interactions, and infants gradually learn to time their turn-taking appropriately (Harder et al., 2015).

A child's VI easily compromises turn-taking in early interactions. That is, due to lack of gaze, parents and their children with VIAD may not know when their

expressions are being directed at each other (cf. D'Odorico & Cassibba, 1995). Moreover, children with VIAD often need a notably longer time to respond to their parents than typically developing infants. This can alter turn-taking patterns and complicate the interpretation of their expressions (Johnson & Parker, 2013). In addition, the findings of Rowland (1984) indicate challenges in turn-taking. She discovered that although infants with VIAD vocalized within normal limits, their vocalizations were not responsive to their mothers. Moreover, some of the mothers provided almost continuous vocal stimulation to their infants, which did not leave time for infants to take their turns.

Some parental actions can facilitate turn-taking. One of these actions is *questioning*. Interestingly, parents address their infants as conversational partners from the start and pose infants questions in a phase in which the child cannot yet answer them (e.g., Snow, 1977; Trevarthen & Hubley, 1978). A question is a powerful way to create turn-taking, because it nominates an infant as the next speaker and creates an expectation of his or her answer (Filipi, 2009, p. 26). When the infant responds through a nonverbal expression, the parent treats it as an answer to their question (Sierra, 2017). Thus, through parents' actions, their infants' expressions become part of the turn-taking sequences.

Imitation is another powerful mechanism to establish turn-taking. Parents spontaneously imitate their infants' movements, facial expressions, and sounds with playful exaggeration. Infants recognize their parents' imitations, and respond to them with increased attention, smiling, and approach behaviors (Sauciuc et al., 2020). Infants' imitative ability is innate (Trevarthen, 1979). Newborns can already imitate adult facial and manual gestures (Meltzoff & Moore, 1977). At 1–3 months, infants begin to produce sporadic imitations of parents' sounds that belong to their repertoire, and they use these imitations more systematically at 4–8 months (Papoušek & Papoušek, 1989). At 9 months, infants can exhibit immediate and deferred imitation (imitation after a delay) of novel objects (Heimann & Meltzoff, 1996; Meltzoff, 1988). The low vision of children with VIAD easily prevents them from making nonverbal imitations and receiving visual feedback from their parents' imitations. However, they can engage in imitative exchanges in the vocal (Rowland, 1984; see also Preisler, 1991, 1995) or bodily-tactile (see Hart, 2006) modality.

Affectionate parental *touch* is important for parent-infant bonding, temporal coordination of parent-infant behaviors, and infants' social cognition (Carozza & Leong, 2021). Parents use touch to communicate emotions and information about their actions to their infants (Hertenstein, 2002). They also regulate their infants' arousal levels and behavior through touch (Hertenstein, 2002). The use of touch by mothers is most frequent during the first months of their infants' lives and decreases in the second half of the first year (Goldstein Ferber et al., 2008; see also Chiesa et al., 2015; Rattray & Zeedyk, 2005). However, mothers with VI continue using

frequent touch throughout the first year of their infants' life and beyond (Chiesa et al., 2015; Rattray & Zeedyk, 2005), which indicates touch as a strategy to compensate for their VI. Similarly, Loots et al. (2005) found that deaf parents used more visual-tactile strategies in interactions with their deaf or hard-of-hearing toddlers than hearing parents.

Gaze is a powerful way for infants and parents to connect with each other in early interactions. Mutual gaze provides attentional signals and a context in which expressions become meaningful for the recipient (Wildt & Rohlfing, 2024). Parents monitor their infants' gaze and interpret it as an intentional turn in interactions (Rączaszek-Leonardi et al., 2013). Similarly, infants obtain important emotional feedback from their parents' faces through gaze (Winnicott, 2003). Mutual gaze between infants with VIAD and their parents is possible only if the infant has residual vision (see Gui et al., 2023). Infants with more severe VI use vocalization or body gestures to initiate contact (Preisler, 1991). However, the only secure way to establish contact with infants with CDB is through touch (Nafstad & Rødbroe, 2015, p. 26).

Lack of gaze can explain why young children with VIAD have been described as unresponsive and showing few initiations in interactions with their parents (Grumi et al., 2021; Rogers & Puchalski, 1984; Rowland, 1984; see also Van keer et al., 2017). Low vision may prevent children with VIAD from anticipating actions and recognizing moments of turn-taking, which may reduce their initiations and responsiveness (cf. Nomikou et al., 2017; Sacks et al., 1974). Moreover, their limited facial expressions may not provide their parents with a sense of discourse (Fraiberg, 1979). As a result, parents can experience a kind of stimulus deprivation and try to overcome it by understimulating or overstimulating their infants (see Stern, 1974).

Delafield-Butt and Trevarthen (2015) argue that *movements* are an essential part of infants' meaning-making. That is, infants' movements are closely related to the temporal structure of adults' actions from early on (Condon & Sander, 1974; Jover et al., 2019; Reddy et al., 2013). Neonates have been found to synchronize their motor behavior in the same rhythm as adults' speech (Condor & Sander, 1974). At 2–4 months, infants show postural changes indicating anticipatory responses when approached by their mothers (Reddy et al., 2013). Movements also express infants' engagement. At 3 months, infants show individual patterns of limb movements during singing games (Fantasia et al., 2014). Older 6-month-old infants increase their motor activity during the time slots of the songs (Jover et al., 2019). Later, infants can use specific activity-related movements in their responses. Sierra (2017) observed that a 7–8-month-old infant used a bouncing movement involved in a singing game when responding to his mother.

Preisler (1991, 1995) found a developmental process of the interactional use of movements in blind infants without AD. She discovered that 3–6-month-old blind

infants increased motor activity in their hands and legs when they were approached by their mothers. At 6 months, they anticipated actions in rhythmic body-touching games and used eyebrow and body movements as turns in conversations. At 7–9 months, they used repeated body movements to express their wish to replay a game. Moreover, some 9-month-old infants used play movements in their initiations. Rogow (1982) had similar findings of play movement-based initiations in older children with VIAD.

During the second half of the first year, parent-infant interactions change from dyadic engagements to triadic person-person-object engagements. Trevarthen and Hubley (1978) call this stage *secondary intersubjectivity*. During secondary intersubjectivity and sometime later at 6–18 months, infants develop a growing interest in and capacity to share their attention between objects and other persons, which they express through gaze and gesture (Bakeman & Adamson, 1984). This ability is called *joint attention*. Joint attentional skills result from a process which has a foundation in dyadic face-to-face interactions (Reddy, 2003). That is, infants first experience themselves as the objects of their parents' attention. Next, they become aware of their parents' attention related to their actions, before they learn to share attention to external objects (Reddy, 2003). Infants' abilities to direct their own attention and guide adults' attention emerge gradually at 12–30 months. Multimodal information in interactions facilitates this process. That is, infants learn to respond to adults' attempts to direct their attention earlier when they can perceive their expressions through speech, gazing, and pointing, compared to unimodal auditory information (Adamson et al., 2021). Likewise, it is easier for infants to invite adults to share a multimodal object than a sound (Adamson et al., 2021).

VI often prevents infants from expressing their attention through gaze. However, very young infants with VI can express their attention toward their parents' voices through stillness and immobility (Als et al., 1980). At an older age, infants with VI have challenges in developing joint attention skills (Ayyıldız et al., 2016; Bigelow, 2003; Dale et al., 2014). Preisler (1995) found that although infants with VI began to increase activities with toys at 7–8 months, dyadic interactions were still their main activity at one year. This may be due to their difficulties in gaining visual information about their parents' attention (Urwin, 1978). When infants with VI begin to express joint attention, they can do it through body orientation and vocalizations toward their parents (Urqueta Alfaro et al., 2021). However, these behaviors may be difficult for their parents to detect and interpret as joint attention.

Overall, Trevarthen's theory explains how typically developing infants are actively involved in early interactions from the start and how their abilities develop in reciprocal exchanges with their parents. The research indicates challenges in primary intersubjectivity for young children with VIAD and their parents. However, only little is known about how their dyadic interactions could be fostered in

intervention contexts. Their interactional resources, especially those related to the bodily-tactile modality, have not yet been uncovered.

2.2.2 Emotional availability

Positive emotional interactions with others are important for the well-being of every person. For infants and older nonverbal children with VIAD, they can be even more fundamental. This is because emotional exchanges may provide a main medium for them to connect with others. Hence, it is essential to evaluate their interactions with others from an emotional perspective. This chapter discusses research-based findings on EA, which is one of the most central theories on parent-child interaction.

EA refers to the emotional relationship between children and adults. It is closely connected to attachment theory and underlies children's secure attachment (an affectional tie with parents; Ainsworth et al., 1974) and favorable social-emotional development (Biringen et al., 2014). However, EA is a more broadly-based construct of parent-child relationship than attachment is. It is connected to several other theories such as the transactional model of development (Sameroff & Chandler, 1975) and mentalizing theory (Fonagy et al., 2002), which underline the reciprocal influence of parents and children on each other. That is, EA acknowledges not only the adult's but also the child's contribution to their emotional relationship (Biringen et al., 2014). EA has been found to predict children's developing competences such as emotion regulation and social and language development (Biringen et al., 2014).

EA is composed of six dimensions, which are all dyadic. This means that each dimension is viewed in relation to the partner's response. Adult *sensitivity* refers to the parent's ability to have a positive emotional connection with the child, read the child's communications, and respond to them. Adult *structuring* is the ability to structure the child's play through guiding or scaffolding and follow the child's lead. Adult *nonintrusiveness* is connected to the adult's ability to interact with the child without being overdirective, overstimulative, or overprotective. Adult *hostility* is the absence of nonverbal or verbal negativity toward the child. *Child responsiveness* refers to the child's emotional and social responsiveness toward the parent. *Child involvement* is connected to the child's initiative and ability to draw the parent into his or her play or activity.

Different disorders such as sensory, intellectual, and physical disabilities can compromise EA (Biringen et al., 2005). Children's deafness or blindness may especially complicate parents' EA (Campbell & Johnston, 2009; Paradis & Koester, 2015). Campbell and Johnston (2009) found that the mothers of one-year-old blind children without additional disabilities had challenges in sensitivity and structuring. Likewise, Paradis and Koester (2015) discovered that hearing mothers of deaf infants had lower sensitivity than hearing mothers of hearing infants. However, generally

parents of children with disabilities have similar EA profiles to parents of typically developing children (Kubicek et al., 2013; Pipp-Siegel et al., 1998).

Children with disabilities have comparable EA results to typically developing children (Kubicek et al., 2013; Pipp-Siegel et al., 1998). Nevertheless, some children's characteristics may influence their EA. Gul et al. (2016) found that the EA scores of infants with autism spectrum disorder, other psychiatric disorders, and developmental delay were related to their age, diagnosis, and developmental level (language-cognitive, fine motor, gross motor, social, and self-help). Children who had a higher developmental level showed more responsiveness and involvement with adults. In contrast, Barfoot et al. (2017) found that the functional capabilities (self-care, mobility, and social function) of children with CP were not related to parent-child EA. Deafness may also influence the child's EA. Paradis and Koester (2015) found that deaf infants of hearing mothers scored lowest in child responsiveness compared to deaf infants of deaf mothers, hearing infants of deaf mothers, and hearing infants of hearing mothers. These findings could be connected to the challenges hearing mothers experience with creating reciprocal communication with their deaf infants through the visual and tactile modalities and a lack of a shared language.

The parents of blind children may have challenges in EA because they experience higher stress than parents of sighted children (Reda & Hartshorne, 2008; Sakkalou et al., 2018; Tröster, 2001). The severity of the child's VI, difficulties in parent-child interactions, and the presence of additional disabilities can further increase parents' stress (Gui et al., 2023; Sakkalou et al., 2018; Tröster, 2001; see also Hastings et al., 2006). In children with VIAD, low EA may lead to problems in attachment and emotional well-being. Lang et al. (2017) found that children with VIAD or VI already had lower social-emotional competences in empathy and peer relationships compared to their sighted peers at 1–3 years. Moreover, they discovered that children with VIAD had fewer competences in compliance than children with isolated VI. At the age of 4–11 years, children with VIAD already have four times more emotional and behavioral problems, including internalizing problems (withdrawal, anxiety/depression, somatic complaints) and externalizing problems (aggressive behavior and delinquent behavior), compared to typically developing children (Alimovic, 2013). Similar challenges have been described in children with CDB (Hartshorne & Schmittel, 2016; Nelson et al., 2013).

Compensatory strategies may help children with disabilities to cope with their difficulties and establish EA with their parents (Biringen et al., 2005; Campbell & Johnston, 2009; Shahar-Lahav et al., 2022). For instance, research suggests that increased use of parental touch is related to higher EA in interactions between children with hearing impairment and their mothers (Paradis & Koester, 2015; Pipp-Siegel et al., 1998). Thus, parents and their children with VIAD may benefit from

compensatory strategies which can help them to be more emotionally available to each other. Their EA could be enhanced by increasing interactional reciprocity through the bodily-tactile modality. That is, the bodily-tactile modality increases reciprocal accessibility in the same modality and thereby may increase reciprocity. However, previous early intervention studies have not addressed this potential.

2.2.3 Early social play routines as an intervention context

Early social play routines may provide an especially useful context for enhancing turn-taking and EA in parent-child interactions. Their key mechanism is founded on predictability. By repeating early play routines, infants learn to recognize the actions in the routines and perform them. This facilitative mechanism of play routines is different from contingency to child's behaviors, which is characterized by adults' responsiveness toward infants' actions (Snow et al., 1987).

Camaioni and Laicardi (1985) divide early social play routines into nonconventional games and conventional games. *Nonconventional games* consist of multimodal stimulations and imitations, which are typically played with 3–6-month-old infants (e.g., Stern, 1974). Parents use nonconventional games to provide infants positive emotional experiences and maintain them in a state of attention and arousal, which elicits positive social behaviors from the infants (Stern, 1974). As nonconventional games serve important functions in interactions, parents should have an adequate repertoire of them (Stern, 1974). *Conventional games* are rhythmic multimodal games which include repetition of a sequence of behaviors and pausing (e.g., "patacake," "peekaboo," and "give and take"). Even young infants can memorize multimodal structures of the games and notice if they are violated (Fantasia et al., 2014). The variety and time used for conventional games increase when infants are 6–12 months old (Camaioni & Laicardi, 1985; see also Crawley et al., 1978). This may be due to infants' developing sensorimotor skills, which allow them to perform the motor components of the games (Crawley et al., 1978).

Conventional games have several qualities which promote infants' communication (Ratner & Bruner, 1978). First, they have a restricted semantic content and a limited number of successive actions, which make them easy to repeat (Nomikou et al., 2017; Ratner & Bruner, 1978). Infants do not need to understand the content of the game to be able to join it. Second, the multimodal game structures provide different resources for infants' participation through joint actions (Fantasia et al., 2014). Third, the games have a clear temporal structure. The repetition of the game permits anticipation of the order of the events, which facilitates infants' participation (Nomikou et al., 2017). Fourth, the multimodal games create positive emotional experiences for the participants (e.g., Fantasia et al., 2014). Tactile and kinesthetic games in particular have been found to evoke positive emotions in infants

with VI (see Fraiberg, 1979; Preisler, 1991). Lastly, the roles of conventional games are reversible, which facilitates acquiring the conventions of social interaction. These roles can be roles as players (e.g., the mother or infant can hide in peekaboo) or motoric components of the games (e.g., rhythmic clapping; Crawley et al., 1978).

Infants' participation in the games gradually increases (Camaioni & Laicardi, 1985; Gustafson et al., 1979). Initially, their engagement is expressed through emotional expressions (Ratner & Bruner, 1978). Next, infants begin to anticipate the actions of the game through smiling, laughing or vocalizations. Preisler (1991) found that 3–6-month-old blind infants without additional disabilities anticipated specific actions of the games by opening their mouth or raising their arm. At a later stage, infants can perform the actions of the games and reverse roles with adults (e.g., Ratner & Bruner, 1978). Infants first make the actions nonverbally, which is followed by attempts to match vocal utterances to the routinized expressions used in the game (e.g., "boo" in peekaboo). Gradually, infants learn to coordinate their nonverbal and verbal actions at appropriate moments in the game (Ratner & Bruner, 1978). Finally, they also use the actions of the games in other contexts (Hodapp et al., 1984; Ratner & Bruner, 1978; Urwin, 1978).

Parents can structure conventional games to be optimal for their infants' participation by creating slots for turn-taking and anticipating actions (e.g., Hodapp et al., 1984; Nomikou et al., 2017). Anticipation can consist of game-related verbal or nonverbal cues, which help infants to prepare for the following action and establish joint attention to it (e.g., in peekaboo the mother lifts the cloth a bit, stops and says "attention" before covering her face; Nomikou et al., 2017). Anticipatory cues may also help infants to perform the actions of the games. For instance, Nomikou et al. (2017) found that mothers' use of a preparation phase in peekaboo with their four-month-old infants was positively related to their infants' participation two months later. In summary, early social play routines offer an optimal context to foster the participation of infants with or without VIAD. Therefore, early social play routines were selected as the primary avenue for change in the intervention described in this thesis.

2.3 Communication and language development of children with VIAD

Infants' gestural expressions and word-like vocalizations during the second half of the first year do not appear out of nowhere. They are based on earlier skills that infants have gained in reciprocal interactions with their parents (e.g., Wildt & Rohlfing, 2024). Further, children's preverbal communication skills predict their later language skills (e.g., Bates et al., 1979; Rowe & Goldin-Meadow, 2009; Wildt & Rohlfing, 2024) and social-emotional competencies (Rautakoski et al., 2021). In

addition to early communication development, this chapter summarizes literature on the communication and language profiles of children with VIAD. As there is very little information available about this topic apart from AAC; the focus is on the communication profiles and gestural expressions of children with CDB.

2.3.1 Communication development during the first year

Gestures serve as an important means to communicate for typically developing children before they begin to talk. Their development is connected to intentional communication, which is characterized by intention to direct an expression toward adults through eye gaze, bodily orientation or touch and waiting for their response (Crais et al., 2004). Gestures are typically made with the hands and accompanied by gaze and vocalizations (Laakso et al., 2010). Some gestures can be made with facial features (e.g., lip-smacking for cookies) or bodily actions (e.g., bouncing up and down for a horse; Iverson & Thal, 1998). Fraiberg (1971, 1979) found that blind infants without additional disabilities expressed intentions through subtle gestures with their hands (e.g., an infant could touch the adult after a game as a means of expressing "more"). These gestures were not clear for most of their mothers, and it also took a long time for the professionals to learn to read them. When the mothers learned to read their infants' gestures, their turn-taking dialogues increased.

Deictic gestures such as showing, giving, reaching, and pointing refer to objects or events and are interpretable only in their contexts (Caselli, 1990). Infants begin to produce them at 8–14 months (Crais et al., 2004; Iverson & Thal, 1998). However, early forms of deictic gestures can already be seen earlier (Bates et al., 1979, p. 86). For instance, infants may use early pointing as part of their own directedness and interest toward the world and begin to use it in social situations when they learn its communicative function from the adults' responses (Carpendale & Carpendale, 2010; see also Bates et al., 1979).

Representational gestures can be object-related (e.g., DRINKING) or culturally defined (e.g., nodding the head for "yes") gestures, which have specified semantic content (Iverson & Thal, 1998). Typically, they emerge at 11–12 months (Caselli, 1990). Caselli (1990) found that the first representational gestures of his son were bodily gestures derived from specific routines with his parents (e.g., DANCING expressing a request for music derived from a routine in which he was asked to dance to the sound of music at 11 months). Object-related gestures (e.g., PACIFIER) emerged later, at 12–13 months. The repertoire of representational gestures expands at the time when children utter their first words. Initially, the lexical items are acquired through gestures and words, but gradually speech becomes superior to gestures (Iverson & Thal, 1998).

Residual vision can enable infants with VI to use gestures such as pointing similarly to sighted children (Preisler, 1991). However, when vision is severely impaired, gesture development follows atypical patterns. Rowland (1984) observed that 11–32-month-old infants with VIAD used nonconventional gestures (e.g., batting their arms), which were often connected to emotions such as excitement or aversion. Only one of the five children made conventional gestures (e.g., waving bye-bye). Giving and showing, as well as pointing and reaching, were absent. Similarly, Preisler (1991, 1995) found an absence of deictic gestures in blind infants without additional disabilities. At 10–11 months, blind infants expressed their attention to sounds of the environment by movements of the head and/or body toward the sound or a stiff body posture/face (Preisler, 1991, 1995). These movements, which functioned like body-pointing gestures, were easily misinterpreted as lack of interest by their parents. Other researchers (Fraiberg, 1979; Urwin, 1978), however, observed blind infants to make typical reaching gestures connected to familiar voices or sounds at the end of the first year.

Blind infants can create representational body or hand gestures based on their experiences. These gestures can be elicited by sounds or speech connected to the experiences. For instance, Fraiberg (1979) described a 9-month-old blind infant making a pantomime of bell ringing with his hand when he heard the bell's sound. Similarly, Preisler (1991) found a 10–11-month-old blind infant using hand movements as if she was splashing water when her mother talked about the activity. Moreover, Iverson et al. (2000) described a one-year-old blind boy, Teddy, who experienced a vocal-tactile routine with his mother. During the routine, the mother was running her hands over his hair from the front to the back of his head and said "Oh, Teddy is so pretty. He's such a pretty boy." Later, Teddy used the same gesture for commenting on various referents in different contexts.

Vocalizations are an efficient means for infants to participate in proto-conversations with their parents. At 2 months, infants produce cooing sounds and soundless movements with their lips and tongue, which Trevarthen (1974) called "prespeech." Later, at 7 months, infants begin to produce canonical babbling consisting of consonant-vocal (CV) syllables (Kent & Miolo, 1995). Over time, infants elaborate syllables into proto-word utterances (e.g., CVCV), which their parents interpret as having different referents and functions based on the contextual and accompanying nonverbal information (Laakso et al., 2010). Proto-words are followed by infants' first words, which appear at approximately one year old (Kunnari, 2000).

Some studies have explored vocal development in infants with VI but there appear to be no descriptions of vocal development of children with VIAD. Preisler (1991, 1995) found that 3–6-month-old blind infants without additional disabilities made prespeech movements when their mothers began to talk to them and used

cooing sounds in proto-conversations with their mothers. Canonical babbling also occurs in a typical timetable in blind infants (Fraiberg, 1979). At a later stage, blind children have roughly a half-year delay in word acquisition related to sighted children (Campbell et al., 2024). However, 20% of blind children have an advanced vocabulary over the average of sighted toddlers (Campbell et al., 2024).

2.3.2 Communication and language profiles

Only a limited number of scientific studies have explored the communication and language profiles of children with VIAD. Their findings indicate that the majority of these children use nonverbal means for expressing themselves for years or throughout their lives (Argyropoulos et al., 2020; Ayyıldız et al., 2016; Blackstone et al., 2021; Boster et al., 2021; Daelman, 2003; Mallineni et al., 2006; Miliou, 2024). For example, Argyropoulos et al. (2020) report that most of the children with VIAD in their Erasmus+ project communicated through nonverbal expressions such as smiling or body movements. Similarly, the parents in Blackstone et al. (2021) study ($N = 63$) reported that their 2–34-year-old children with VIAD depended primarily on bodily expressions in communication. However, some children with VIAD have been reported to use a few signs, words, or phrases (Aasen & Nærland, 2014). Children with VIAD who learn to produce speech often have numerous speech sound production errors (Gordon-Pershey et al., 2019), which limit their speech intelligibility.

The communication of children with CDB has been studied more than that of children with VIAD who have normal hearing (e.g., Bruce et al., 2016; Damen et al., 2017; Janssen et al., 2010; Wolthuis et al., 2019). However, the findings are mostly based on case studies, which cannot be generalized to the population. Findings suggest that early communication development appears to follow the same patterns as in typically developing children (Preisler, 2005). Nevertheless, the atypical contact initiatives of children with CDB through bodily expressions and signs can be easily unnoticed by their parents (Nafstad & Rødbroe, 2015, p. 21; Preisler, 2005). These challenges persist in toddlerhood. Vervloed et al. (2006) found that a 3-year-old child with CDB and his teacher missed over half of each other's initiatives. Moreover, less than 2% of the recording time in daily activities contained prolonged interactions between the child and his teacher. These findings exemplify a problem that may have resulted from mutual challenges to access communicative expressions.

Older children with CDB communicate through different means and modalities. Dammeyer and Ask Larsen (2016) found that 3–18-year-old children with CDB ($N = 71$) used tactile language (23%), oral language (32%), or visual sign language (39%) in communication. The level of their language acquisition varied. Less than half of the children (41%) used preverbal communication, and for about the same

number of children (42%), the language development was at symbolic level but delayed. Only a minority of the children (18%) had language skills corresponding to their age-related expectations. However, it is unclear whether children with Usher syndrome were included in the study. If they were, it is probable that the results indicate better than expected level of communication skills in children with CDB. This is because children with Usher syndrome generally have higher-level linguistic skills and fewer additional disabilities than other children with CDB, and their functional deafblindness is of a progressive type (see Dammeyer, 2012b). It is common that children with CDB who have other types of etiologies, such as Trisomy 13, express themselves through nonverbal actions such as movements while some of them may develop a limited number of symbolic gestural expressions (e.g., conventional gestures or manual signs; Braddock et al., 2012; Liang et al., 2015) or single words (Liang et al., 2015).

2.3.3 Bodily-tactile expressions of children with congenital deafblindness

Descriptions of children's spontaneous expressions through touch and movements, which arise from their bodily-tactile experiences come mainly from the deafblind field (e.g., Ask Larsen, 2003; Bruce et al., 2007; Daelman et al., 2004; Nafstad, 2018; Nafstad & Rødbroe, 2015; Souriau, 2015). This does not mean that only children with CDB can make such expressions. Rogow (1982) described bodily expressions based on familiar play routines in normally hearing children with VIAD. However, she did not report the modalities used in the routines, so it remains unclear whether the children's expressions were related to their visual or bodily-tactile experiences. Overall, the connectedness between bodily-tactile experiences and gestural expressions has not yet received much scientific attention in normally hearing children with VIAD. However, as children with VIAD have the same bodily resources for expressing themselves as children with CDB, it is necessary to discuss the characteristics of the spontaneous bodily-tactile expressions of children with CDB and the conditions from which they may arise. This knowledge is also essential in supporting communication development through gestures and signs in normally hearing children with VIAD.

When contact through vision or hearing is not possible, children with CDB can make contact using their hands or feet when their parents are within reach (Nafstad & Rødbroe, 2015, p. 26). Tactile contact is necessary for their interactions with others, and its absence easily prevents communication (Vervloed et al., 2006). When interactions are of good quality, children with CDB often communicate their bodily-tactile experiences through spontaneous gestures (e.g., Ask Larsen, 2003; Nafstad & Rødbroe, 2015; Souriau, 2015; see also Fraiberg, 1979). Ask Larsen (2003) calls

these gestures "proto-signs." Proto-signs can derive from bodily experiences related to inner states (e.g., emotions), perceived movements, tactile sensations, or location of touch (Ask Larsen, 2003). Due to their specific origins, proto-signs can be challenging to read (e.g., Ask Larsen, 2003; Nafstad & Rødbroe, 2015). This is because they convey messages that are not typical in the non-CDB community and may not match their experiential perspectives (Bezemer & Kress, 2014; Nafstad, 2018). However, interpretation of proto-signs becomes easier if adults and children with CDB share the same experiences from which the proto-signs emerge (see Souriau, 2015).

There can be at least three different types of proto-signs arising from a child's bodily-tactile experiences. *BETs* (Bodily-Emotional Traces) are spontaneous gestures that arise from emotionally-charged impressions of bodily-interactional experience (Daelman et al., 2004). Typically, a BET emerges as a touch that children with CDB make on a particular place on their bodies where a specific experience has left a trace (e.g., a child touches a spot on her cheek where she felt her mother's kiss before; Nafstad & Rødbroe, 2015, p. 43). *Mimetic gestures* are imitations of movements, bodily positions, and emotions involved in an action that children with CDB experience in the bodily-tactile modality (Nafstad & Rødbroe, 2015, p. 149). Thus, mimetic gestures represent an action and its corresponding mental state. *Iconic gestures* are gestures that represent their references iconically. Typically, the resemblance between iconic gestures and mental images is observable from a visual perspective (e.g., the sign *DRIVE* referring to holding a wheel when driving a car; Nafstad & Rødbroe, 2015, p. 151). In children with CDB, iconic gestures can be connected to their bodily-tactile impressions of an experience (e.g., after exploring a panel wall tactilely, a child with CDB might refer to his experience through a gesture in which his fingers iconically represent the panel boards with cracks, and the bent-in thumb demonstrates the position of the thumb during the exploration; Forsgren et al., 2018). Iconic gestures only partially express an experience, which differentiates them from mimetic gestures and makes them more difficult to detect (Forsgren et al., 2018; Nafstad & Rødbroe, 2015, p. 151; Souriau, 2015).

Proto-signs can also be called "authentic communication" or "thinking gestures," which may not be initially directed at others (Nafstad, 2018). However, they express children's sense-making cognition and have high *meaning potential* (Daelman et al., 2004; Gregersen, 2018; Nafstad, 2018). That is, when the gestures are noticed and responded to, they can be shared and developed into a shared sign (Nafstad & Rødbroe, 2015, p. 44). The first part of the process is spontaneous engagement in making sense of an impression; the second part is the negotiation of the gesture into a sign function that takes place through reciprocal imitation in the bodily-tactile modality. The third phase in the process is the pragmatic use of the proto-sign in particular contexts, which enables the co-construction of shared meaning (Nafstad,

2018). If the thinking gestures are not responded to, they may disappear (Daelman et al., 2004).

Brede and Souriau (2016) described a process in which a BET from five-year-old Fredrik with CDB was developed into a shared sign. During the first stage, Fredrik made an emotion-based gesture (moving his fisted hands down on his cheeks) in anticipation of tooth brushing—a bodily-tactile experience that he strongly disliked. This gesture also appeared in other situations in which Fredrik experienced something he felt sorry about. His caretakers started responding to this BET through immediate imitation, which resulted in a more conscious use of the gesture. At the next stage, Fredrik's teacher began to use the cultural sign *CRY* by performing it on his cheeks when he was crying. *CRY* was also embedded in a hurt-and-cry story. Next, Fredrik was observed gesturing to himself, and a new modified gesture *CRY-SORRY* emerged. Fredrik's teacher responded to this gesture, sharing it with Fredrik. Later, when Fredrik was crying, he grabbed his caretaker's hand, placed it on his cheek, and helped the adult perform the modified sign. In the last phase, when Fredrik's teacher saw him making the sign, she first imitated it on his cheek and then took his hand and led him to feel the sign on her own face. In this way, the newly constructed sign became communicative because both Fredrik and his caretakers knew what it meant.

The storytelling of children with CDB can consist of mimicry and deictic expressions. Souriau (2015) analyzed shared storytelling between a mother and her four-year-old son, Emil, who had CDB and a cochlear implant. When they discussed their earlier visit to the playground, Emil did not use standard signs, but his use of physical space and mimicry in retelling about his bodily-tactile experiences of climbing up a ladder, sliding down, and meeting a girl with a cochlear implant. In his narrative, Emil used real space (physical space) to refer to actions that occurred in the narrative space (mental imaginary space) and combined his expressions into haptic-temporal sequences of action.

Although categorizing the proto-signs of children with CDB may not always be clear-cut, recognizing the different gesture types can increase an understanding of the bodily-tactile experiences from which they may arise. This recognition of proto-signs is essential for them to become co-created signs. Furthermore, as proto-signs often relate to what children with CDB think about, their communicative function reaches beyond instrumental communicative acts, to which AAC is often restricted. Overall, the proto-signs suggest that children with CDB have an innate meaning-making ability. However, language acquisition in the bodily-tactile modality is a special case because tactile language acquisition has not been reported to exist naturally, like language acquisition in other modalities (cf. deaf children acquiring sign language from their deaf parents, Vonen & Nafstad, 1999). That is, children with CDB typically do not have the possibility of many direct tactile interactions

with other deafblind individuals, which would allow for a new language community to arise (Vonen & Nafstad, 1999). This makes it difficult to measure or describe "typical" language acquisition in the bodily-tactile modality (Ask Larsen, 2013).

2.3.4 Augmentative and alternative communication

Children with VIAD can learn to use AAC (Brittlebank et al., 2024). However, finding the best solutions for them is challenging, as AAC systems are mostly visual (Boster et al., 2021; McCarty & Light, 2023). Moreover, studies provide limited information on the rationales for how these solutions are selected for children with VIAD (Boster et al., 2021). The selection process would necessitate detailed knowledge of children's functional vision (e.g., CVI range assessment; Blackstone et al., 2022; Wilkinson et al., 2023). If this kind of essential information is lacking, it may complicate AAC decision making and confuse parents (McCarty & Light, 2023). In general, parents of children with VIAD have experienced AAC interventions as ineffective in promoting their children's language skills (Blackstone et al., 2021), which may be due to inadequate assessments and several limitations in implementing interventions. First, the interventions have focused mainly on requesting or choice making, while social interaction and the training of communication partners have often been disregarded (Brittlebank et al., 2024). Second, most interventions have been implemented in isolated contexts and were not connected to daily activities (Brittlebank et al., 2024). Third, the majority of the children included in AAC intervention studies were over six years of age, which is too old to achieve the best possible outcomes (Brittlebank et al., 2024). Lastly, speech-language pathologists (SLPs), teachers of the visually impaired, and other school-based professionals working with children with VIAD have identified a lack of expertise and training with CVI and AAC (Blackstone et al., 2021).

When these critical aspects are considered, AAC interventions can be successful. For instance, Blackstone et al. (2022) investigated 3–11-year-old children with CVI ($N = 13$) who studied in a school specialized for children with multiple disabilities. Each class was co-taught by a full-time special education teacher and an SLP. The school also used systematic CVI assessments and interventions, which were integrated into the education curricula and AAC interventions. All 13 children with CVI used multiple means of communication. Twelve used gestures; nine used pictographic symbols, photos, or PAAS (Partner-Assisted Auditory Scanning); and seven used speech. Five children used letters and numbers, four utilized written words or phrases, and two used tangible symbols. Only one child used manual signs. Children who had better functional vision and fewer medical diagnoses had higher communication skills than the others. The findings indicate that children with VIAD have more capacity to develop communication with AAC than expected and can

utilize their potential when provided with appropriate assessments and interventions (see also Wilkinson et al., 2023). However, the possibilities related to tactile communication are rarely addressed in the literature. Aasen and Nærland (2014) found that 5–17-year-old blind children with additional disabilities were more likely to follow requests, which were expressed by tactile symbols, compared to verbal instructions. Thus, the tactile symbols appeared to help the children become more active in participating in school activities. If normally hearing children with VIAD were provided access to services for children with CDB from infancy, they could have more systematic support for developing their interactional and communicative skills in the bodily-tactile modality (Andersen & Rødbroe, 2005).

2.4 Early intervention

Early intervention has the potential to minimize the negative effects of children's disabilities, enhance children's development, and provide support to families (Bailey et al., 2005; Guralnick & Bruder, 2020; Heckman, 2006). This potential is connected to heightened brain plasticity in infancy, which allows for possibilities of affecting brain functioning through positive experiences (Chen, 2014, p. 5). Early interventions achieve the best results when children are younger than 3 years and their parents are involved in the process (Bailey et al., 2005; Launonen, 1998; see also Heckman, 2006). Children with VIAD are no exception. It is essential to address their parents when increasing reciprocal accessibility in interactions. This is because parents have knowledge of their children's lived experiences and are typically the most important people in their children's lives. However, it is not self-evident that parents are included in interventions for children with VIAD.

Family-centered practices recognize that children are interconnected within their family contexts, and the best results of interventions can be achieved by involving parents in natural environments, including homes (Ely & Ostrosky, 2018; see also Bronfenbrenner & Ceci, 1994). Family-centered practices can *empower* parents with new attitudes, knowledge, and skills that give them the perception of control, confidence, and competence (Dunst & Dempsey, 2007). Guralnick (2011) argues that parent-child interactions that consist of sensitive responsiveness, affective warmth, and engagement are especially fundamental to parents' empowerment. That is, early intervention can help parents create positive transactions with their children (Sameroff & MacKenzie, 2003a).

Parents' empowerment necessitates *relational* and *participatory* practices in early intervention (Dunst & Dempsey, 2007). Strong relational practices involve close professional-parent collaboration, mutual trust, and active listening (Dunst & Dempsey, 2007; Ely & Ostrosky, 2018; Konstantina et al., 2014). Hopkins and Puhlman (2025) discovered that a strong relationship with an early interventionist

contributed to parents' feelings of empowerment during early interventions. Participatory practices involve parents in decision making and engage them in activities that strengthen their existing competencies (Dunst & Dempsey, 2007). These practices also involve professionals learning from the expertise of parents concerning their children's uniqueness (Rouse, 2012; see also Breemer, 2025).

This chapter discusses participation as a right of children and explains why accessibility is a necessity for the participation of children with VIAD. It also introduces tactile strategies that can be used to increase accessibility and multimodality in interactions. The studies described have explored the effects of early interventions for parents and their 0–2-year-old children with VIAD. This demarcation excludes early interventions for children with isolated VI (e.g., Beelmann & Brambring, 1998; Dale et al., 2018; Fraiberg, 1979), for children aged 3 and older with VIAD (see Sundqvist et al., 2023), and those that did not involve parents (Lake, 1985).

2.4.1 Participation as a right of the child

Early intervention can fulfill children's rights to development and participation (Brown & Guralnick, 2012; United Nations [UN], 1989). Participation can be defined as follows: "Participation describes meaningful involvement in life situations in the home, at school, and in the community and provides opportunities for the development of functional skills, connecting with others, developing independence, and engaging in enjoyable and meaningful activities" (Williams et al., 2020). Generally, participation is discussed in relation to older speaking children, but it is also relevant to preverbal infants, who are often ignored in policies, discussions, and decision making (Bakkenget & Våpenstad, 2023). Infant participation is embodied in parent-infant intersubjectivity, which makes the relationship with their parents the most important context for infants' participation (Våpenstad & Bakkenget, 2021). As infants do not express themselves verbally, their voices originate through their playful, interactive and affectionate initiatives in particular cultures of interaction (Bonsdorff, 2021). A detailed analysis of parent-child interactions can reveal these expressions and their impact on parents and vice versa (e.g., Trevarthen, 1974, 1979). When infants' contributions are recognized and valued, we can learn more about their cultural agency (creative activity that contributes to society) and capacity to co-create communicative events (Bonsdorff, 2021).

Nonverbal children with VIAD are often in a position similar to typically developing infants regarding participation because they cannot express themselves verbally. Nevertheless, their voices can be heard through their initiatives in interactional activities with others. Early social play routines in the bodily-tactile

modality are optimal contexts for this because they provide repetitive interactional experiences that children with VIAD can utilize in creating their communicative gestures. Thus, early interventionists can guide parents of infants with VIAD to use accessible imitation-based and game-based routines as initial contexts to foster their children's participation (Chen, 2014, pp. 430–431; Rogow, 1982). Through participation, children with VIAD can develop agency, learn new communication skills, and have their voices heard (Bruner, 1975; Nomikou et al., 2017; Smith & Fluck, 2000).

Parents of infants with VIAD may experience challenges accessing services that provide systematic support for their children's participation and development. That is, children's complex medical conditions, low expectations of medical and educational professionals (Breemer, 2025; McCarty & Light, 2023), professionals' lack of knowledge, or diagnostic practices (Blackstone et al. 2021; McCarty & Light, 2023) can delay the start of early intervention. When early intervention programs are available, the families of children with VIAD are generally satisfied with them (Battistin et al., 2024; Konstantina et al., 2014). However, parents continue to experience anxiety about their children's lack of speech and difficulty interpreting their idiosyncratic expressions (Miliou, 2024). This suggests that general early intervention programs may not always provide families with enough knowledge about how to support their children's participation and communication. This may be due to professionals' lack of knowledge. Ely et al. (2020) found that vision professionals felt inadequately trained to work with young children with VI/VIAD. Similarly, House and Davidson (2000) discovered that a great number of SLPs did not feel knowledgeable about VIs (59%) or deafblindness (76%). The recent findings of Luo et al. (2022) showed no improvement in the self-evaluations of SLPs, which indicates a need to develop the content of the study programs for vision professionals and SLPs.

2.4.2 Accessibility

Early intervention can help to increase accessibility in interactions between children with VIAD and their parents. Due to VI, children with VIAD have limited access or no access to their parents' nonverbal expressions. Specifically, although sighted infants can use visual information to gain knowledge of others' emotions, actions, and intentions, infants with VIAD often miss these. However, when other senses are used to compensate for the lack of vision, VI does not necessarily compromise the quality of early interactions (Rattray & Zeedyk, 2005). This makes the conditions for perception and cognition fundamental in designing interactions and interventions for children with VIAD (Gregersen, 2018; see also Loots et al., 2005). Accessibility through the bodily-tactile modality is important for children with VIAD and critical

for children with CDB. To be precise, the communication development of children with CDB depends fully on sharing tactile and motor experiences with others (Souriau, 2015). However, Bruce (2003) discovered that although the teachers of three children with CDB were responsive, they often used only verbal expressions, which were inaccessible to two children and intermittently inaccessible to the third child.

When bodily-tactile information is aligned with speech, it aims to increase children's possibilities for *cross-sensory perception* (matching of stimuli from different senses; Guellaï et al., 2019). Adults use cross-sensory perception in actions such as speech perception, which consists of integrating auditory information from speech and visual information from mouth movements (Rosenblum, 2008). Even infants are able to make cross-sensory correspondences based on the temporal synchrony of sensory information (Guellaï et al., 2019). Moreover, they can transfer information from one modality to another. The pioneering study of Meltzoff and Borton (1979) found that 1-month-old infants showed a clear visual preference for the shape of the pacifiers they had previously explored orally. The mechanism of cross-sensory perception, however, is not well understood. Stern (1985, pp. 47–53) suggests that infants might process sensory information in a supramodal form, which involves encoding sensory information from one or more modalities into a modality-neutral *amodal representation* of the experience (see also Kaup et al., 2024; Spence & Di Stefano, 2024). Amodal representations are understood as abstract descriptions of the objects they represent (e.g., Kaup et al., 2024). Their formulation may be enhanced by multimodal stimulation (Bahrick et al., 2004).

When adults use the bodily-tactile modality to increase accessibility in interactions with their children with VIAD, the children receive information through *passive touch* (Gibson, 1962). Gibson (1962) distinguished passive touch from active touch, which means touching and exploring something. Generally, active perception is considered superior to passive perception. That is, exploring an object tactilely gives more information about its form than just passively feeling it in the palm (Gibson, 1962). However, Magee and Kennedy (1980) discovered that persons whose index fingers were passively traced around pictures identified them more accurately than persons who used independent exploration. They suggested that this difference could be explained by the execution of movements. Active explorers need to plan their movements, which may limit their resources to distinguish relevant kinesthetic information (knowledge of how movements occur in space). Thus, the term "passive" conveys incorrect information when considering the complexity of tactile information processing in the brain.

2.4.3 Tactile strategies

Children with VIAD can benefit from tactile strategies, which are "planned, systematic methods of using the sense of touch to support a child's understanding of information and to promote interaction and communication (Chen & Downing, 2006, p. 73)." As the sense of touch is most often intact in children with VIAD, tactile strategies work to their strengths and help to complement auditory and visual information (e.g., Aasen & Nærland, 2014; Atkinson, 2022; Bruce, 2005; Chen & Downing, 2006; Daelman et al., 2004; Deuce & Rose, 2019; Lindström, 2019; McLinden & McCall, 2016; Miles, 2003; Vege & Nafstad, 2022). However, processing tactile information is slow and requires more time than processing information from other sensory modalities (e.g., Goold & Hummel, 1993, p. 70). In addition to their therapeutic use, tactile strategies are observed in natural interactions between deaf parents and their infants (Loots et al., 2005; Maestas y Moores, 1980).

Tactile strategies need to be utilized respectfully (Chen & Downing, 2006, p. 73). Respectful touch requires the consent to touch, considers the location of touch, and responds to children's feedback (Atkinson, 2022; Goold & Hummel, 1993). Moreover, it is important to observe whether a child with VIAD has tactile defensiveness, which refers to the avoidance of touch, aversion to non-noxious (non-painful) touch, atypical affective responses to non-noxious tactile stimuli, and objection, withdrawal, or negative responses to touch contact (Bundy & Lane, 2020, pp. 167–171). Tactile defensiveness should be treated first to help children with VIAD habituate themselves to tactile interactions.

Tactile strategies can increase accessibility to nonverbal information in several ways. First, they can transmit information related to the context of the interaction. For instance, the movements and gestures of early social play routines become accessible for children with VIAD when their parents coactively create them with their children. Alternatively, children with VIAD can be placed in a position that enables an embodied perception of their parents' movements and postures (see Gregersen, 2018).

Second, tactile strategies can be used to increase access to nonverbal information. *Touch-speech cues* are "a simultaneous touch-speech production in which a target word for comprehension is paired with a specific signal on a specific location on the learner's body or limbs" (Goold & Hummel, 1993, p. 18). They were developed to enhance the receptive communication of children with multiple and/or sensory disabilities (Goold & Hummel, 1993). Some touch signals may also involve moving a body part. Touch-speech cues are individualized and context-based, not symbols like body signs (Chen & Downing, 2006, p. 103). Goold and Hummel (1993) discovered that touch-speech cues were helpful for three 10–18-year-old youngsters with VIAD to anticipate actions, recognize and comprehend target words, and develop the use of object symbols in communication.

When adults want to signal that they have perceived a bodily expression of a child with VIAD, they can do so by providing *confirmation* of the child's expression in the bodily-tactile modality. This may be especially important if the child cannot access or understand the adults' speech (Nafstad & Rødbroe, 2015, p. 59). However, bodily-tactile confirmation has been studied mainly in the deafblind field. For instance, Damen et al. (2014, 2015a) guided communication partners to attune their behaviors and emotions to those of persons with CDB in an accessible (tactile) way (e.g., by lightly tapping on the cheek of a person with CDB to respond to his smiling). The communication partners' use of these strategies, along with other strategies, increased reciprocity in interactions.

Imitating the nonverbal actions of children with VIAD in the bodily-tactile modality can foster reciprocity in adult-child interactions in the same way that parents' imitations foster dialogue in early interactions with their typically developing infants (Miles, 2003). When children with VIAD perceive that their movements are imitated, they learn that they can influence another person. Thus, imitating the hand and body movements of children with VIAD can develop their agency (the ability to initiate and control their actions) and create tactile turn-taking exchanges with them (Chen & Downing, 2006, pp. 34–36; Hart, 2006; Lee & MacWilliam, 2008, p. 25; Miles, 2003).

Third, tactile strategies can provide access to cultural language and AAC. Manual signs of the visual sign languages can be adapted for children with VIAD in such a way that they can be received through the sense of touch (Chen & Downing, 2006, pp. 120–121). *Body signs* are made on children's bodies. Maestas y Moores (1980) found that deaf parents spontaneously used body signs in interactions with their infants. They made signs on their infants' torsos, foreheads, and hands and used their infants' bodies as referents for the pronoun "you." When signs are made on children's bodies, they receive information about the place of the sign and potentially also about its movement. However, body signs do not provide information about the signer's hand shapes. Thus, only when the other types of tactile signs are used with children with VIAD will they receive the information that is needed to recognize the signs and learn to produce them (Chen & Downing, 2006, p. 122). In *coactive signing,* the adult physically helps the child to produce the sign from the child's perspective (Chen & Downing, 2006, p. 126). The findings from natural interactions between deaf parents and their infants suggest that coactive signing can be a helpful strategy for children to learn to produce signs during the early stages of signing. Maestas y Moores (1980) observed that deaf parents guided their infants to produce different signs when the infants were 2–5 months old. However, coactive signing has the potential to be intrusive, which is why it needs to be used with caution (Rose, 2018). In *tactile signing* (also referred to as "hands on," "hand-over-hand," or "hand-under-hand" signing), the signer produces a sign, and the receiver holds on to the

hands of the signer, which allows him or her to follow the signer's hand movements (Mesch, 2001). Following the hand movements of others through tactile signing can enhance the expressive use of signs and tactile sign language acquisition in children with VIAD (Chen & Downing, 2006, p. 128; see also Dammeyer et al., 2015).

Some children with VIAD may have the capacity to learn more complex linguistic skills beyond single signs if they are provided with access to tactile sign language. However, it is unlikely that hearing parents of children with VIAD have knowledge of the visual sign language of the community when their children are born (see Kanto, 2022), which may delay children's access to tactile sign language. Deafblind people with Usher syndrome are typical users of tactile sign language. They learn visual sign language as their first language and begin to use tactile sign language after their vision deteriorates or disappears (Mesch, 2001, p. 9). Furthermore, some individuals with CDB may develop tactile sign language skills (Tuomi & Lahtinen, 2019). The processing of tactile linguistic information shapes the brain's functioning. Obretenova et al. (2010) found activation within the occipital cortical regions and in the classical language areas when an early blind and congenitally deaf man was presented with words in tactile sign language, braille, and print on palm (sequential writing of the alphabet on the palm when spelling words). These findings indicate that the brain processes tactile language like any other language.

Fourth, some tactile strategies can be used to increase access to information about the environment. In *hand-over-hand guidance,* adults place their hand/s over the child's to help him or her grasp or manipulate an object (Chen & Downing, 2006; McLinden & McCall, 2016, pp. 65–67). This strategy can be used in activities such as feeding children. However, hand-over-hand guidance can be intrusive and may cause resistance in some children with VIAD (Chen & Downing, 2006, p. 88). This type of guidance may also develop passivity in children, as adults lead the exploration (Miles, 2003). *Hand-under-hand guidance* is a less intrusive and preferable strategy. In hand-under-hand guidance, adults guide a child with VIAD by placing their hand/s underneath his or her hands (Chen & Downing, 2006, p. 84). This allows the child to have more control of the situation, as he or she can freely move his or her hands. Moreover, adults' movements and touches under the child's hand can function like a tactile variation of the pointing gesture when they are exploring an object (Miles, 2003).

Lastly, tactile strategies can increase access to emotional expressions. For example, parents can express their emotions by touching the shoulders of their children with VIAD, who can learn to recognize emotions from the type of their parents' touch and movements (Lahtinen, 2008, p. 121; see also Metell, 2015). Moreover, some parents' emotions, such as laughter, are manifested in the whole body and become more accessible to their children with VIAD when the parents'

and children's bodies are aligned with each other (Gregersen, 2018). Furthermore, parents can attune to the emotions of children with VIAD by imitating them tactilely (Damen et al., 2014).

Overall, there is limited scientific information available regarding the benefits of tactile strategies and how parents and other caretakers learn to use them in practice. Lindström (2019) discovered that care workers of Martin, a youngster with CDB, used several strategies over the years to transform customs from visual sign language to tactile sign language. The tactile signing position (hand-over-hand position) developed gradually as Martin developed the ability to participate in tactile conversations. When Martin was in the tactile signing position, the care workers expressed deictic gestures to him through *tactile pointing* (see also Souriau, 2015). Moreover, the care workers used their hand and body movements to refer to people in the signing space and a "wiggling motion" of their hands and body to share positive emotions with Martin (see also Martens et al., 2017).

Some interventions have utilized tactile strategies with positive outcomes (Shakele et al., 2022; see also Brady & Bashinski, 2008; Janssen et al., 2010). Shakele et al. (2022) found that after a bodily-tactile intervention, the mother and brother of a 3-year-old girl with CDB increased their use of tactile sign language, tactile imitations, and hand-over-hand positions. They also became aware of the girl's signals and responded to them appropriately. The girl began to use more communicative expressions, including imitation, signs, and hand-over-hand positions, after the intervention.

Chen et al. (2000) discovered that a focus group consisting of family members and service providers of children with VIAD found an individualized approach essential in selecting appropriate tactile strategies. They also identified a need to develop guidelines for the process of determining tactile strategies. Moreover, the focus group emphasized that the instruction of tactile strategies needs to be positive, non-intrusive, and implemented in familiar routines. Furthermore, they underlined the importance of systematicity in instruction (routines and repetition) and considered tactile learning to involve not only the hands but the whole body.

Lastly, Loots et al. (2005) found that visual-tactile communication strategies (e.g., tapping the child to attract the child's attention, placing hands on the upper body of the child to stimulate and check the child's vocalizing, placing the child's hands in the form of sign configurations, and making body signs) facilitated primary and secondary intersubjectivity between hearing parents and their deaf or hard-of-hearing toddlers. However, the results indicated that the use of sign language was necessary to foster the development of symbolic intersubjectivity ("mental involvement in a mutual exchange of linguistic or symbolic meaning"; Loots et al., 2005) in the parent-child dyads.

2.4.4 Early interventions focused on parent-child interaction and communication

Four studies explored the effects of interventions that fostered interaction or communication between young children with VIAD and their parents. Two utilized music and early social play routines as the content of the intervention (Metell, 2015; Rogow, 1982). The first, Rogow's (1982) study, used early social play routines to develop intentional communication, imitation, and the use of social signals (cues used to elicit a response from others) in children with VIAD. The participants were 10 children aged 15 months to 7 years. Three children were visited in their homes, and their mothers participated in the intervention. Seven children had school visits. Rogow (1982) did not report the total length of her intervention. However, as the video data was gathered every 2 months, the intervention continued over several months. The results indicated that all the children became more aware of their roles in the interactions. Moreover, they developed communication skills, including imitation and intentional communication, in their early social play routines. The children used gestures and body positions to refer to the games they wished to play (e.g., one child stretched her arms in front to indicate her desire to play *London Bridge*). Each child expressed himself or herself through the modalities that were most accessible.

The other study, that of Metell (2015), explored the effects of music therapy on bonding and social interaction between 10 children with VIAD aged from 1 to 4 years old and their parents. The intervention was implemented weekly in a pedagogical institution and continued for over 10 weeks. The results indicated that music therapy fostered positive bonding and enhanced the elements of early interaction. The parents and their children with VIAD obtained experiences of joy, joint attention, and togetherness. In this way, music therapy empowered both the children and their parents.

Chen et al. (2007) investigated the primary outcomes of a curriculum called *Promoting Learning Through Active Interaction* (PLAI). The PLAI curriculum aimed to support interactions between 27 infants with VIAD aged 8–33 months and their parents within daily routines in their homes. It was implemented during 6–21 months and consisted of five modules: 1) understanding child cues, 2) identifying child preferences, 3) establishing predictable routines, 4) establishing turn-taking, and 5) encouraging communicative initiations. Each module included several objectives, such as identifying different kinds of sensory cues to help children with VIAD anticipate well-known routines. The results suggested that the parents found the PLAI curriculum strategies helpful in fostering interactions with their children with VIAD and supporting their children's communication development. For instance, the parents reported that their infants began to anticipate more activities and to participate in them.

Lastly, Rensfeldt Flink et al. (2023) investigated the effects of a communication course *AKKtiv ComAlong* for two mothers and their children aged 2 and 7 years with severe/profound intellectual and multiple disabilities. The 2-year-old participant also had VI. The communication course consisted of eight sessions organized at local habitation centers for children. It aimed to guide parents in identifying their children's behaviors and communication and in using naturalistic communication strategies and AAC in the home. The results indicated that there were no observable behavioral changes in responsive communication style, mothers' use of AAC, or interactive engagement of their children after the course. However, the mothers expressed that their understanding of communication with their children changed during the course, which suggests that they became more aware of their children's behaviors.

2.4.5 Early interventions focused on parents' sensitivity

Two studies explored the effects of interventions that aimed to foster parents' sensitivity and parent-child relationships in families with children with VIAD. The first one, *video-feedback intervention to promote positive parenting-visual* (VIPP-V), was based on an attachment-focused and evidence-based intervention called VIPP (Platje et al., 2018). The participants were 77 children with VIAD or VI aged 1–5 years and their parents, who were randomized into two groups (VIPP-V and care-as-usual). The intervention followed the four themes of the original VIPP: 1) exploration versus attachment behavior, 2) "speaking for the child," 3) "sensitivity chain," and 4) sharing emotions. However, the intervention was individualized and adapted for each family. In adapting the intervention, the specific focus was on increasing exploration, joint attention, and the parents' capacity to read their children's expressions and emotions. VIPP-V included 7 sessions and was conducted over approximately 5 months in the home. The results showed that the intervention did not increase parents' sensitivity or the quality of parent-child interactions. However, the self-efficacy of the parents was boosted, and this predicted an increase in parent-child interaction.

Another study by Dyzel et al. (2023) investigated the effects of an interactive technology-based playmat, the *Barti-mat*, on parents' sensitivity and responsiveness, including mirroring, and the happiness of their children with VIAD or VI. Mirroring was defined as the mimicking of a child's vocalizations (verbal mirroring), movements (behavioral mirroring), or voicing the child's experiences and emotions (affective mirroring). Altogether, 11 parents and their children with VIAD ($N = 9$) or VI ($N = 2$) aged 9–55 months participated in the study. The home-based intervention had a within-series single-case design with randomized blocks, which consisted of playing with the Barti-mat and play-as-usual. The intervention took

place within 1 hour. The results indicated that at least one subcategory of the parents' mirroring behavior improved. Moreover, the results suggested that the Barti-mat increased happiness among the participating children.

To summarize, the different interventions for 0–2-year-old children with VIAD and their families used different means, including early social games, music, daily routines, a communication course, video feedback, and technology-based material. The findings indicate that play routines and music-based activities were helpful contexts in which to develop the participation of children with VIAD and reciprocity in interactions with their parents. The results also suggest that parents benefit from different strategies, including sensory cues and interactive play material, to support interactions with their children with VIAD. Moreover, the findings indicate that theoretical guidance alone is not sufficient to support interactions and communication between children with VIAD and their parents. Although Metell (2015) observed touch as a means for contact and attention between parents and their children with VIAD, and Chen et al. (2007) utilized tactile cues, among other sensory cues, for anticipating actions, neither of these studies had the main focus of utilizing tactile strategies to increase accessibility in interactions. Moreover, previous studies did not explore EA, which is a more comprehensive construct than parents' sensitivity.

3 Aims of the study

The main aim of this research was to gain research-based knowledge of early intervention to enhance early interactions between children with VIAD and their parents. Currently, only a few studies have explored the effects of early interventions for 0–2-year-old children with VIAD, and none have focused on investigating the systematic use of bodily-tactile modality as an interactional strategy to compensate for the child's lack of vision. For this reason, this doctoral study developed and implemented a home-based early intervention in which mothers were guided to use the bodily-tactile modality in interactions with their children with VIAD. The mothers were also guided to respond to their children's bodily and gestural actions in addition to their vocalizations. This study aimed to explore mothers' use of the bodily-tactile modality in interactions with their children with VIAD and the reciprocity of their interactions before, during, and after the early intervention. A special interest in this research was to explore the relatedness of mothers' actions to their children's participation. Moreover, this study aimed to investigate whether possible changes in mother-child interactions during the intervention have an impact on the emotional availability of dyads. The intention is that the results of this study will inform practices for implementing early interventions for children with VIAD and their families.

The specific research questions were as follows:

1) Does tactile imitation guidance change the characteristics of imitations between a mother and her child with CDB (Study I)?
2) Does the mothers' use of the bodily-tactile modality in interactions with their children with VIAD change during the early intervention (Studies I, II, and IV)?
3) Does the participation of children with VIAD change during the intervention, and if so, are the changes in the children's expressions related to their bodily-tactile experiences of interactions with their mothers (Studies I, II, and III)?

4) Does reciprocity between children with VIAD and their mothers change during the early intervention, and if so, how do the mothers and their children construct their interactions during the intervention (Studies I, II, and III)?
5) Does the emotional relationship between children with VIAD and their mothers change during the early intervention (Studies I, II, and IV)?

4 Methods

4.1 Participants

Information related to children's development and functioning of the senses was gathered from medical records and a parental interview, which was designed for this study. The parents were asked about their children's early development, vision, hearing, motor abilities, play, communication, emotional expressions, and family. All the children's names are pseudonyms.

4.1.1 Study I

In Study I, the participants were a mother and her daughter *Emma*, who was 3 years and 10 months old. Emma had trisomy 13 (also called Patau syndrome), which is associated with multiple malformations (e.g., anomalies of the central nervous system) and typical facial features, including a sloping forehead, eye abnormalities, low-set ears with an unusual shape, a small jaw, a prominent occiput, and a cleft lip and/or palate (Pereira, 2023). Emma needed to stay five and a half weeks in the hospital after birth. She had congenital visual and hearing impairments. In a hearing test, she was found to react to speech with hearing aids at 60/65 dB and music at 55 dB. Emma had microphthalmia (an abnormally small eye) and congenital corneal opacity in both eyes. She could only see a small amount of light and black and white stripes, which indicated that she was almost blind. Based on her dual sensory impairment and the severity of the impairments (see Dalby et al., 2019), Emma was defined as a child with CDB in this study. Emma also had a severe learning disability, a congenital heart defect, epilepsy, an operated cleft palate, severe problems in her motor development, and an extra finger on one hand. Her motor problems prevented her from standing or walking independently. She also needed support when she was seated. However, Emma could keep her head upright and use her hands and fingers to explore objects and the faces of people (e.g., checking if the person was wearing glasses or earrings). Based on information from Emma's mother, she herself was employed and had good physical and mental health.

Emma and her family had received support for communication from a local center for individuals with developmental disabilities. A communication adviser

from the center met Emma in kindergarten weekly. Moreover, the family had been in a multidisciplinary individual rehabilitation course organized by the Finnish Federation of the Hard of Hearing. They had received 10 teaching sessions for manual signing. Emma had only had appointments with an SLP in the hospital. The parents mainly utilized vocal modality for interacting with Emma. However, they also used some tactile strategies, including tactile contact and objects of reference, in anticipating daily routines. Emma used noncanonical vocalization, smiling, laughing, and bodily means to express herself. She utilized one spontaneous sign *DRINK*, which she made in the air. Emma could imitate her parents' tone of voice and make initiatives through movements with her hands and legs (e.g., lifting her hand up when expressing a wish to continue bodily activity). Her parents were not sure how much Emma could comprehend speech or signs.

4.1.2 Study II

In Study II, the participants were a mother and her son *Robin,* who was one year and five months old. He was born preterm and had an L1CAM gene mutation causing L1 syndrome with agenesis of the corpus callosum, obstructive hydrocephalus (with a shunt), adducted thumbs, epilepsy, and a mixed specific developmental disorder. Robin had unqualified visual loss in both eyes (suspected CVI), which caused an estimated 50% degree of visual disability. Moreover, he had strabismus and nystagmus. Robin used eyeglasses for half of the day. It was difficult for him to see objects that were not close to him or pictures in books, but he could detect a toy when it was brought near him. He had normal hearing. Robin could not sit without support or grasp objects with both hands. He had some tactile defensiveness with his hands. Robin's mother is a healthcare professional.

Robin and his family did not have systematic support for communication. However, they had had five counseling sessions with an SLP due to Robin's eating difficulties. According to Robin's mother, Robin appeared to understand his own name and easy speech connected to routines. Robin used vocalizing and body movements to express himself. He made initiatives infrequently. At times, he could bring his hands together at the beginning of the Finnish nursery rhyme "Hämä-hämä-häkki" (Itsy Bitsy Spider), trying to imitate the movements of the song. Moreover, he could imitate his mother vocally if she used a sound belonging to his sound repertoire to initiate the dialog. Robin liked to sit on his parents' laps and explore their faces using his hands. It was easy for Robin's mother to read his emotions. However, she wished Robin could express his thoughts and desires better.

4.1.3 Studies III and IV

The participants of Studies III and IV were *Thea*, *Sara,* and *Alex* and their mothers. All the children had epilepsy and developmental delays. Sara received a diagnosis of ID during the data collection. The children's hearing was reported to be normal. However, Thea's parents pointed out that Thea only showed her first reactions to sounds (e.g., rattles) at the age of 9–10 months. It was difficult for the children to make voluntary movements and sit without support. The families of Thea and Alex had not received systematic support for communication. Sara received speech therapy approximately once a month in kindergarten. The mothers of Thea and Sara work in healthcare, and Alex's mother is a homemaker.

Thea was exactly 1 year old. She had CVI and athetoid CP. Her disabilities were caused by severe birth asphyxia and infection. Thea needed to stay for long periods in the hospital during her first six months. She was medically fragile and had nursing assistance at home. Her parents could only achieve eye contact with her for a moment. Thea expressed herself through vocalizations, crying, and facial expressions. She did not imitate her parents' expressions. Thea's mother utilized some haptices (touch messages; Lahtinen, 2008) with Thea in daily activities. Thea had some functional vision. She could detect objects with a strong contrast in color and moving objects. Thea liked to be in bodily contact and enjoyed early social play routines, which included strong tactile sensory stimulation. Thea's mother wished she could obtain guidance for elaborating on haptices and developing reciprocal interactions with Thea.

Sara was 1 year and 9 months old. She had CVI and athetoid CP. Her disabilities were caused by prenatal hypoxic-ischemic encephalopathy and severe anemia as a newborn. She needed to stay in the hospital for approximately six weeks after birth. Her parents could achieve eye contact with her for short periods. Sara used vocalizations, crying, facial gestures, and movements (e.g., kicking her feet) to express herself. If her parents imitated her vocalization, she could sometimes continue the imitative exchange. Sara had some functional vision. She could see objects with bright colors or clear figures and detected them best from a distance of 20–30 cm. The play between Sara and her mother consisted of interacting with toys and physiotherapy exercises. Sara liked to be in bodily contact with her parents and to interact with them. She smiled at her parents' voices and other interesting sounds. Sara's mother wished that they could have more reciprocity in interactions and that Sara could develop her expressive communication skills.

Alex was 1 year and 7 months old. He had CVI and spastic quadriplegic CP. His disabilities were caused by severe birth asphyxia. Alex was born preterm, and he needed to stay in the hospital for approximately one month after birth. He also needed periods of hospitalization at a later stage. Alex spent weekends in a temporary care unit and the rest of the time with his family. He used smiling,

laughing, crying, and bodily actions to express himself. His parents had not observed him imitating their expressions. It was not clear how much functional vision Alex had. However, his mother indicated that his vision had improved and that he could perceive some objects. The play between Alex and his mother consisted of stretching, chatting, and exploring toys. Alex enjoyed being close to his family members and touched. Alex's mother wished Alex could engage more in play and develop his expressive communication skills.

4.2 Study design

This study uses case report (Study I), single-case study (Study II), and multiple-case study designs (Studies III and IV). Case reports are connected to findings in clinical practices and may provide early signals of the effectiveness of interventions with previously unreported features (Alpi & Evans, 2019). Single-case study designs cover more complexity than case reports and may involve one or multiple participants (Horner et al., 2005). Single-case designs "often involve repeated, systematic measurement of a dependent variable before, during, and after the active manipulation of an independent variable" (e.g., applying an intervention; Kratochwill et al., 2010, p. 2). Typically, the behaviors of each participant are compared to his or her prior behaviors (Kratochwill et al., 2010). Single-case studies are useful in learning more about low-incidence disabilities, such as VIAD (Campbell & Johnston, 2009). They are also ideal for studying dynamic interdependencies among the participants (Marková et al., 2020).

Single-case studies can have different designs. After considering the specifics of the interventions, it was concluded that the ABAB reversal design would not be appropriate for the studies because the dependent variables were unlikely to be reversed after the intervention (see Kratochwill et al., 2010). Study I used a case report design (AB). Study II was a single-case study using a longitudinal design (ABA). Studies III and IV were multiple-case studies using a longitudinal design (ABA). Longitudinal case studies produce information about how conditions and their underlying processes change over time (Yin, 2014, p. 53). The study designs are presented in Figure 1. A refers to the time without intervention and B to the intervention. The studies were approved by the ethics committee of the Helsinki and Uusimaa Hospital District, and research permits were granted from university hospitals in Southern Finland.

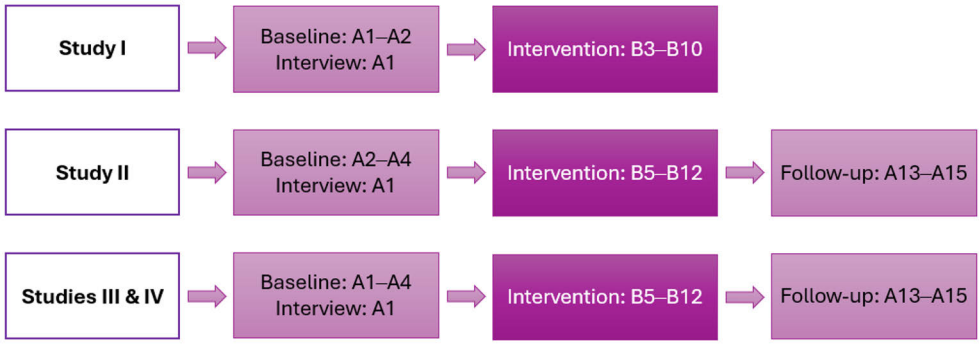


Figure 1. Study designs and the progress of data collection.

In Study I, the family was contacted through the Finnish Federation of the Hard of Hearing. The inclusion criteria for the child were dual sensory impairment and an early phase of language development (expressive vocabulary limited to a maximum of 10 spontaneous words or signs). A contact person in the Finnish Federation of the Hard of Hearing sent an information letter regarding the study to the family. The information letter explained to the parents that the study would focus on exploring the characteristics of interactions between children with CDB and their parents and would include video recordings. The parents were also informed about the place of the videorecording (home or another environment, if preferred) and the number and duration of the sessions. Moreover, that the study would consist of two parts was also explained to them. In the first part, the researcher will interview the parents and record free play between them and their child. In the second part, the researcher will cooperate with the parents and continue videotaping parent-child play sessions. Furthermore, the parents were informed that their own and their child's contributions to the interaction would be analyzed. After reading the letter, the mother contacted the researcher by telephone. During the call, she had the opportunity to ask additional questions related to the study. The parents gave their informed written consent for their child's participation.

The participant families in Studies II, III, and IV were reached through university hospitals in Southern Finland. Searches for the children were made using the following criteria: (a) maximum age of two years, (b) severe VI, (c) preverbal language skills (no more than 10 words or signs in use), and (d) Finnish as the language spoken at home. Candidate families received an information letter about the study from contact persons at the university hospitals. The information letter explained to the parents that interactions with their children with VIAD can be fostered by guiding the parents to use communication strategies that their children can understand. They were also informed about the place of the intervention (home or another environment, if preferred), the number and duration

of the sessions, the video recording of the sessions, and the use of video feedback as part of the guidance. The volunteer mothers contacted the researcher by telephone, and the parents provided their written consent for their children's participation. After the data collection, each family received a toy gift card for a maximum of 25 euros.

4.3 Data collection

This study used *video recording* as a method for data collection. Video recording is a useful method for data collection when the focus of the study is to investigate the subtle behaviors of the child. Without videos, the emerging behaviors of the child could be missed or captured only partly. Moreover, the videos can be viewed several times, which improves the reliability of the observations (Bates et al., 1979, p. 83; Nafstad & Rødbroe, 2015). Altogether, over 24 hours of data were gathered for Studies I–IV. The progress of the data collection is presented in Figure 1.

Originally, the data for Study I were collected for a master's thesis at the University of Groningen, the Netherlands (Peltokorpi, 2011). In this doctoral study, the data were analyzed with new research questions and methods. In Study I, the researcher met the family 10 times, and the video data were gathered from 9 sessions (I–II and IV–X). This made over 2 hours of video data, which included mother–child interactions with or without toys, father-child interactions, and sessions in which both the father and mother played with Emma. Altogether, 2–3 recordings were made per week over a 6-week period. The recordings A1–B4 and B8–B10 were made in the home. Recordings B5–B7 were made at the Service and Activity Centre for the Visually Impaired (IIRIS) in Helsinki, where the family stayed for a week. The first two sessions (A1–A2) were baseline sessions. Before the video recordings, the parents were asked to play with Emma as they normally would. Sessions B3–B10 included guidance for the parents. Emma had an ear infection during the data collection and could use her hearing aids only in sessions A1, A2, and B10.

In Study II, the researcher met the family 15 times at home. Based on the parents' decisions, only the mother participated in the intervention. During the first session, the mother was interviewed. Video data on free play were gathered from 14 sessions (A2–A4, B5–B12, and A13–A15) using two video cameras. The mother chose the most convenient day and time for the recordings, which was early in the morning. Before the free play recordings, the mother was asked to play with Robin with and without toys, as she liked. These two types of play were recorded separately. The baseline recordings (A2–A4) were made weekly and lasted about 30 min each. The recordings during the intervention (B5–B12) were made weekly, and each session included two separate recordings. The first recording included triadic play among

the researcher, Robin, and his mother, and the second recording consisted of free play between Robin and his mother. During free play, Robin and his mother played without toys in all sessions, and in some sessions, they played with toys. The intervention sessions lasted a maximum of 90 min. The follow-up recordings were made one, five, and nine weeks after the last intervention session and lasted about 30 min each. Robin wore his eyeglasses during all the recordings. In the A14 and A15 recordings, he had nasogastric intubation due to eating problems and vomiting. Altogether, there were over 7 hours of video data. The data consisted of video-recorded mother-child interactions with or without toys, triadic play sessions, and extra video clips of mother-child interactions.

The data collection for Studies III and IV followed the principles of Study II, with some exceptions. First, four baseline recordings (A1–A4) were used instead of three to obtain a longer baseline period. Second, the mothers chose the most convenient day and time for the video recordings, which could be morning or afternoon. Third, the mothers were asked not to play with toys during the free play sessions. Fourth, there were exceptions to the scheduling of the recordings. Due to Thea's illness, there were three weeks between baseline recordings A2–A3. For Alex, there were two weeks between baseline recordings A1–A2 and A3–A4. There were also some exceptions to the scheduling of the intervention sessions. Due to Alex's illness, a one-week adaptation training course, holidays, and other family reasons, there were two weeks between recordings B7–B8, three weeks between recordings B8–B9, and two weeks between recordings B9–B10, B10–B11, and B11–B12. There were no exceptions in the scheduling of intervention sessions with Sara or Thea. The follow-up recordings were carried out mostly as planned. However, Alex's A15 recordings were made 24 weeks after the last intervention session due to the coronavirus pandemic. He stayed for about three months in temporary care between recordings A14–A15. All the children had frequent health problems during the recordings. Thea had difficulty breathing and nausea, Sara had epileptic seizures, and Alex had frequent serious respiratory infections and breathing difficulties. Altogether, over 14 hours of video data were collected. The data consisted of video-recorded mother-child interactions with or without toys, triadic play sessions (mother, child, and the researcher), and extra video clips of mother-child interactions.

In Studies III and IV, the mothers were given two questionnaires (Brief EA Self-Report and a questionnaire designed for this study) after the first baseline recording and after the last intervention session. After the intervention, the parents of Study I were asked to give written feedback about the guidance. Similarly, all the mothers in Studies II–IV were asked to provide feedback using a feedback form, including a numeric evaluation of the intervention and a video-recorded interview.

4.4 Tactile imitation guidance (Study I)

4.4.1 The theoretical framework

Tactile imitation guidance (Study I) was inspired by research on typically developing infants and Trevarthen's theory of intersubjectivity (Trevarthen, 1979; Trevarthen & Hubley, 1978). Trevarthen's (1979) findings indicate that imitation creates turn-taking in the dyadic interactions between infants and their parents. That is to say, when parents imitate their infants' expressions, they treat them as initiatives. This encourages conversational activity and creates sequences in parent-child interactions during primary intersubjectivity (Trevarthen, 1974). Moreover, adults' imitations have been found to have a positive impact on infants' responsiveness, which is embodied through their increased levels of attention, smiling, and approach behaviors (e.g., Sauciuc et al., 2020). Due to these positive effects in connection to being imitated, imitation has become a well-known strategy to support reciprocity in interactions with persons with CDB or VIAD (Chen, 2014; Dyzel et al., 2023; Hart, 2006; Nafstad & Rødbroe, 1999) or autism spectrum disorders (e.g., Delafield-Butt et al., 2020). Additionally, communication approaches, such as intensive interaction, utilize imitation as a strategy to foster the quality of interactions with persons with severe learning disabilities (Nind & Hewett, 2001).

Tactile imitation guidance was also inspired by tactile strategies (e.g., Chen & Downing, 2006; Miles, 2003). The theoretical knowledge of cross-sensory perception and the brain's flexibility in the processing of sensory information (Guellaï et al., 2019; Obretenova et al., 2010) made it possible to hypothesize that Emma (Study I) could connect the tactile information of the parents' imitations to her own expressions. Thus, it was assumed that an increase in the bodily-tactile modality in imitations would increase their accessibility. The intervention was designed and implemented by a researcher with an MA in speech-language pathology and an MSc in educational sciences, with a specialization in communication and CDB.

4.4.2 Content of tactile imitation guidance

Based on observations during the baseline sessions, it was noted that Emma's mother often used vocal modality to imitate Emma's vocal expressions. She also made spontaneous nonverbal imitations of Emma's movements and gestures, but it appeared that Emma was unable to perceive these imitations due to her severe VI.

During the guidance, the researcher shared information about imitation with Emma's parents and gave them suggestions for imitation. She guided the parents before the recorded play sessions or after them and sometimes also during the

recordings. The researcher explained to the parents the characteristics of imitation in typical early interactions and the use of imitation as a strategy to enhance reciprocity in interactions with children with CDB (e.g., Dyzel et al., 2023; Shakele et al., 2022). Moreover, she showed some video examples of the previous sessions to demonstrate moments of imitation. She also shared video examples of other caretakers imitating persons with CDB to model different ways of *tactile imitation* (Janssen & Rødbroe, 2007; Rødbroe & Janssen, 2006). All the video examples were discussed together. It was concluded that it is unlikely that the parents' nonverbal spontaneous imitations were accessible to Emma. The parents agreed that they could begin to use more of the bodily-tactile modality in their imitations to compensate for Emma's VI. They could transmit their nonverbal imitations tactilely and add tactile elements to their vocal imitative responses to increase multimodality in their imitations (e.g., making the imitative response on Emma's body, guiding her hand in a hand-over-hand position to "listen" the parent's imitation, or imitating her movements in a manner that enables perception through the sense of touch).

When guiding the parents, the researcher advised that almost all Emma's movements or vocalizations could be imitated. However, she emphasized that parents do not need to imitate Emma's every action, and they can apply tactile imitation in interactions naturally the way they prefer. The researcher also provided concrete examples of tactile imitation when she interacted with Emma. Moreover, she informed the parents that when they succeeded in establishing turn-taking exchanges with Emma through imitation, they could make variations in their imitations to keep the content of the interaction interesting. The variations should belong to Emma's vocalization and gestural repertoire, and new expressions could be used at a later stage.

4.5 Bodily-tactile early intervention (Studies II–IV)

4.5.1 The theoretical framework

The theoretical base of bodily-tactile early intervention is connected to the findings of cross-sensory perception (Guellaï et al., 2019), the brain's capacity to process information through alternative modalities (Obretenova et al., 2010), and the literature on tactile strategies (e.g., Chen & Downing, 2006; Miles, 2003). Based on this knowledge, *sensory accessibility* became a crucial concept for the intervention. Moreover, Study I inspired the broadening of the use of bodily-tactile modality beyond imitation. The researcher developed the bodily-tactile early intervention model based on theories that emphasize the role of the social environment and parent-child interactions in children's development (e.g., Bronfenbrenner & Ceci, 1994; Sameroff & Chandler, 1975; Vygotsky, 1978). One of the most influential

theories is *the transactional model of development,* which underlines the mutual influences of children and their social environments (Sameroff & Chandler, 1975). According to this theory, the development of a child is a result of dynamic interactions between the child and his or her social environment over time (Sameroff & MacKenzie, 2003a).

Sameroff and Chandler (1975) demonstrated that poor clinical status or other risk factors in newborns do not solely explain children's later outcomes. Instead, the findings indicated that the environment had a great impact on children's development, which could be positive or negative. Furthermore, they discovered that not only did parents influence the child but also the child influenced his or her parents. The researchers concluded that it was the specific *transactions* of a child and his or her parents that predicted the child's developmental outcomes. However, this was not to say that severe disabilities would not compromise children's development in optimal social environments. Nevertheless, it is the view of the transactional model that supportive social environments can help children with severe disabilities reach their full developmental potential (Sameroff & MacKenzie, 2003a). When implementing an intervention, it is essential to understand how parents and children think about each other, as this impacts their behavior in interactions. Moreover, understanding how their actions influence each other is relevant for guidance (Sameroff & MacKenzie, 2003a).

Before implementing the intervention of this study, an extensive quantity of literature on the developmental milestones of children with VI/VIAD and the characteristics of their interactions with their parents was studied (e.g., Als et al., 1980; Fraiberg, 1971; Preisler, 1991, 1995; Rogow, 1982; Urwin, 1978). The findings indicated the importance of reciprocity and emotional connection in parent-child interactions and the parents' ability to provide rich multimodal experiences for their children with VI/VIAD. The intervention was also inspired by an intervention model developed for children with CDB (Nafstad & Rødbroe, 2015) and the mentalization-based parent-child intervention model called "Nurture and Play" (Salo et al., 2019).

4.5.2 Main principles

The bodily-tactile early intervention utilized elements similar to previous early interventions designed for children with VIAD and their parents. These elements included early social play routines, music, the use of imitation, and video feedback (e.g., Dyzel et al., 2023; Metell, 2015; Rogow, 1982). However, unlike the previous interventions, the bodily-tactile early intervention focused primarily on increasing accessibility in early interactions between children with VIAD and their mothers through the *sharable* bodily-tactile modality. Thus, the intervention was based on

the children's strengths. The aim was that increased accessibility would enhance reciprocity in mother-child interactions and children's participation.

The baseline recordings of each family were viewed several times to learn the characteristics of their interactions. The observations were discussed with other research group members, and the information was utilized in planning the content of the intervention. Thus, although the themes and principles were the same for all the mothers and their children with VIAD, the intervention was individualized based on their individual characteristics and preferences. Moreover, some baseline recordings revealed the children's abilities, which were discussed with the mothers. For instance, the baseline recordings of Study II revealed that Robin had learned three gestures from "Itsy Bitsy Spider," which he had played several times by coactive signing with his mother. However, Robin's mother was not aware that Robin could make these gestures independently. After the last baseline recording, the researcher informed the mothers about the content of the intervention and gave them the first suggestions related to the use of tactile strategies. Each intervention session consisted of three parts: (a) discussion and video feedback, (b) triadic play session, and (c) free play session (Figure 2).

Figure 2. The content of the intervention sessions.

4.5.3 Discussion and video feedback

The first part of the intervention session included introducing the themes of the session and discussing them with the mothers. The themes (different tactile strategies) were designed before the intervention, and the most appropriate themes were selected for each child. Video examples of other children with VIAD and their caretakers and modeling were used to demonstrate different tactile strategies to the mothers (Janssen & Rødbroe, 2007; Rødbroe & Janssen, 2006). Moreover, during the intervention, the researcher analyzed the video data and showed some video clips to the mothers to demonstrate reciprocity in the mother-child interactions, the children's participation, and the mothers' use of the tactile strategies. All the videos were analyzed and discussed with the mothers. The mothers were given explanations of why specific strategies could be useful in interactions with their children with

VIAD. Moreover, the researcher utilized the video recordings and the mothers' ideas to design the content of the following sessions. The researcher gave the mothers folders that included brief texts about the themes of the sessions and the lyrics of the songs, which aimed to help them learn and memorize the information. The mothers also received information sheets on useful books, articles, and webpages connected to tactile strategies and early intervention.

4.5.4 Triadic play session

During the triadic play sessions, the researcher played with the children and their mothers. Occasionally, the father or other family members were also present in some families, but they did not engage in the play activities. Typically, the researcher modeled how the bodily-tactile strategies can be applied in play with the children and asked their mothers to repeat the modeled actions with their children. Thus, *modeling* was a frequently used strategy in the guidance. The researcher also gave feedback to the mothers on their use of tactile strategies during the play activities. Overall, the guidance aimed not to cause an over-reliance on professional input. Instead, it was aimed at supporting mother-child interactions and equipping the mothers with new ideas and resources. Initially, the researcher informed the mothers that their children may use tactile contact instead of eye contact (Figure 3). This was important because otherwise, the contact initiatives of the children with VIAD could have been unnoticed (Nafstad & Rødbroe, 2015). During the sessions, several tactile strategies were practiced, which are described below.

Figure 3. Illustration of tactile contact. Illustration: Saara Waked.

The mothers were introduced to new *bodily-tactile play routines*. Creating new early social play routines was important because they create discourse frames in early parent-infant interactions (Snow et al., 1987). Moreover, ensuring that play routines have a bodily-tactile structure makes them accessible to children with VIAD. Some mothers already had several bodily-tactile play routines in their repertoire at baseline, and some of them did not have any. In the case where a mother already had a large repertoire of bodily-tactile play routines at baseline, emphasis was placed on the optimal structuring of the play routines for her child's participation. The new intervention-based play routines in the bodily-tactile modality consisted of existing cultural play routines with bodily-tactile structure (e.g., a Finnish rhyme "Magpie Makes Porridge"), self-created choreographies for songs, and self-created games. When trying out new games, the mothers provided important insights into their children's preferences, and the games that appeared most enjoyable for the children were utilized in the triadic play sessions. In Study II, Robin's mother was guided to use play routines with and without toys when playing with Robin. However, in Studies III and IV, only play routines without toys (nonconventional and conventional games) were utilized because they were considered developmentally easier activities for Thea, Sara, and Alex than games with toys (Trevarthen, 1980).

The mothers were guided to *create slots* for their children's turn-taking and to *observe* their children's bodily expressions during the slots. This was essential because children with VIAD may need a longer wait time to process information to respond to their communication partners (Johnson & Parker, 2013; see also Damen et al., 2014). Moreover, focusing on children's participation was a necessary part of the intervention because most of the tactile strategies were connected only to the input for children with VIAD. When observing the children, special attention was paid to their bodily and gestural expressions, which are often difficult for their communication partners to detect and interpret (e.g., Fraiberg, 1979; Nafstad & Rødbroe, 2015). Moreover, this study aimed to support turn-taking in mother-child interactions by guiding the mothers to respond to diverse movements of the children. Responding to children's movements was also used in a previous approach "Learning together" developed for children with VIAD (Lee & MacWilliam, 2008, pp. 21–40).

When the mothers observed their children's bodily responses during the slots, they were encouraged to notice them through touch (Figure 4). Thus, if a child moved his hand, the mother was encouraged to touch the hand after the movement while acknowledging the child's action verbally. *Tactile noticing* can be considered a variation in the parent's responsiveness (Bigelow, 2003; Damen et al., 2015a; Nafstad & Rødbroe, 2015). Providing a means to strengthen the multimodality of parents' responsiveness is important because parents' responsivity is critical for

developing socioemotional competences in children with VIAD (Lang et al., 2017; Van keer et al., 2017). Moreover, parents' tactual and vocal responsiveness expresses to children with VIAD that their actions have an impact on others, which can help them associate meaning with their behaviors (Bigelow, 2003; Yoder & Warren, 1998). Furthermore, tactile noticing can also be a helpful strategy for marking segments of action in parent-infant interactions (see Bruner, 1975). Specifically, when a mother touches her child's hand or leg after movement, her touch can facilitate forming units (turns) in sequences. Finally, tactile noticing may provide tactile information for children with VIAD about their parents' attentional focus (see Bigelow, 2003).

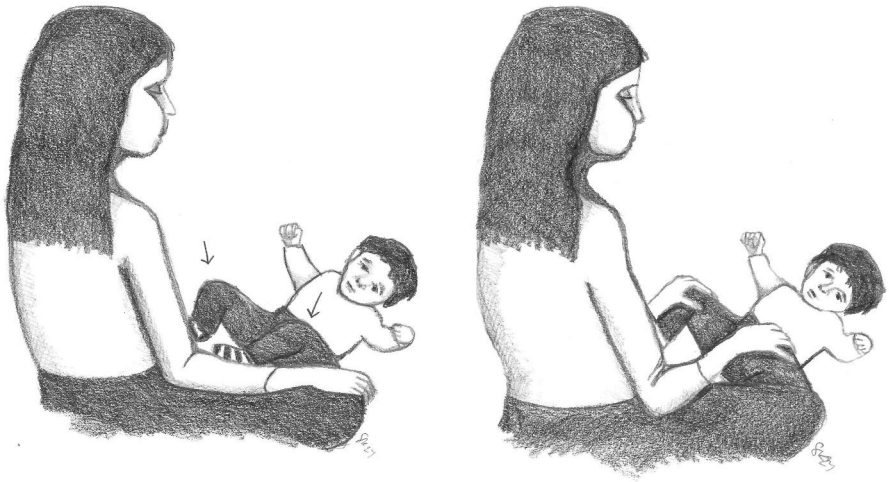


Figure 4. Illustration of tactile noticing. Illustrations: Saara Waked.

The mothers were guided to use *tactile anticipatory cues* to anticipate actions (e.g., touching the child's hand before moving it in a game; Figure 5). Tactile anticipatory cues are touches or movements that are used in connection with speech to inform the recipient about the following action. Thus, they aim to increase perceptual accessibility to adults' intentions (cf. Reddy, 2015). Tactile anticipatory cues resemble touch-speech cues described by Goold and Hummel (1993) and haptices (Lahtinen, 2008). However, as tactile anticipatory cues are used only for anticipation, their function is narrower. Tactile anticipatory cues were considered important in helping the children predict the subsequent actions and prepare them (see Nomikou et al., 2017; Reddy et al., 2013). When children can anticipate the next action and its timing, they can coordinate their own actions with those of others (see Axelsson et al., 2014; Deppermann & Streeck, 2018; Reddy et al., 2013).

Figure 5. Illustration of tactile anticipatory cues. Illustrations: Saara Waked.

Tactile imitation was introduced to the mothers as a strategy to enhance turn-taking with their children (Hart, 2006; Miles, 2003; see also Chen, 2014). The mothers were encouraged to imitate their children's movements and gestures in an accessible way through a sense of touch. For instance, if the children were tapping with their hands, the mothers were encouraged to respond by tapping the children's hands or legs. Moreover, the mothers were encouraged to continue their personal ways of imitating their children's expressions vocally.

Tactile signs. The mothers were informed of the different ways of making tactile signs. This was to provide the children with the opportunity to learn the cultural signs of Finnish Sign Language from early on. Coactive signing (Figure 6A) and body signs (Figure 6B) were practiced in the play routines. These strategies were easy to implement with young children with VIAD, as they were often sitting on their mothers' laps or lying on a mattress during play activities.

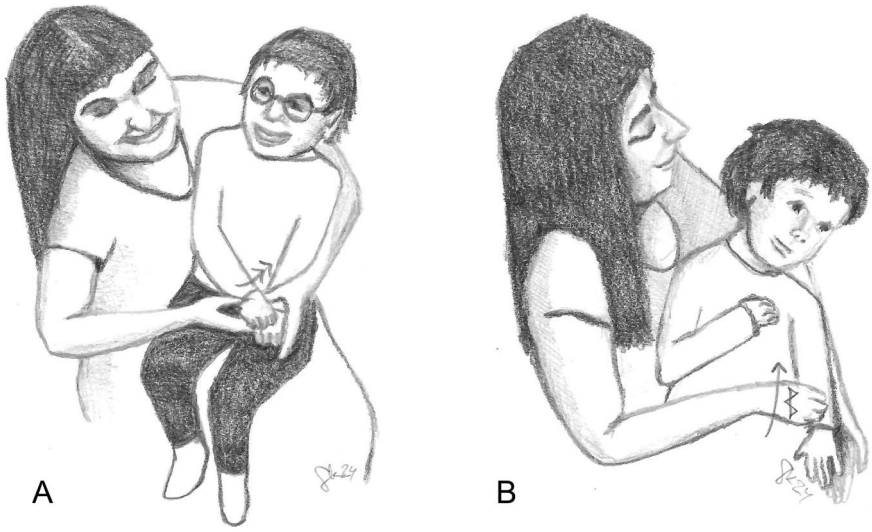


Figure 6. Illustrations of tactile signs: Coactive signing (A) and body signing (B). Illustrations: Saara Waked.

In Study II, Robin's mother was instructed to use *hand-under-hand guidance* (Figure 7A) as a less intrusive and alternative way to *hand-over-hand guidance* (Figure 7B) when she was guiding Robin to explore toys. She was also shown how a *tactile pointing* gesture could be made (Figure 8). Because Robin had some functional vision, tactile pointing was aimed at helping him follow his mother's pointing gestures. Hand-under-hand guidance and tactile pointing were also addressed in discussions with other families in Studies III and IV, but they were not actively practiced in the sessions.

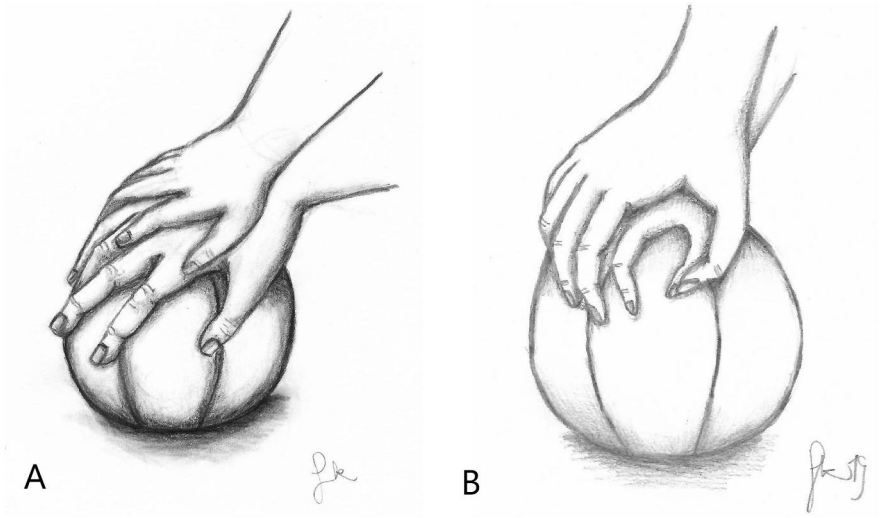


Figure 7. Illustrations of hand-under-hand guidance (A) and hand-over-hand guidance (B). Illustrations: Saara Waked.

Figure 8. Illustration of tactile pointing. Illustration: Saara Waked.

Overall, the different themes were rehearsed several times during the sessions, and some themes were practiced more with some mothers than with others. Moreover, the mothers were encouraged to continue speaking to their children with VIAD as they typically did. Thus, tactile strategies were not aimed at replacing any

verbal behaviors but at complementing them and giving the children access to multimodal information about interactions.

4.5.5 Free play session

After each triadic session, free play between the mothers and their children was recorded (Figure 2). These data were utilized to evaluate the effects of the intervention in the video analysis. In Study II, free play with and without toys was recorded separately. In Studies III and IV, only free play without toys was recorded. This was due to the different developmental stages of the children and the individualized aims for their interventions. Before the recordings, the mothers were asked to play with their children as they wished. After the free play recordings, the mothers were given some suggestions for the strategies they could apply in interactions with their children during the following week.

4.6 Data analysis

In Study I, four recordings (A1, B4, B8, and B10) of Emma and her mother were analyzed. The length of the recordings varied between 8 and 10 minutes, resulting in a total of 36 minutes of data. The recordings from other sessions were omitted from the analysis due to the change in participants (father and Emma in recordings A2 and B5), Emma's sleepiness due to a different location for the recordings (recordings B6 and B7), and technical reasons (recording B9). In Study II, free play without toys was analyzed from three baseline, three intervention, and three follow-up sessions. The length of the recordings varied between 10–13 minutes, making a total of 1 hour and 43 minutes of data. ELAN (2020, version 6.0) software was used to code the videos. In Study III, altogether, 1 hour 21 minutes of video data were analyzed from baseline, intervention, and follow-up sessions. In Study IV, free play from four baseline, three intervention, and three follow-up sessions was analyzed for each mother-child pair. The researcher selected one recording from the beginning, middle, and end of the intervention for the analysis. The selection was made based on the children's activity in the interactions. The length of the recordings varied from 9 to 17 minutes for Thea, from 10 to 14 minutes for Sara, and from 10 to 11 minutes for Alex. This resulted in 5 hours and 39 minutes of analyzed data. ELAN (2021; version 6.2) software was used in the coding. The different methods that were utilized in analyzing the video data are presented in Table 1.

Table 1. The participants, interventions, and analyses used in the studies.

STUDY	PARTICIPANTS	INTERVENTION	DATA ANALYSIS
STUDY I	Emma and her mother	Tactile imitation guidance	Imitation coding procedure EA Scales
STUDY II	Robin and his mother	Bodily-tactile early intervention	Bodily-tactile coding procedure Multimodal conversation analysis EA Scales
STUDY III	Thea, Sara and Alex and their mothers	Bodily-tactile early intervention	Multimodal conversation analysis
STUDY IV	Thea, Sara and Alex and their mothers	Bodily-tactile early intervention	Bodily-tactile coding procedure EA Scales

4.6.1 Imitation coding procedure

In Study I, the characteristics of imitations between Emma and her mother were analyzed using a coding system devised by O'Neill and Zeedyk (2006), which was modified in this study. The imitation coding procedure was used to discover whether the characteristics of imitations between Emma and her mother changed during tactile imitation guidance (Research Question 1). These characteristics were related to the modalities used in the imitations, Emma's participation, and the length of the reciprocal imitative dialogs (Research Questions 2–4). First, *an imitative bout* was coded when Emma or her mother imitated the other's vocal or nonverbal expressions. A minimum imitative bout included an expression and its imitation. An imitation of Emma or her mother needed to appear within three seconds of the end of the initial expression to be registered. A longer time than in the original study (O'Neill & Zeedyk, 2006) was used because Emma's imitations occurred at a slower pace. The initiator and length of the imitative bout were marked. The length was calculated by calculating the *number of rounds* in each imitative bout. If an expression was imitated only once, the imitative bout had a length of one round.

Next, the *communicative mode* of each imitative bout was registered. As the original coding procedure (O'Neill & Zeedyk, 2006) included only two categories (vocal and physical imitation), more categories were created for the present study. The categories were 1) vocal imitations (e.g., vocalizations, imitative sighs, and whispers), 2) gestural imitations (e.g., head-shaking), 3) tactile imitations (e.g., the mother touched Emma in a similar way as she had touched her), 4) gestural-vocal imitations (e.g., simultaneous vocalization and shaking head gesture), and 5) vocal-tactile imitations (e.g., the mother imitated Emma vocally and traced the movement

of her mouth onto Emma's hand). For instance, vocal imitation was marked if the mother imitated Emma's "ah" sound by saying "ah." Accordingly, a gestural imitation was registered if Emma shook her head and the mother imitated it by shaking her head.

4.6.2 Bodily-tactile coding procedure

A bodily-tactile coding procedure was developed for Studies II and IV. It was used to gain information about the frequency and duration of the mothers' use of the bodily-tactile modality in interactions with their children with VIAD (Research Question 2). Thus, a bodily-tactile coding procedure was developed to capture potential changes in accessibility. Moreover, in Study II, the bodily-tactile coding procedure was utilized to investigate potential changes in Robin's participation (Research Question 3). A new coding procedure was developed because the existing coding procedures did not capture the characteristics of the data. The length of each recording was edited and rounded to the nearest full minute (e.g., 10:00 or 12:00) to compare the frequencies of the studied phenomenon per minute. The bodily-tactile expressions were coded in their contexts. This was necessary to be able to categorize the expressions correctly (e.g., using tactile noticing to respond to a child's expression). Mutually exclusive categories were used in the coding. However, if there were two simultaneous bodily-tactile actions belonging to different categories (e.g., nonconventional play and tactile noticing), both actions were coded.

The categories used in the coding were based on the data. However, only bodily-tactile behaviors related to interaction and communication were noted. Study II used more categories in the coding than Study IV used. This was due to the low frequency of some behaviors in Study IV and the different emphasis on the content of the interventions based on the children's abilities. The bodily-tactile behaviors related to the themes of the intervention were coded in both studies. In Study II, the spontaneous tactile behaviors of the mother were also coded. In Study IV, the category "touches related to anticipating and noticing" used in Study II was divided into two different categories (tactile anticipatory cues and tactile noticing).

In Study II, two successive similar touches or movements were coded as one behavior if they occurred within 2 s in the following categories: signs, touches related to anticipating and noticing, touches or movements connected to play, hand-over-hand guidance, and other tactile attention-directing gestures. The timeframe clarified the coding; otherwise, it would have been difficult to determine whether the behaviors should be coded as one or two separate actions. The categories used in the coding are presented in Table 2.

Table 2. The categories of the mothers' bodily-tactile behaviors in Studies II and IV.

	STUDY II	**STUDY IV**
INTERVENTION-BASED ACTIONS	Touches and movements connected to play	Nonconventional and conventional games
	Touches related to anticipating and noticing	Tactile anticipatory cues
	Bodily-tactile imitation	Tactile noticing
	Tactile attention-directing gestures: Hand-under-hand guidance and tactile pointing	Coactive signs and body signs
	Tactile and nontactile signs	
SPONTANEOUS ACTIONS	Conventional gestures	
	Tactile attention-directing gestures: Hand-over-hand guidance and other spontaneous gestures	
	Touches connected to naming	
	Bodily-tactile emotional expressions	

Early play routines. In Study II, touches and movements connected to early social play routines were coded. The registering of movements required that they were accessible to Robin (e.g., bouncing movements when Robin sat on his mother's lap). Tickles, blowing on the skin, and playful touches with objects were also coded. However, coding of the sensations created with air flow necessitated tactile contact between Robin and his mother. This was due to the interactional aspect of the game.

In Study IV, games with toys were not registered because they were not used in the intervention. Moreover, the play routines were coded using a modified version of Camaioni and Laicardi's (1985) procedure. An early play routine was defined as an "interaction episode characterized by the repetition of specific behaviors or the presence of invariant conventional roles" (Camaioni & Laicardi, 1985, p. 32). The play routines included two categories: nonconventional and conventional games.

In a study by Camaioni and Laicardi (1985), a *nonconventional game* was registered when at least one action made in the previous turn (e.g., motor or vocal component of a tickling game) was repeated in the same person's subsequent turn, while other elements of the previous turn could change. Nonconventional games consisted of tactile, motor, visual, and/or acoustic stimulation or vocal or gestural imitation. In Study IV, a nonconventional game was registered when mothers stimulated their children repetitively in the bodily-tactile modality with or without

speech (e.g., bouncing). Moving, wiggling, massaging, or stretching the child's limbs were registered only if they were play-like activities, including sounds or melodies. This criterion facilitated coding because otherwise, it would have been challenging to decide which actions could be classified as social games. Tickling, bouncing, and swinging were registered only in cases where there were at least two subsequent actions successively. If there were five seconds or less between the actions, they were registered as one long stimulation. However, actions such as moving the child during the mother's singing without conventional lyrics were coded from the beginning until the end because they resembled conventional games. Imitations were not included in the nonconventional games. This was done to prevent double coding.

Camaioni and Laicardi (1985) defined a *conventional game* as one that includes invariant conventional roles (e.g., giving-taking or pat-a-cake). In Study IV, conventional games were registered when the mothers played nursery rhymes and games with a systematic bodily-tactile structure with their children with VIAD (e.g., peekaboo or "Head, Shoulders, Knees, and Toes"). The games were coded from beginning to end. The coding was paused only if the children were unwell and their mothers had to stop playing and lift the children up. If a conventional game was repeated and there were five seconds or less between the first and second games, they were coded as one game. Conventional games that included tactile signing were not coded as conventional games to avoid double coding.

Tactile noticing. In Study II, touches associated with noticing were coded in the same category as anticipation (see Table 2). Tactile noticing was coded when the mother touched some part of Robin's body after detecting his movement or gesture. For instance, she might touch Robin's hands and tell him that she noticed his gesture but did not understand it yet. In Study IV, three different tactile noticing behaviors were included in this category: (a) separate touches related to the mother's responsiveness (e.g., the child moves her leg while playing, and the mother responds to it by touching the leg before continuing the play), (b) bodily-tactile imitation (e.g., the child rolls on his or her right side, and the mother imitates the movement with her body, while the child's legs are on the mother's shoulders), and (c) contingent responses to the child's reaching gestures in the form of an action (e.g., the child reaches her hand toward the mother, and the mother responds to it by making a vibration sound on the child's hand with her lips). The tactile noticing behaviors needed to have the same locus as the child's expressions to be coded. However, the quality of the touch associated with the tactile noticing could vary (e.g., tapping or stroking). In cases in which two or more subsequent tactile noticing behaviors followed the child's action, they were coded as one behavior if there were five seconds or less between them.

Tactile anticipatory cues. Tactile anticipatory cues correspond to preliminaries of spoken conversations (Schegloff, 1980). Speakers use preliminaries to project their subsequent actions, such as posing questions (e.g., "Can I ask you a question?"; Schegloff, 1980). By doing so, they aim to ensure the recognizability or understandability of the projected actions and set the stage for the next move in the conversation. Verbal and nonverbal anticipatory actions have also been observed in typical early interactions (e.g., Nomikou et al., 2017). In Study II, touches associated with anticipation were coded in the same category as tactile noticing (see Table 2). They were defined as touches that preceded an action involving Robin's body (e.g., the mother touches Robin's armpits before lifting him up).

In Study IV, tactile anticipatory cues were defined as touches or movements that informed the child with VIAD about the following action (e.g., touching the child's hands before grasping them). Thus, the category of tactile anticipatory cues was broadened to include movements (Goold & Hummel, 1993). Tactile anticipatory cues during speech or without speech were both registered. However, tactile anticipatory cues had to make contact with the same place on the body as the following touch or movement to be coded. Two subsequent tactile anticipatory cues were coded as one cue if there were five seconds or less between them. Tactile anticipatory cues associated with toys were not registered because only interactional games without toys were used in the intervention. Moreover, to prevent double coding, tactile signs used to anticipate actions were not registered.

Tactile signs. In Studies II and IV, signs from Finnish Sign Language and self-created signs were both coded as signs. In Study II, the modality (tactile or nontactile) and context of the signs (made during a song or speech) were registered. In Study IV, signs were coded only if they were made in an accessible way as coactive signs or as body signs. Two subsequent similar signs were coded as one sign if there were five seconds or less between them. Whether a sign was made during a song or speech was indicated by the coding. Tactile signs made during songs and during speech were coded as separate signs, even if there was less than five seconds between them.

Tactile attention-directing gestures. Tactile attention-directing gestures were coded only in Study II. They were defined as tactile strategies that aimed to help direct Robin's attention or facilitate his exploration of objects. The subcategories were hand-under-hand guidance (Figure 7A) and tactile pointing (Figure 8). Nontactile pointing was registered separately.

Bodily-tactile imitation. Bodily-tactile imitation was registered as a separate category only in Study II. In Study IV, it was included in the category of tactile noticing. In Study II, bodily-tactile imitation was defined as the mother's imitation of Robin's hand or body movements in an accessible way through the sense of touch.

Based on the observational data, the imitation had to occur within 3 s of Robin's action to be coded.

In Study II, the mother's nonintervention-based bodily-tactile forms of communication were also coded. First, *conventional gestures* that have a cultural meaning (e.g., clapping hands) were coded if they were not part of a game. Tactile and nontactile forms of conventional gestures were registered. Second, the mother's spontaneous tactile attention-directing gestures were registered. These included *hand-over-hand guidance* (Figure 7B) and *other gestures* (e.g., the mother lifting Robin's head up to get his attention). Third, *touches connected to verbal naming* were registered (e.g., the mother touching Robin's leg and naming it). Fourth, the mother's *bodily-tactile emotional expressions* were coded (e.g., kissing and hugging). The child's expressions were coded only in Study II. The categories used for the coding and their descriptions are presented in Table 3.

Table 3. The categories of Robin's expressions in Study II.

CATEGORY	DESCRIPTION
SIGNS	Signs from Finnish Sign Language and self-created referential expressions with negotiated meaning. Two similar signs were coded as one sign if there were less than 2 s between them. Sign imitations were coded separately. A sign imitation had to appear within 4 s of the mother's sign.
REACHING AND REQUESTING	Reaching was coded if Robin reached with one or both hands toward his mother or an object. Intentional actions with objects were also registered (e.g., pulling a scarf from a mother's face in peekaboo). The actions were coded as one behavior if there were less than 2 s between two similar subsequent actions.
MOTOR IMITATION	Tactile or nontactile imitation of the mother's preceding hand or body movement. The imitation needed to occur within 4 s of the mother's movement.
VOCAL EXPRESSIONS	The highest level of vocal expression was marked in each recording. Three different levels were defined: non-canonical vocalizations, canonical vocalizations, and single words. Canonical vocalization was defined as a vocalization which has at least two subsequent consonant-vowel syllables (e.g., ma-ma).

4.6.3 Multimodal conversation analysis

The principles of multimodal conversation analysis (CA; Mondada, 2018) were used to explore potential changes in the children's participation and interactional reciprocity in Studies II and III (Research Questions 3 and 4). Multimodal CA draws on detailed microanalysis to explore verbal and nonverbal conduct, including tactile interactions (e.g., Iwasaki et al., 2019). Multimodal CA was selected for this study because in-

depth sequential and longitudinal analyses can be particularly useful for studies investigating potential changes in *transactions* between parents and their children with VIAD (Van keer et al., 2017). Micro-level analysis is useful for identifying potential changes in *turn-taking structures* and can reveal dialogical processes that could not otherwise be identified (Nafstad, 2015). Moreover, microanalysis is an optimal means of gaining information on gradual transitions in children's development of communication skills (Bates et al., 1979, p. 101). Multimodal microanalysis can also be used to investigate how persons with disabilities participate in interactions with others and learn about the characteristics of their expressions (Antaki, 2011). Thus, multimodal CA can identify the competencies of individuals with disabilities. Observations of atypical interactions can be analyzed in light of concepts and knowledge related to typical conversations (Antaki, 2011).

Multimodal CA analyzes sequences, that is, turns organized as serial units (Jefferson, 1972). This focus offers a more comprehensive understanding of the interactions between children with VIAD and their parents than investigations of single expressions. By analyzing several turns, a researcher can gain information about parents' strategies for engaging their children and features of the children's participation (Chen, 1996). For instance, sequence analysis can provide detailed information about how children's bodily expressions are connected to their parents' previous actions. Early social play routines provide an optimal context for analyzing sequences because they follow a predictable pattern of subsequent actions, which children can learn to utilize in their own participation (Chen, 1996).

In Study II, the data indicated that Robin's new gestural expressions appeared in the context of "Magpie Makes Porridge" during the intervention. "Magpie Makes Porridge" is an early play routine that includes a simultaneously verbal and bodily-tactile narrative that climaxes at the end. It resembles the English nursey rhyme "Round and Round the Garden." Six episodes of "Magpie Makes Porridge" were found in the data and analyzed in detail using multimodal CA. Robin's gestures were recognized from the play routines and analyzed sequentially with respect to timing and the bodily-tactile experiences initiated by his mother. The verbal and tactile structure of "Magpie Makes Porridge" is described below, and an English translation is provided.

1. Harakka huttua keittää, hännällänsä hämmentää.
Magpie makes porridge, stirring it with her tail.
THE MOTHER MAKES A CIRCULAR MOVEMENT ON THE CHILD'S PALM WITH HER INDEX FINGER.
2. Antaa tuolle pojalle, antaa tuolle pojalle, tuolle pojalle, tuolle pojalle, mutta yksi poika jäi ilman.
She gives (it) to that chick, gives (it) to that chick, that chick, that chick, but one chick is left without.

THE MOTHER TOUCHES THE CHILD'S FINGERS ONE BY ONE, STARTING FROM THE THUMB.
3. Se hyppäsi kivelle,
She jumps on a stone,
THE MOTHER TOUCHES THE CHILD'S WRIST.
4. kannolle
on a tree stump
THE MOTHER TOUCHES THE CHILD'S ELBOW.
5. ja lähti vettä hakemaan, ja lähti vettä hakemaan.
and goes to look for some water and goes to look for some water.
THE MOTHER TICKLES THE CHILD'S ARMPIT.

In Study III, the analysis of the data gathered in the time-series design took the form of longitudinal CA, which investigates how social interactions change over time (Deppermann & Pekarek Doehler, 2021). Ten play routines that indicated a potential increase in reciprocity were selected for the analysis of each mother and her child: four routines from the baseline, five from the intervention, and one from the follow-up recordings. Information on the analyzed play routines is presented in Table 4.

Table 4. The analyzed play routines in Study III.

	BASELINE	INTERVENTION	FOLLOW-UP	DURATION
THEA	The Elephant March Head, Shoulders, Knees, and Toes Five Little Ducks (2)	The Elephant March Head, Shoulders, Knees, and Toes The Wheels on the Bus (3)	The Wheels on the Bus	26 min
SARA	Soft piano[a] Soft book Teddy bear Tambourine	The Wheels on the Bus (2) The Little Dog Sings The bouncing play Magpie Makes Porridge	The counting game	33 min
ALEX	Peek-a-boo Lifting up game Leg stretches Arm stretches	The swinging game (2) Arm stretches The dog game The counting game	Arm stretches	22 min

Note: The number indicated in the brackets indicates that the same play routine appeared in several recordings and was analyzed more than once.
[a]The data at baseline included only play routines with toys.

In the first phase of the analysis, annotations and rough transcriptions were made using ELAN (2021, version 6.2) computer software. The mothers' verbal and bodily-tactile expressions were annotated. This was followed by the annotation of the children's vocalizations (phonation, grunting, and smacking sounds) and bodily actions. Children's loud breathing sounds, silent mouth movements, and yawning were annotated only if the mothers responded to them. Similarly, if the mothers held their children's legs while the children moved, the movements were annotated only if the mothers verbally confirmed the children's initiative in making the movements. Otherwise, it would have been difficult to determine the initiator of the movements. Children's movements stemming from epilepsy or difficulty keeping their heads upright were not annotated. In the second phase of the analysis, the children's bodily expressions to which their mothers responded were marked and analyzed in collaboration with other researchers. The analysis of these expressions was based on prior research indicating that parents' responses are pivotal in sensitizing children's recognition of their expressions as social acts (e.g., Rączaszek-Leonardi et al., 2013; Yoder & Warren, 1998).

In the third phase, the mothers' questions were analyzed in detail. This focus was inspired by observational data and prior research indicating that mothers' questions are crucial in establishing conversational patterns with their children, including turn taking (e.g., Snow, 1977). We explored whether the mothers expected answers from their children and, if they did, which kinds of behaviors from their children they treated as answers. Thus, we investigated the modalities according to which the mothers interpreted their children's actions.

Transcription. Multimodal CA was used in the transcription (Mondada, 2018, 2022). In Study II, all selected play routines were transcribed. In Study III, the transcriptions included three play routines from each mother-child dyad. The transcriptions were simplified for readability, and some additional transcription conventions were used (see the Appendix). Since the objective of the study was to explore the effects of mothers' bodily-tactile conduct on their children's participation, the movements each participant made with their entire body were recorded in the transcriptions (Iwasaki et al., 2019; Mondada, 2018). The pauses were marked in different ways in the studies. In Study II, we marked pauses between the mother's verbal utterances and Robin's vocal and play-related gestural expressions. In Study III, pauses were marked only in moments in which there were no bodily-tactile or vocal actions. This analytical decision was based on the children's bodily perspective. From this perspective, their mothers take a turn not only when speaking but also when they are actively touching or moving their children.

The mothers' verbal utterances were transcribed in Finnish in bold letters, with the English translation in italics below (see Example 1, Line 01). The children's vocalizations were transcribed using lowercase letters. However, only vocalizations involving phonation were considered turns. This choice was made based on the data-based observation that the mothers responded almost exclusively to these types of vocalizations. The nonverbal actions of the mothers and children were transcribed in capital letters. However, we transcribed only the mothers' nonverbal actions that were accessible to their children through the sense of touch (see Iwasaki et al., 2019). Moreover, a bodily-tactile action was transcribed on a line of its own if it occurred independently without speech. All the children's movements were transcribed, but only those movements to which their mothers responded were transcribed as turns (Study III). The signs were written in italics and capital letters (Study II). The mothers' gazes were transcribed in double parentheses (Study III). Instances of the children smiling were transcribed in italics below their bodily-tactile actions and indicated with slashes (Study III). Only the smiles to which the mothers verbally responded were marked as turns. An example of the transcription is provided below.

Example 1.

```
01 MOT:    +Sit sielä on +ka*toppa* (1.2)
            And look then there is
   mot     +PLAYS A QUACK SOUND+((GAZES AT THE PIANO))
   sar                        *LIFTS UP HER HEAD*
```

4.6.4 Emotional Availability Scales

The EA Scales were used to investigate the emotional relationships between children with VIAD and their mothers in Studies I, II, and IV (Research Question 5). Full video recordings were used in the analysis. The EA Scales (4th edition) comprise an observational system for evaluating the quality and *emotional reciprocity* of parent-child interactions (Biringen, 2008). It has four subscales for the parent (sensitivity, structuring, nonintrusiveness, and nonhostility) and two subscales for the child (responsiveness and involvement). Each subscale is evaluated based on global judgment rather than the assessment of discrete behaviors. These scales can be used to assess children from infancy to adolescence (Biringen et al., 2014). The EA Scales were chosen for the analysis because they are flexible enough to evaluate clinical populations and sensitive enough to capture changes related to interventions (Biringen et al., 2022). The EA guidelines for assessing children with disabilities were followed in the scoring process (Biringen et al., 2005; Biringen, 2008). Definitions of the EA subscales and their scoring are presented in Table 5.

Table 5. The definitions and scoring of Emotional Availability Scales.

EA SUBSCALE	DEFINITION	SCORING
SENSITIVITY	Parent's warmness and ability to create an emotional connection with the child.	7 = highly sensitive 5.5/6 = neutral sensitivity 4 = inconsistently sensitive 2.5/3 = somewhat insensitive 1 = highly insensitive
STRUCTURING	Parent's ability to guide the play with the child successfully.	7 = optimal structuring 5.5/6 = moderately structuring 4 = inconsistent structuring 2.5/3 = somewhat unstructuring 1 = non-optimal structuring
NONINTRUSIVENESS	Parent's capacity to interact with the child without intervening in his or her autonomy.	7 = nonintrusive but emotionally present/available 5.5/6 = generally nonintrusive but sometimes benign forms of intrusiveness 4 = "benign" intrusiveness 2.5/3 = somewhat intrusive 1 = intrusive
NONHOSTILITY	Parent's behavior which does not indicate overt or covert signs of negativity.	7 = nonhostile 5.5/6 = generally nonhostile 4 = covertly hostile 2.5/3 = slightly overtly hostile 1 = markedly and overtly hostile
CHILD RESPONSIVENESS	Child's positive affect and responsiveness toward the parent.	7 = optimal in responsiveness 5.5/6 = moderately optimal in responsiveness 4 = complicated responsiveness 2.5/3 = somewhat non-optimal in responsiveness 1 = clearly non-optimal in responsiveness
CHILD INVOLVEMENT	Child's initiative in interaction.	7 = optimal in involving behaviors 5.5/6 = moderately optimal in involving behaviors 4 = complicated involvement 2.5/3 = somewhat non-optimal in involving behaviors 1 = clearly non-optimal in involving behaviors

The EA assessments were made by different researchers in each study (Studies I, II, and IV). All assessors were trained and certified by the method developer. In Study I, the assessor was the first author, who was familiar with Emma's sensory functioning and development. In Studies II and IV, the assessors were psychologists, who were given information about the children's levels of sensory functioning and development prior to coding. They were also blinded to the occasions of the recordings.

In Study IV, the participating children had a lower level of developmental function than the children in Studies I and II, which necessitated flexibility in scoring (Biringen et al., 2005). In assessing *sensitivity,* there was a stronger focus on voice, touch, general emotional tone, and approach to the child than on eye contact. In evaluating *structuring*, developmental information related to the children's motor and language development was considered. In particular, the use of both verbal and nonverbal guidance and their success (as opposed to the mere mechanical repetition of some play activity) were recognized. When evaluating *nonintrusiveness*, the children's disabilities were considered, as many required additional stimulation and had special needs in terms of being held. In assessing *nonhostility,* there was no need for special flexibility. In assessing *child responsiveness,* it was necessary to consider the children's level of communication. All their responses or efforts to respond were acknowledged (e.g., smiling, moving their hand or leg in response, or turning their head toward the sound). Similarly, in evaluating *child involvement*, all attempts by the children to make a connection or communicate were acknowledged. Overall, the participating children were assessed with reference to low responsiveness and involvement in their group and not in comparison to children without disabilities. Finally, the researcher who trained the others in the method (Z. Biringen) was consulted to clarify the scoring of the data. This resulted in a rescoring of nonintrusiveness for each mother.

4.6.5 Reliability

All second coders were informed of the observed children's levels of development and sensory functioning. They were also blinded to the phase of the intervention prior to coding. The second coders of the EA Scales completed reliability training in the use of these scales and the coding framework, and they followed the EA guidelines for assessing children with disabilities (Biringen et al., 2005; Biringen, 2008). The reliability of the coding was calculated as the percentage of agreement between the coders, that is, the number of agreements divided by the number of agreements plus disagreements multiplied by 100.

The imitation coding procedure. In Study I, the reliability of the imitation coding procedure was measured using intrarater and interrater reliability tests. Intrarater tests were conducted for all data by the main researcher (first author). The level of agreement was 95%. The interrater reliability test was conducted by the first second coder (SC1), who has experience working with children with multiple disabilities and is fluent in Finnish Sign Language. She was trained to apply the imitation coding procedure to the data not used for analyzing reliability. Altogether, 25% of the data were reevaluated, and the interrater agreement was 88%.

The bodily-tactile coding procedure. SC1 also conducted the reliability test in Studies II and IV. Before coding, she was trained to use the bodily-tactile coding procedure with the unanalyzed data. In Study II, she was also given information on the sign repertoire of the data. In Study II, all data (100%) were recoded. In terms of the mother's behavior, the interrater agreement varied between 88%–97% in different categories. For Robin's expressions, the interrater agreement was 65% for signs, 69% for sign imitations, 70% for reaching and requesting, and 80% for motor imitation. As the levels of interrater agreement for signs, sign imitations, and reaching and requesting did not attain acceptable levels of reliability, only the expressions identified by both coders were included in the results. Among the signs identified by both coders, 3% were categorized under different labels (e.g., *MAGPIE* vs. *SPIDER*). The quality of Robin's vocalizations was reanalyzed for 33% of the data. One video each from the baseline, intervention, and follow-up recordings was randomly chosen for the reliability test. The interrater agreement was 100%.

In Study IV, 30% of the data were recoded by SC1. One video from the baseline, intervention, and follow-up recordings from each mother-child dyad was randomly chosen for the reliability test. The interrater agreement on bodily-tactile early play routines varied between 83%–100% among the mothers. The interrater agreement on tactile noticing was 89% for Thea's mother, 42% for Sara's mother, and 96% for Alex's mother. Because the interrater agreement on tactile noticing for Sara's mother was low, her results were not reported. The interrater agreement on tactile anticipatory cues varied between 81%–89% for the mothers. The interrater agreement was 100% on tactile signs for all mothers.

EA Scales. In Study I, the reliability of the scores with the EA Scales was established by including another second coder (SC2). The researcher (the first author), together with SC2, negotiated the rating for one recording (25% of the data), and a reliability test was conducted with two recordings (50% of the data). The interrater agreement was 100%, with a 1-point difference between the coders.

In Study II, the reliability of the scores assigned using the EA Scales was established by including SC2. One video each from the baseline, intervention, and follow-up recordings was randomly chosen for the reliability test. This comprised 33% of the data. The reliability test resulted in 94% agreement when counting the maximum 0.5-point differences between the coders on each scale.

In Study IV, the reliability of the scores on the EA Scales was established by adding a third second coder (SC3). She cooperated with the main scorer and practiced scoring with unanalyzed data. Altogether, 50% of the data from each family were reanalyzed. The videos for the reliability test were randomly chosen. However, we ensured that videos from each phase (baseline, intervention, and follow-up) were included in the reliability test, namely, two videos from the baseline recordings, and three videos from the intervention and follow-up recordings.

Due to the challenges in coding the data, some videos were watched by both SC3 and the main scorer, including one video (all EA dimensions) for Sara and three (all EA dimensions) for Alex. For Thea, one dimension from each of two videos was watched by both researchers. The consensus scores were not included in the reliability test. The final number of videos included in the reliability test was 50% for Thea (including videos from all phases of the study), 40% for Sara (including videos from all phases of the study), and 20% for Alex (including videos from the intervention and follow-up). The rescored nonintrusiveness was not rescored in the reliability test because these scores were reached by consensus among the scorers. When calculating the maximum 1-point differences between the coders in each dimension, the agreement levels on the EA Scales were 91% for Thea and her mother, 90% for Sara and her mother, and 100% for Alex and his mother.

5 Results

5.1 Study I

5.1.1 Postural and behavioral changes

The typical interactional play between Emma and her mother was characterized by dyadic face-to-face interactions without toys in all the sessions. During the baseline session (A1), the mother held Emma either by her hands (Figure 9A) or under her armpits (Figure 9B). During the tactile imitation guidance (B4, B8, and B10), she mainly held Emma under her armpits, which allowed Emma to move her hands freely in interaction. Emma did not place her hands on her mother's face during their interactions in A1. During the tactile imitation guidance, she once placed her hands on her mother's face in B4, and this action occurred more frequently in B8. In B10, Emma continually placed her hands on her mother's face, including beyond the imitative bouts (Figure 9C). Similar development was observed in Emma's positive emotional expressions in relation to being imitated. During the tactile imitation guidance (B4, B8, and B10), Emma expressed her positive emotional expressions significantly more often when she was being imitated compared to A1. These findings indicate that the tactile imitation guidance had a positive impact on Emma's participation (Research Questions 1 and 3).

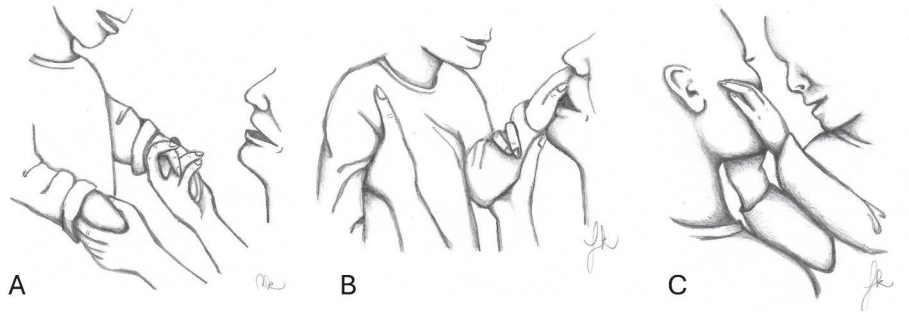


Figure 9. Illustrations of the mother's holding of Emma and Emma's action of placing her hands on her mother's face. Illustrations: Saara Waked. Original publication: Peltokorpi, S., Daelman, M., Salo, S., & Laakso, M. (2020). Effect of tactile imitation guidance on imitation and emotional availability. A case report of a mother and her child with congenital deafblindness. Frontiers in Psychology, 11, Article 540355. doi: 10.3389/fpsyg.2020.540355

5.1.2 Frequency and length of imitative bouts

The frequency and length of the imitative bouts are demonstrated in Table 6. Emma's mother initiated most of the bouts in all sessions. Most of the bouts had a length of one round. Imitative reciprocity changed during the tactile imitation guidance (Research Questions 1 and 4). In A1, the imitative bouts were short, whereas at the end of the tactile imitation guidance (B10), they became notably longer.

Table 6. Frequency and length of imitative bouts initiated by Emma or her mother.

Participants	A1	B4	B8	B10
Mother	16 (1 round) 3 (2 rounds)	4 (1 round)	11 (1 round) 2 (2 rounds)	10 (1 round) 3 (2 rounds) 1 (3 rounds) 1 (4 rounds) 1 (9 rounds) 1 (11 rounds)
Emma	1 (1 ½ rounds)	1 (7 ½ rounds)	1 (1 ½ rounds)	1 (1 ½ rounds) 1 (2 ½ rounds)

Note: The length of an imitative bout is indicated in parentheses.

5.1.3 Communication modes used in imitations

Emma and her mother used various communication modes in their imitations, which are presented in Table 7. Emma's mother made most of her imitations vocally in A1. She used a tactile modality only in connection to one vocal imitation in which she imitated Emma's laughter by shaking Emma's hands in the same rhythm as Emma's laughter. During the tactile imitation guidance, the characteristics of the mother's imitations changed, as she began to use more tactility in her imitations (Research Questions 1 and 2). In B4, she made one tactile imitation by touching Emma's arm in the same way as Emma had touched her. When Emma vocalized, her mother made vocal-tactile imitations by tracing the movement of her mouth onto Emma's hand (Figure 9B). In B8, Emma's mother made 10 vocal-tactile imitations altogether. She could imitate Emma's vocalization by tracing the movement of her mouth onto Emma's hand, kissing Emma's cheek, or touching Emma's head with her nose, forehead, or head while speaking or vocalizing. In B10, Emma's mother used tactility less often in her imitations than in B8. This was due to a change in Emma's interactive behavior. Emma was often touching her mother's face before her mother began to imitate Emma's vocalizations. Thus, as Emma was continually touching her mother's face during and after her mother's imitations, there was no need for her mother to add tactility in her imitations.

Emma occasionally made imitations of her mother's actions, which belonged to Emma's vocal or gestural repertoire. For instance, Emma's mother could initiate a

dialogue by repeating a vocal utterance belonging to Emma's repertoire. After several repetitions, Emma could imitate her mother vocally. When Emma made a gestural or gestural-vocal imitation, her mother had used tactility in transmitting her gestures to Emma during her previous turn. Thus, the mother's gestures were accessible to Emma through the sense of touch.

Table 7. Communication modalities used in the imitations by Emma and her mother.

Communication modalities	A1	B4	B8	B10
Vocal	10 (E1)	0 (E1)	2	12 (E1)
Gestural	5	0	1 (E1)	0
Tactile	0	1	0	0
Gestural-vocal	3	1	0	2 (E1)
Vocal-tactile	1	2	10	3
All imitations including the tactile modality[a]	1	3	12	10

Note: Emma's imitations are marked with E and written in parentheses.
[a] The turns in which Emma's mother used the tactile modality in her imitations and the turns when Emma was exploring her mother's mouth during her mother's imitation.

5.1.4 Emotional availability

The raw EA scores of Emma and her mother are reported in Table 8. The results indicate that the tactile imitation guidance had a positive impact on the emotional relationship between Emma and her mother (Research Question 5). In A1, Emma's mother scored 5 for sensitivity, structuring, and nonintrusiveness. During the tactile imitation guidance, her scores in these dimensions ranged between 6 and 7. Similar development was observed for Emma. Her scores for child responsiveness and child involvement ranged between 3 and 4.5 in A1. During the tactile imitation guidance, her scores were higher, ranging between 3.5 and 6. The clearest positive change was observed in her involvement in B8 and B10.

Table 8. Emotional availability between Emma and her mother.

	A1	B4	B8	B10
Sensitivity	5	6	7	7
Structuring	5	6	7	7
Nonintrusiveness	5	6	7	7
Nonhostility	7	7	7	7
Child responsiveness	4.5	5	6	6
Child involvement	3	3.5	6	5.5

Note: All the scales range from 1 (low) to 7 (high).

5.2 Study II

5.2.1 The mother's use of intervention-based and non-intervention-based tactile strategies

Robin's mother increased her use of the bodily-tactile modality during the early intervention (Research Question 2). Figure 10 illustrates the results of the mother's total use of the bodily-tactile modality in interactions and her use of touch and movement connected to play routines. Her use of the bodily-tactile modality increased in both cases. During the intervention, Robin's mother began to use new play routines, including coactive hand and body movements and bodily-tactile sensory experiences (e.g., air flow).

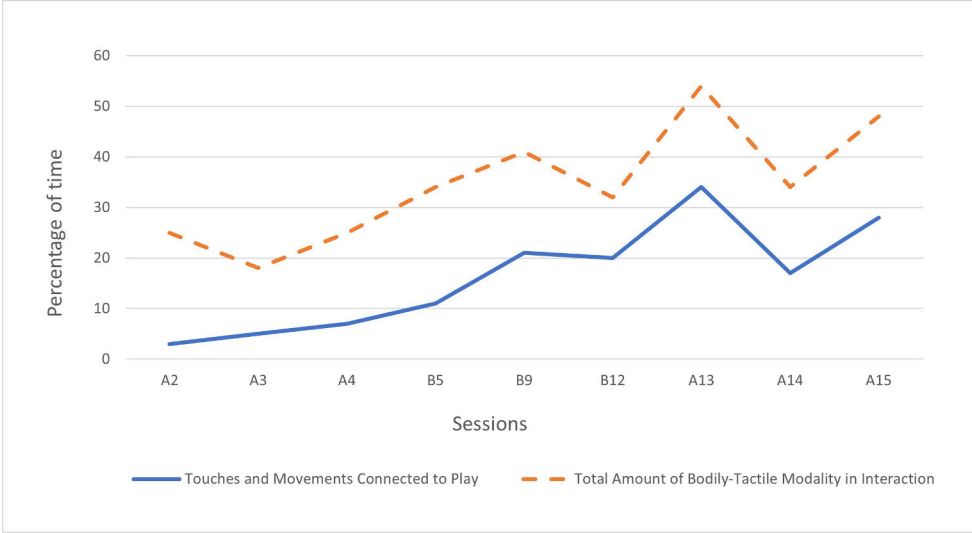


Figure 10. The mother's use of the bodily-tactile modality in interactions and touches and movements connected to play routines as a percentage of time per session. Original publication: Peltokorpi, S., Salo, S., Nafstad, A., Hart, P., Tuomikoski, E., & Laakso, M. (2023). Bodily-tactile early intervention for a mother and her child with visual impairment and additional disabilities: A case study. Disability and Rehabilitation, 45(12), 2057–2072. doi: 10.1080/09638288.2022.2082563

Tactile signs. Table 9 presents the frequency and context of the mother's tactile signs. Robin's mother had already used several tactile signs at baseline. However, she used them only in "Itsy Bitsy Spider," which she frequently played with Robin. During the intervention, Robin's mother also began to use tactile signs to support her spoken messages when talking to Robin. She also increased her repertoire of songs in which she used tactile signs. Thus, the contexts for using tactile signs were

expanded during the intervention. Moreover, her sign vocabulary doubled as she began to use tactile signs in new play routines and daily activities with Robin during the intervention and follow-up (see Table 10). Robin's mother made signs mainly through coactive signing (Figure 6A).

Table 9. Frequencies of Robin's gestural expressions and his mother's signs.

Participants and categories	A2	A3	A4	B5	B9	B12	A13	A14	A15
Robin's mother									
Tactile signs	16 (1.6)	6 (0.5)	12 (1.2)	20 (1.8)	20 (1.7)	17 (1.7)	21 (1.9)	15 (1.4)	18 (1.6)
Tactile signs during speech	0	0	0	6	8	14	5	7	11
Tactile signs during songs	16	6	12	14	12	3	16	8	7
Robin									
Signs[a]	7 (0.7)	5 (0.4)	7 (0.7)	12 (1.1)	20 (1.7)	15 (1.5)	4 (0.4)	12 (1.1)	5 (0.5)
Sign imitations	0	1	1	1	0	1	2	1	0
Reaching and requesting	4	8	1	4	12	4	4	7	9
Motor imitation	0	1	0	1	1	3	0	4	0

Note: The numbers in brackets show the frequency of the phenomenon per minute.
[a] Mimetic gestures are included in Robin's spontaneous signs.

Table 10. The sign vocabulary of Robin and his mother.

Categories	Baseline	Intervention	Follow-up
The mother's tactile signs	***SUN, JUMP, SPIDER, ANTHILL, ANT, SLEEP, RAIN, TAKE AWAY, VIOLIN, DILIGENT***	***SUN, JUMP, SPIDER, VIOLIN, SLEEP, RAIN, TAKE AWAY*** *CAT, DOG, COW, PIGGY, BLOWING ON THE SKIN GAME, MAGPIE, THE END, EAT, ROBIN'S NAME SIGN, LAMP, MOTHER*	***DILIGENT, JUMP, SLEEP, ANTHILL, SPIDER, ANT, VIOLIN*** *MAGPIE, CAT, DOG, COW, PIGGY, THE END, RUB EYES, GO ON*
Robin's spontaneous signs	***ANT, VIOLIN, SPIDER***	***ANT, VIOLIN, SPIDER****, MAGPIE*	***ANT, VIOLIN, SPIDER,*** *MAGPIE, DOG*
Robin's sign imitations	***SPIDER***	*DOG*	***ANT, VIOLIN,*** *EAT*[a]

Note: The bolded words are signs from "Itsy Bitsy Spider."
[a] The sign was observed in a separate video clip in A15.

Tactile attention-directing gestures. Robin's mother did not use hand-under-hand guidance (Figure 7A) during the recordings. She utilized nontactile pointing gestures at baseline ($N = 3$). However, Robin did not direct his attention toward the

indicated objects in any of those situations. During the intervention, Robin's mother began to use tactile pointing (Figure 8) in B9 (N = 13) and B12 (N = 2). Tactile pointing appeared to facilitate Robin's attention direction, as he could direct his attention to the objects pointed at (e.g., a lamp) in about half the cases.

Touches related to anticipating and noticing. Robin's mother did not use the bodily-tactile modality for anticipating actions or noticing Robin's expressions at baseline. She began to utilize these strategies during the intervention in B5 (N = 18) and continued using them in the follow-up sessions A13 (N = 13), A14 (N = 15), and A15 (N = 5). Her anticipation cues (Figure 5) were observed in connection to a specific game and before lifting Robin up. Her actions connected to tactile noticing (Figure 4) occurred in situations in which she wanted to express to Robin that she had noticed his movement or non-readable gestural expression. Robin's mother used *tactile imitation* in one of the baseline sessions (e.g., Robin touched his mother's leg with his fingers, and the mother touched his leg in a similar way). She continued using imitation in all the intervention sessions (e.g., creating dialogues based on tapping on each other's hands) but did not imitate Robin's actions in the follow-up sessions.

Non-intervention-based bodily-tactile forms of communication. Robin's mother used hand-over-hand guidance (Figure 7B) in all the sessions except one (B5). She used other non-intervention-based bodily-tactile forms of communication sporadically.

5.2.2 Robin's expressions

Typically, Robin could not make eye contact with his mother during their interactions. However, he could make *tactile contact* with his mother using his foot when he was seated in a supportive chair facing his mother (Figure 3) or lying on the floor with his mother within reach. When he sat in his mother's lap, tactile contact was established through body-with-body alignment.

The frequencies of Robin's *gestural expressions* are presented in Table 9, and his sign vocabulary is shown in Table 10. At baseline, Robin used three signs from "Itsy Bitsy Spider," and he continued using these signs during the intervention and follow-up. During the intervention, his participation increased as he developed new gestural expressions (Research Question 3). Robin used the mimetic gesture *MAGPIE* in the context of "Magpie Makes Porridge" and other contexts in B9, B12, and in all the follow-up recordings. Gradually, this gesture became a negotiated sign for "Magpie Makes Porridge." Moreover, Robin began to use the sign *DOG* imitatively and spontaneously. Furthermore, during the follow-up recordings, Robin began to imitate the sign *EAT.* His mother reported that sometimes he also signed *EAT* spontaneously.

Robin's *vocalizations* consisted of an /s/ sound, phonation, vowel sounds, lip vibration sounds, smacking sounds, sighs, and laughter. His vocalizations were non-canonical throughout the sessions.

5.2.3 Contextual emergence of new gestural expressions

"Magpie Makes Porridge" was introduced to Robin and his mother in the fourth intervention session (B8). The analysis revealed how Robin participated in this play routine and how his gestural expressions were related to his mother's actions in form and timing, indicating changes in the reciprocity of actions (Research Question 4). The first extract from B9 demonstrates the mother's use of the bodily-tactile modality in the rhyme (Figures 11 and 13). Robin then makes a mimetic gesture in anticipation of his mother's touch on his fingers (Figure 12).

Extract 1. Robin's mimetic gesture.

```
01 MOT:   +Harakka °hut#tua keittää°(1.2)hännällän[sä hämmentää+
           Magpie makes porridge         stirring it with her tail
   mot     +MAKES A ROTATING MOVEMENT ON THE BACK OF ROBIN'S LEFT HAND+
   fig                  #fig. 11

02 ROB:                                                [LIFTS UP HIS FINGERS


03 ROB:   #TOUCHES HIS [LEFT INDEX AND MIDDLE FINGER
          ((A mimetic gesture, which later became the MAGPIE sign))
   fig    #fig. 12

04 MOT:                [Joo sin- niille °annetaan sieltä°(.)+.hh (.)
                        Yes ther- they will be given
   mot                                                    +…--->

05 MOT:       +Antaa tuolle pojalle(0.5)+
               She gives to that chick
   mot     --->+TOUCHES COACTIVELY WITH ROBIN HIS LEFT THUMB+

06 MOT:   +#antaa tuolle pojalle* (1.4)           *tuolle pojalle+ (0.8)
            she gives to that chick                that chick
   mot     +TOUCHES COACTIVELY ROBIN'S INDEX AND MIDDLE FINGER+
   rob                          *LIFTS UP HIS HEAD*
   fig      #fig. 13
```

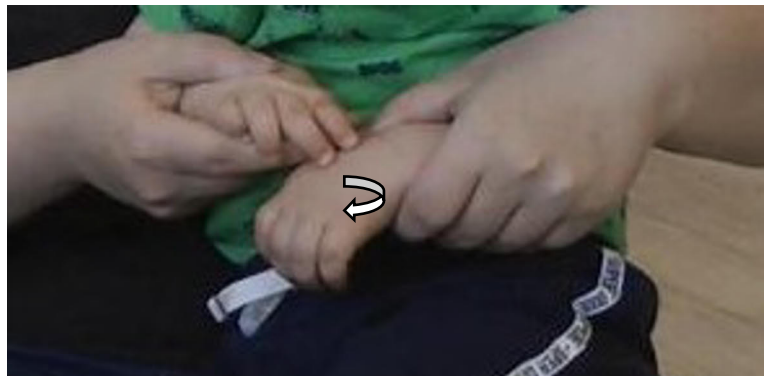


Figure 11. The mother plays the rhyme coactively with Robin. Original publication: Peltokorpi, S., Salo, S., Nafstad, A., Hart, P., Tuomikoski, E., & Laakso, M. (2023). Bodily-tactile early intervention for a mother and her child with visual impairment and additional disabilities: A case study. Disability and Rehabilitation, 45(2), 2057–2072. doi: 10.1080/09638288.2022.2082563

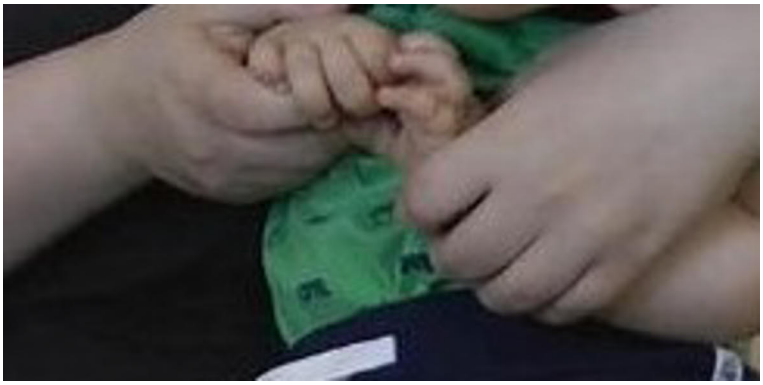


Figure 12. Robin's mimetic gesture. Original publication: Peltokorpi, S., Salo, S., Nafstad, A., Hart, P., Tuomikoski, E., & Laakso, M. (2023). Bodily-tactile early intervention for a mother and her child with visual impairment and additional disabilities: A case study. Disability and Rehabilitation, 45(2), 2057–2072. doi: 10.1080/09638288.2022.2082563

Figure 13. Robin's mother coactively touches his fingers one by one. Original publication: Peltokorpi, S., Salo, S., Nafstad, A., Hart, P., Tuomikoski, E., & Laakso, M. (2023). Bodily-tactile early intervention for a mother and her child with visual impairment and additional disabilities: A case study. Disability and Rehabilitation, 45(2), 2057–2072. doi: 10.1080/09638288.2022.2082563

Robin's left hand is the scene of the bodily-tactile narrative "Magpie Makes Porridge." His mother makes rotating movements of the rhyme coactively with Robin's right hand on his left hand (Figure 11). Robin is attentive in perceiving the story through auditive and bodily-tactile modalities. His attentiveness is observed in his body language, which reflects expectant stillness. The timing and form of his mimetic gesture shows his detailed knowledge of the rhyme. Robin's action begins to emerge when his mother is still narrating the first phrase of the rhyme (Lines 01–02). His mimetic gesture (Line 03, Figure 12) anticipates his mother's subsequent touches on his fingers (Figure 13). Robin's mother detects his gesture and responds to it verbally (Line 04), which reinforces its shared meaning.

When the story continues, Robin makes another anticipatory gesture that reflects his embodied memory of the rhyme. This time, the anticipated action is his mother's touch on his wrist, where the story continues. Robin's anticipatory gesture and its sequential context are presented in Extract 2.

Extract 2. Robin's gesture anticipating his mother's next point of touch.

```
01 MOT:    +#Se hyppäsi+
             She jumped
   mot     +LIFTS UP HER RIGHT HAND COACTIVELY WITH ROBIN'S RIGHT HAND+
   fig      #fig. 14

02 ROB:    (0.2)+#MOVES HIS WRIST [DOWNWARDS AND FINGERS UPWARDS
                  ((An anticipatory gesture))
   mot          +…--->
   fig            #fig. 15

03 MOT:                            [+kivelle+
                                    on a stone
   mot                           --->+TOUCHES ROBIN'S LEFT WRIST COACTIVELY+
```

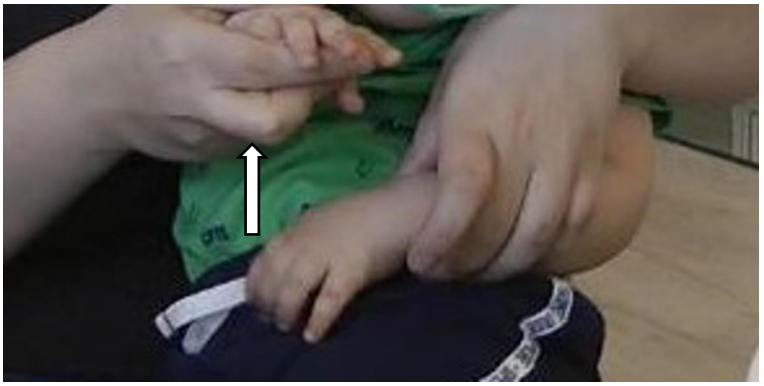


Figure 14. The mother lifts her hand up coactively with Robin. Original publication: Peltokorpi, S., Salo, S., Nafstad, A., Hart, P., Tuomikoski, E., & Laakso, M. (2023). Bodily-tactile early intervention for a mother and her child with visual impairment and additional disabilities: A case study. Disability and Rehabilitation, 45(2), 2057–2072. doi: 10.1080/09638288.2022.2082563

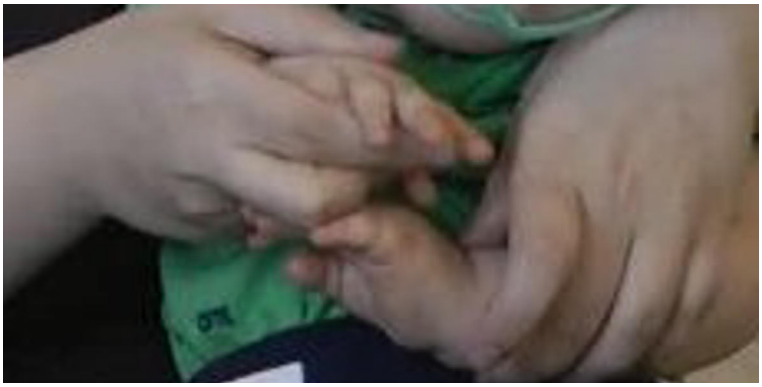


Figure 15. Robin's anticipatory gesture before his mother's touch on his wrist. Original publication: Peltokorpi, S., Salo, S., Nafstad, A., Hart, P., Tuomikoski, E., & Laakso, M. (2023). Bodily-tactile early intervention for a mother and her child with visual impairment and additional disabilities: A case study. Disability and Rehabilitation, 45(2), 2057–2072. doi: 10.1080/09638288.2022.2082563

The mother continues storytelling by lifting her right hand up coactively with Robin's right hand (Line 01, Figure 14). Because the movement is accessible to Robin, he can perceive detailed bodily-tactile information on the direction and timing of his mother's hand movement. He responds to his mother's action by making an anticipatory gesture in which he moves his fingers upward when his mother is about to touch his wrist (Figure 15).

Although the rhyme did not include adjacency pairs (e.g., a question and an answer), it included adjacent actions, which consisted of the mother's multimodal expressions related to storytelling and Robin's anticipatory gestures. The bodily-tactile structure of the rhyme helped Robin participate in the activity, as he could use the knowledge of the rhyme's subsequent actions as a resource for his anticipatory gestural expressions. His gestures, however, were very subtle and hard to detect. Robin's mother detected his first gesture and interpreted it as a part of the storytelling (Extract 1, Lines 03–04). She may not have detected Robin's second gesture, as she did not comment on it.

Robin's first gesture was a mimetic gesture (Figure 12) that represented an action he had experienced during the rhyme. He imitated his mother's movement of touching his fingers (index and middle fingers) from his perspective (see Nafstad & Rødbroe, 2015, p. 149). As this gesture occurred before the mother's touch on Robin's fingers, it was an anticipatory gesture. However, it was observed that Robin also used the gesture in other contexts for requesting the rhyme and sometimes for answering his mother. In these contexts, the mimetic gesture could be understood as a referential gesture representing the rhyme (Iverson & Thal, 1998).

Robin's second gesture (Figure 15) was also an anticipatory gesture, as it occurred at a specific part of the rhyme and anticipated his mother's subsequent

touch on his wrist. This gesture could also be an early pointing gesture, which Robin utilized for directing his own attention to the subsequent action (see Bates et al., 1979; Iverson & Thal, 1998). The findings from the data indicate that Robin also used other gestural expressions, which revealed his embodied memory of the rhyme. For instance, when his mother suggested that they would play "Magpie Makes Porridge," he moved his fingers upward. This could be a signal of Robin's *thinking* of the rhyme ("The game in which my fingers are touched").

In summary, Robin's emerging gestures appeared to be closely connected to his bodily-tactile experiences of the rhyme. Ask Larsen (2003) had similar findings regarding the gestural expressions of a child with CDB, who used his gestures to refer to a bodily-tactile rhyme, "Round and Round the Garden."

5.2.4 Emotional availability

The raw EA scores for Robin and his mother are presented in Table 11. The findings indicate positive changes in the emotional relationship of Robin and his mother during the early intervention (Research Question 5). The mother's mean EA scores in sensitivity were at the neutral level at baseline and stayed at the same level during the intervention and follow-up. Her mean EA scores in structuring were at the moderately structuring level at baseline and remained at the same level during the intervention and follow-up. Her mean EA scores in nonintrusiveness were at the level of "benign intrusiveness" at baseline. During the intervention, her mean EA scores were elevated to the level of general nonintrusiveness. At follow-up, her mean EA scores in nonintrusiveness decreased back to the level of "benign intrusiveness." Her mean EA scores in hostility were at generally nonhostile level and stayed at the same level during the intervention and follow-up.

Robin's mean EA scores in responsiveness indicated a complicated responsiveness at baseline. During the intervention, his mean EA scores in responsiveness were elevated to the moderately optimal level and stayed at the same level during follow-up. Robin's mean EA scores in involvement corresponded to a complicated involvement in all the phases of the study.

Table 11. The means and ranges of emotional availability for Robin and his mother before, during, and after the bodily-tactile early intervention.

	Baseline	Intervention	Follow-up
Sensitivity	5.8 (5.5–6.5)	6.0 (6.0–6.0)	6.0 (5.5–6.5)
Structuring	5.7 (5.5–6.0)	6.0 (5.5–6.5)	6.0 (5.5–6.5)
Nonintrusiveness	5.2 (5.0–5.5)	5.7 (5.5–6.0)	5.3 (5.0–6.0)
Nonhostility	6.2 (6.0–6.5)	6.5 (6.5–6.5)	6.5 (6.0–7.0)
Child responsiveness	5.2 (5.0–5.5)	5.8 (5.5–6.0)	5.7 (5.0–6.5)
Child involvement	5.3 (5.0–6.0)	5.2 (5.0–5.5)	4.3 (3.5–5.5)

Note: All the scales range from 1 (low) to 7 (high).

5.3 Study III

The results of the interactions of each mother-child dyad are reported individually. The focus of the analysis is on the mothers' actions, which are closely linked to their children's participation through movements. The findings indicate positive changes in interactional reciprocity and child participation for all the mother-child dyads (Research Questions 3 and 4). Only one extract from each mother-child dyad was selected for this summary. The original article (Study III) includes more examples of transcriptions and more comprehensive analysis of their interactions.

5.3.1 Thea and her mother

The analysis showed that Thea's mother changed her way of structuring the play routines during the intervention. The most significant change was found in her way of creating time and space for Thea's turn-taking, which allowed more reciprocity in interactions. During the intervention, Thea's participation increased through bodily actions. When her mother noticed Thea's turn-taking through a movement during a slot, she often touched the part of Thea's body that she had moved. Moreover, Thea developed her participation during a game in which she began to cocreate a movement pattern with the help of her mother.

Baseline. Thea's mother instigated several bodily-tactile play routines with Thea at baseline. During the play routines, Thea was positioned on her back, face to face with her mother. The play routines included strong sensory experiences and were often played at a fast tempo. Thea enjoyed these routines and expressed her excitement by straightening her arms and smiling. Typically, Thea's mother did not create slots for Thea to act spontaneously during the play routines. When she observed Thea's reactions, she focused more on her face than on her bodily actions. In the moments in which she posed questions to Thea, she either waited for a

predetermined response from her (turning her head toward her mother) or did not wait for any response.

Intervention. The mother's way of structuring the play routines changed during the intervention as she started paying more attention to Thea's participation. She began to create time and space for Thea's turn-taking by pausing the play activity and releasing her hold on Thea. She also began to observe more of Thea's bodily expressions during the slots. When she noticed Thea's movement, she responded to it verbally and acknowledged the movement through touch (e.g., touching the leg that Thea had moved). Thus, through her mother's touch, Thea could become aware that her movement had been noticed. Moreover, when the mother posed questions to Thea, she began to treat Thea's spontaneous bodily responses as answers to her questions.

In B7, Thea and her mother began to play a new song, "The Wheels on the Bus." During the first verse, her mother moved Thea's legs as though Thea were pedaling while Thea was positioned on her back. In the beginning, Thea participated in the song by bending one or both of her knees during the slots created by her mother. In B10, her participation in the song developed. She not only bent her knees during the time slots but also during the activity. That is, she could use her leg movements for cocreating the movement pattern of pedaling with her mother. This was possible because her mother released her grasp on one of Thea's legs alternately, which enabled Thea to make a half round of pedaling independently in both legs. Her pedaling movements were captured in the recordings in B10, B12, and A15. Extract 3 illustrates Thea's participation in "The Wheels on the Bus" in B10.

Extract 3. Thea's (T) co-constructed leg movements in "The Wheels on the Bus" in intervention session B10.

```
01 MOT:    +.hh Pyörät ne pyör+              +[ivä]+t
                The wheels on the bus         go round
   mot     +BICYCLING MOVEMENT+RELEASES HOLD+     +GRASPS T'S R LEG--->

02 THE:                                        [BENDS R KNEE]

03 MOT:      ym+#              +[pä:#]+ri+
             and                 round
   mot     --->+RELEASES HOLD+        +GRASPS T'S L LEG+
   fig          #fig. 16

04 THE:                          [BENDS# L KNEE]
   fig                                 #fig. 17
```

Figure 16. The mother releases her hold on Thea's left leg. Original publication: Peltokorpi, S., Salo, S., Hart, P., Nafstad, A., Kajamies, A., & Laakso, M. (2024). Developing reciprocity between one-year-old children with visual impairment and additional disabilities and their mothers: The effects of bodily-tactile early intervention. Learning, Culture and Social Interaction, 48, Article 100849. doi: 10.1016/j.lcsi.2024.100849

Figure 17. Thea bends her left knee during the pedaling movement. Original publication: Peltokorpi, S., Salo, S., Hart, P., Nafstad, A., Kajamies, A., & Laakso, M. (2024). Developing reciprocity between one-year-old children with visual impairment and additional disabilities and their mothers: The effects of bodily-tactile early intervention. Learning, Culture and Social Interaction, 48, Article 100849. doi: 10.1016/j.lcsi.2024.100849

The co-performed movement pattern of pedaling goes on several times and smoothly during the first verse. Thea participates in the action by bending her legs alternately (Lines 02 and 04) when her mother releases her hold on her legs (Lines 01 and 03). One movement pattern begins when Thea's mother releases her grasp of Thea's left leg (Line 03, Figure 16). Thea continues the movement by bending her left knee (Line 04, Figure 17) before her mother grasps the leg again. When the same movement pattern was repeated with both of Thea's legs, it resulted in a cocreated bodily-tactile "choreography" of the first verse. Rączaszek-Leonardi et al. (2013) argue that these types of coactions are essential for intentionality to emerge.

In summary, during the intervention, Thea acquired new resources for participation through her leg movements. First, she could engage in the games by bending one or both of her knees during time slots created by her mother. At a later stage, she could use her leg movements for co-constructing the pedaling movement of "The Wheels on the Bus" by doing a part of the pedaling independently. These changes in Thea's participation were based on the changes in her mother's interactive behavior.

5.3.2 Sara and her mother

The findings indicate that during the intervention, Sara's mother began to play dyadic play routines with Sara. Moreover, her structuring of the play routines changed. She began to create slots during the play routines and observe more of Sara's body movements during the slots. This enabled Sara to take her turn through

movements. When Sara's mother detected Sara's movements, she responded to them by touching the part of the body Sara had moved and acknowledged her actions verbally as if they were intentional.

Baseline. Typically, Sara's mother used sound toys for playing with Sara at baseline. During their play routines, Sara sat in front of her mother on the floor, and her mother's gaze was focused on the toys or Sara's face. Sara's mother responded to Sara's vocalizations but less to her movements. This is a common finding for mothers of infants with typical verbal development (Rączaszek-Leonardi et al., 2013; Sierra, 2017; Vierijärvi, 1999). Sara's mother posed questions to Sara frequently. She used questions to obtain information from Sara, to inform her about the subsequent actions, and as a means to respond to Sara's vocalizations or smiling. As Sara could only occasionally respond to her mother vocally, her mother often answered the questions herself (e.g., "Do you like the song?" [pause] "Do you?" [pause] "Yeah").

Intervention. Sara's mother began to engage in more dyadic play routines without toys with Sara during the intervention. During the play routines, Sara was either on her back on the floor (Extract 4) or on her mother's lap. These positions gave her more opportunities to participate in the play routines by moving her legs. Sara's mother changed her way of asking Sara questions during the intervention, as she began to expect Sara's bodily answers besides her vocalizations. Moreover, Sara's mother began to create slots for Sara's turn-taking during the games and observed Sara's body during the slots. When she detected Sara's movement, she interpreted it as an intentional action and often acknowledged it tactilely by touching the part of Sara's body she had moved. By doing so, her noticing of Sara's movement became accessible to Sara.

Extract 4 illustrates a moment of interaction in the first intervention session (B5). Sara and her mother are singing and playing "The Wheels on the Bus" and have finished the first verse. The mother asks Sara three times whether she would like to sing the next verse with leg movements (Lines 01–04). Next, Sara moves her body (Line 05), which her mother interprets as an answer to her question (Line 04).

Extract 4. Sara's mother interprets Sara's (S) movements as a response to her question in intervention session B5.

```
01 MOT:    *Otetaanko sitte vielä jalat rakas*+
           Shall we take the legs again darling
   mot     >>TOUCHES S'S LEGS-----------------+((AND GLANCES AT THEM))
   sar     *MOVES HER R HAND-----------------*

02 MOT:    +#°Otetaanko°+ (1.8)
              Shall we
   mot     +TAPS S'S LEGS+((GAZES AT S'S FACE))
   fig      #fig. 18

03 MOT:    Oisko ne kivat +vielä ottaa tähän+ mukaa
           Would it be nice to take them along
   mot                    +TAPS S'S LEGS---+

04 MOT:    ku ne [heiluu niin kivasti#  +Joo:+] (0.2)
           as they swing so nicely       Yes
   mot                                  +TOUCHES S'S LEGS+
   mot                               ((GAZES AT S'S LEGS AND FACE))

05 SAR:          [TURNS AND MOVES HER# LEGS]
   fig                                #fig. 19

06 MOT:    +*Otetaan sit pyyhkijät*+
             Let's take the wipers next
   mot     +LIFTS UP S'S LEGS------+
   sar      *MOVES HER R HAND AND HEAD*
```

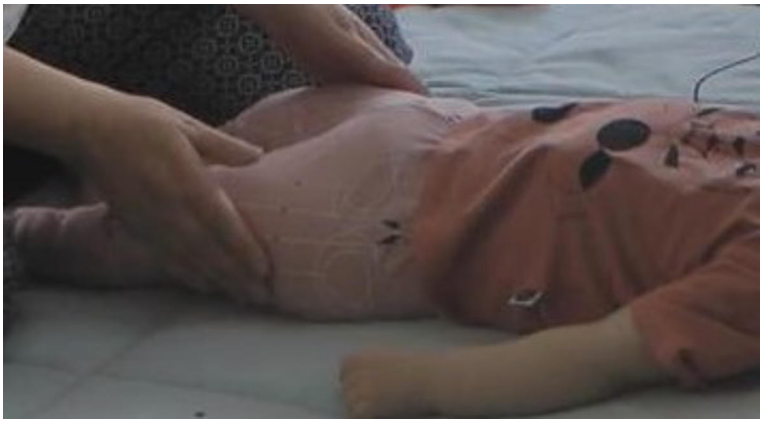


Figure 18. Sara is still during her mother's question and touches. Original publication: Peltokorpi, S., Salo, S., Hart, P., Nafstad, A., Kajamies, A., & Laakso, M. (2024). Developing reciprocity between one-year-old children with visual impairment and additional disabilities and their mothers: The effects of bodily-tactile early intervention. Learning, Culture and Social Interaction, 48, Article 100849. doi: 10.1016/j.lcsi.2024.100849

Figure 19. Sara turns and moves her legs. Original publication: Peltokorpi, S., Salo, S., Hart, P., Nafstad, A., Kajamies, A., & Laakso, M. (2024). Developing reciprocity between one-year-old children with visual impairment and additional disabilities and their mothers: The effects of bodily-tactile early intervention. Learning, Culture and Social Interaction, 48, Article 100849. doi: 10.1016/j.lcsi.2024.100849

The sequence in Extract 4 consists of three parts. *The first part* is the mother's question with repetitions (Lines 01–04), *the second part* consists of Sara's bodily action (Line 05, Figure 19), and *the third part* is the mother's confirmation *joo* (yes) and touch (Line 04). The question, which is the first part of an adjacency pair sets up the conditional relevance of the second part—the answer. The mother's turns include repetitions of her question (Lines 01–04) until she receives a response from Sara, which reflects an inner model of conditional relevance (Snow, 1977; Vierijärvi, 1999). While the mother poses questions to Sara, she also touches her legs several times (Lines 01–03, Figure 18). The mother's touches direct her and Sara's attention to the same locus. Next, Sara responds by taking a bodily action of turning and moving her legs (Line 05, Figure 19). The "nextness" of her turn helps her mother interpret the bodily actions as an answer to her question. Sara's mother expresses her interpretation of Sara's action as an affirmative answer by uttering "Yes" and touching Sara's legs (Line 04). Her interpretation of Sara's bodily action as an affirmative answer can be linked to Sara's rhythmic leg movements, which indicate excitement (Reddy et al., 2013). Through the mother's interpretation, Sara's bodily action becomes a second pair part of the adjacency pair. Sierra (2017) observed a similar sequence in which a mother interpreted the movement of her typically developing child as an answer to her question.

The findings of the sequence suggest that the mother's *knowledge* of Sara's resources to participate in interactions through bodily actions changed her ways of responding to Sara. She began to show *expectancy* toward Sara's bodily responses, and when she observed Sara's movements, she interpreted them as intentional

actions. Moreover, Sara's mother also began to interpret Sara's movements as intentional actions in contexts in which she did not ask her anything (e.g., as participation in a game). These findings suggest that parents' knowledge of their children's bodily resources can increase the reciprocity of their interactions, which is in line with the transactional model of development (Sameroff & MacKenzie, 2003a). Similar observations have been made of typically developing children. Ninio and Bruner (1978) discovered that when mothers became aware of their children's new vocal abilities, their way of responding to their children changed qualitatively. Further, the changes in the mothers' responses advanced their children's vocal development.

In summary, during the intervention, Sara gained new resources for participating in the play routines through movements. These positive outcomes were based on changes in her mother's interactive behavior.

5.3.3 Alex and his mother

The analysis indicated that during the intervention, Alex obtained more opportunities for turn-taking through movements. This change was based on the changes in his mother's interactive behavior. She began to create sequential slots for Alex's turn-taking and observe his actions with great attention. When she noticed Alex's subtle movements during the slot, she treated them as intentional actions and interpreted them as his wishes to continue the game.

Baseline. Alex's mother used physical activities when playing with Alex at baseline. During the activities, Alex was on his mother's lap, held face to face by his mother, or positioned on his back on the floor. Alex's mother observed Alex's responses from his facial gestures and tried to make eye contact with him. She posed frequent questions to Alex. However, she did not typically expect answers from him and used questions to inform Alex about the subsequent actions or to interpret his expressions in the activities. At times, her questions indicated her attempts to obtain Alex's visual attention. She responded to Alex's vocal and emotional expressions but less to his bodily actions.

Intervention. During the intervention, Alex's mother developed new play activities in the bodily-tactile modality with Alex. She also began to create more time and space for Alex to take his turn. During the slots, she paid close attention to Alex's bodily responses. When she noticed Alex's movements, she responded to them verbally and tactilely and often interpreted his actions as requests. Her touches related to Alex's movements made her responsiveness accessible to Alex.

Alex and his mother played a swinging game for the first time in B8. That time, Alex did not engage in the game with observable movements. In B9 and B12, Alex's mother began to respond to his emerging movements in the game as intentional

actions. Extract 5 illustrates this kind of moment in B12. Alex is positioned on his mother's lap during the play activity (Figure 20). He can perceive the movements of swinging through the bodily-tactile modality, and he responds to the initiation of swinging with a smile (Line 01). When the swinging is finished, Alex's mother creates a slot and observes his responses (Line 01). She expresses a soft exclamation *hui* (oh) (Line 02), referring to their shared experience, while observing Alex attentively.

Extract 5. Alex's mother interprets his subtle movements as intentional actions in intervention session B12.

```
01 MOT:    +.hh /kiik#kaa kaak°kaa° .hh °kiik/*kaa kaakkaa:°+* (1.8)
                ((A Finnish catchphrase connected to swinging))
   mot     +SWINGS ALEX ON HER LAP--------------------------+
   mot                                                      ((GAZES AT ALEX'S FACE))
   ale                                          *BREATHES IN LOUDLY*
   ale           /smiles----------------------/
   fig                #fig. 20

02 MOT:    °Hui::°    (1.3)*                *(0.5)*           *(3.8)
            Oh
   mot     ((GAZES AT ALEX'S FACE))
   ale                      *LEANS BACKWARDS*      *TURNS HEAD*

03 ALE:    #LEANS BACKWARDS AND MOVES HIS L LEG AND HEAD+ (0.5)
   mot      ((GAZES AT ALEX'S FACE))                        +……--->
   fig     #fig. 21

04 MOT:       °Te+hään*kö lis*ää tehään+kö#°+
               Shall we do some more shall we
   mot       --->+TOUCHES ALEX'S HEAD+TOUCHES ALEX'S L LEG+
   mot                                      ((GAZES AT HIS FACE))
   ale                 *TURNS HIS HEAD*
   fig                                    #fig. 22
```

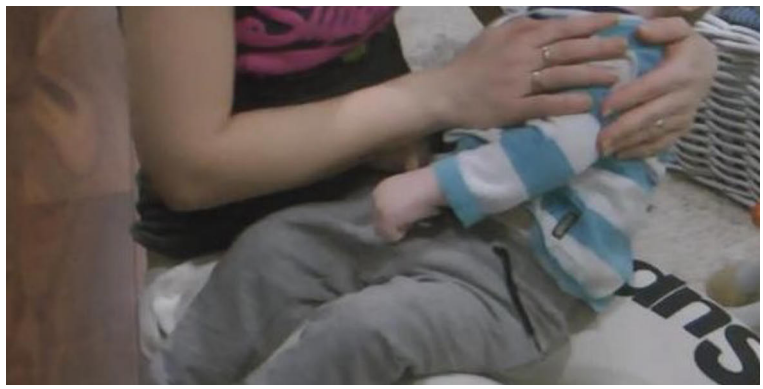


Figure 20. The swinging movement begins. Original publication: Peltokorpi, S., Salo, S., Hart, P., Nafstad, A., Kajamies, A., & Laakso, M. (2024). Developing reciprocity between one-year-old children with visual impairment and additional disabilities and their mothers: The effects of bodily-tactile early intervention. Learning, Culture and Social Interaction, 48, Article 100849. doi: 10.1016/j.lcsi.2024.100849

Figure 21. Alex leans backward and moves his left leg. Original publication: Peltokorpi, S., Salo, S., Hart, P., Nafstad, A., Kajamies, A., & Laakso, M. (2024). Developing reciprocity between one-year-old children with visual impairment and additional disabilities and their mothers: The effects of bodily-tactile early intervention. Learning, Culture and Social Interaction, 48, Article 100849. doi: 10.1016/j.lcsi.2024.100849

Figure 22. The mother notices Alex's leg movement tactilely. Original publication: Peltokorpi, S., Salo, S., Hart, P., Nafstad, A., Kajamies, A., & Laakso, M. (2024). Developing reciprocity between one-year-old children with visual impairment and additional disabilities and their mothers: The effects of bodily-tactile early intervention. Learning, Culture and Social Interaction, 48, Article 100849. doi: 10.1016/j.lcsi.2024.100849

Alex leans slightly backward during his mother's expectant attention (Line 02). His movement may be perceptible to his mother, who, however, does not respond to it. Next, after a long pause (Line 02), Alex repeats his movement of leaning back with a subtle movement with his left leg (Line 03, Figure 21). These subtle actions could mirror his bodily experiences of the game. Similar findings of mirroring

movements have been observed in other children with VIAD (Rogow, 1982). These discoveries suggest that children with VIAD can build their bodily actions by reusing resources of former actions that they have perceived (cf. Goodwin, 2013). Moreover, as Alex's first movement (Line 02) was not responded to, his repetition of the movement (Line 03) could be an attempt to repair communication (Dincer & Erbas, 2010). This time, Alex's bodily actions are noted by his mother, who *interprets* them as a request to continue swinging (Line 04). The mother's interpretation is fundamental for creating shared meaning with Alex (for similar findings, see Rączaszek-Leonardi et al., 2013). In other words, if she had ignored Alex's movements, their potential in interactions would have been unfulfilled. Further, Alex's mother expresses to Alex that she noticed his movements by touching the loci of his body where she perceived his movements (Line 04, Figure 22). In this way, the mother's attention and nonverbal responsiveness become accessible to him.

The swinging game is an example of an early play routine that provides many resources for the participation of children with VIAD, such as Alex. First, it is multimodal and accessible through the bodily-tactile modality. Second, it has a simple structure of one activity, swinging, which can be repeated. Third, it has a distinguishable rhythm, which has been found to enhance togetherness between caregivers and their children with VIAD (Metell, 2015). Fourth, the long time slots during the game can sensitize children with VIAD to perceive their parents' bodily actions and engage in the activity (cf. Johnson & Parker, 2013; Rączaszek-Leonardi et al., 2013).

In summary, during the intervention, Alex's participation in the play routines increased. This was based on the changes in his mother's interactive behavior, which provided more space and time for Alex to take his turns. Moreover, the mother's interpretations of Alex's subtle movements as intentional actions created reciprocity in their interactions.

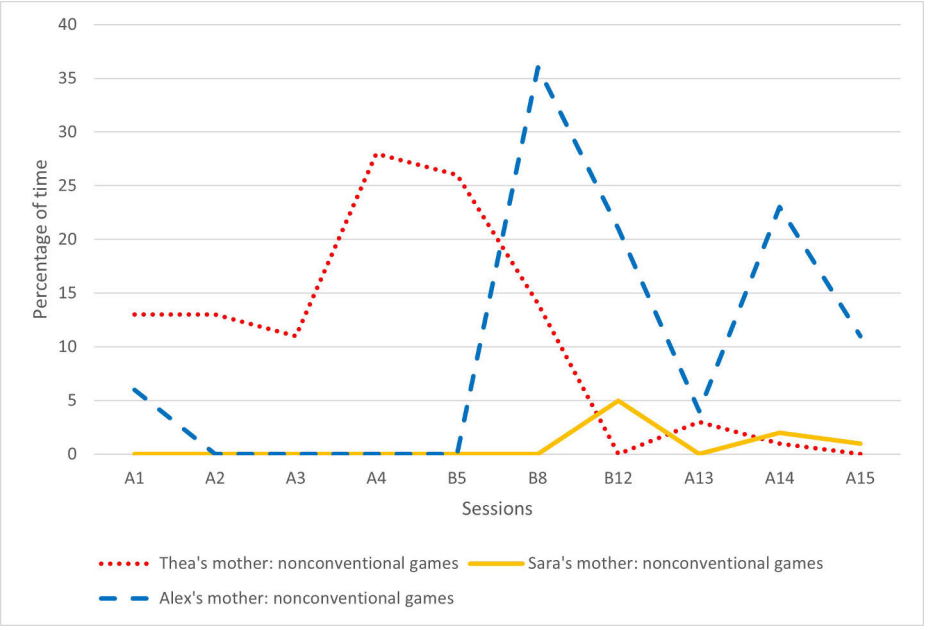
5.4 Study IV

5.4.1 The mothers' use of tactile strategies

All the mothers increased their use of the bodily-tactile modality in interactions with their children with VIAD during the early intervention (Research Question 2). The changes in their use of the bodily-tactile modality are specified below.

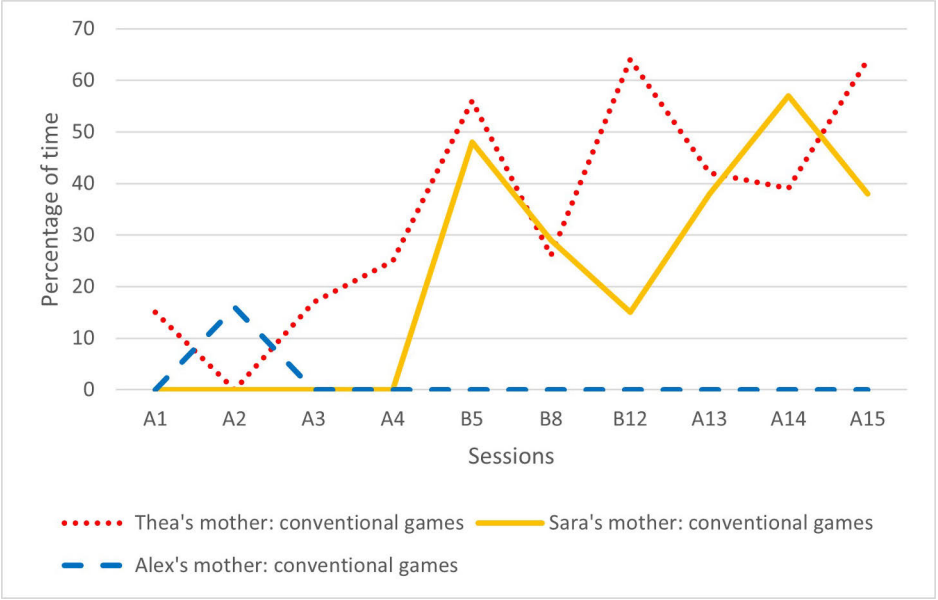
Early play routines. The changes in the amount of time the mothers' played bodily-tactile nonconventional and conventional games with their children are illustrated in Figures 23 and 24. Overall, the mothers increased their use of the bodily-tactile play routines with their children during the intervention. However,

they had differences in the type of games they played more often with their children. Thea's mother especially increased her use of conventional games with Thea during the intervention and follow-up, whereas the time used for nonconventional games decreased. Sara's mother mainly used toys for playing with Sara at baseline. During the intervention and follow-up, she developed new dyadic conventional games with Sara. Alex's mother also mainly used toys for playing with Alex at baseline. During the intervention, she began to play more nonconventional games with Alex.



Note: B5 refers to the session at the beginning of the intervention (B5 or B6), B8 to the session in the middle of the intervention (B8 or B9), and B12 to the session at the end of the intervention (B11 or B12).

Figure 23. The mothers' use of nonconventional games as a percentage of time per session. Original publication: Peltokorpi, S., Salo, S., Nafstad, A., Hart, P., Biringen, Z., & Laakso, M. (2024). Bodily-tactile early intervention: A pilot study of the role of maternal touch and emotional availability in interactions between three children with visual impairment and additional disabilities and their mothers. Frontiers in Psychology, 15, Article 1439605. doi: 10.3389/fpsyg.2024.1439605



Note: B5 refers to the session at the beginning of the intervention (B5 or B6), B8 to the session in the middle of the intervention (B8 or B9), and B12 to the session at the end of the intervention (B11 or B12).

Figure 24. The mothers' use of conventional games as a percentage of time per session. Original publication: Peltokorpi, S., Salo, S., Nafstad, A., Hart, P., Biringen, Z., & Laakso, M. (2024). Bodily-tactile early intervention: A pilot study of the role of maternal touch and emotional availability in interactions between three children with visual impairment and additional disabilities and their mothers. Frontiers in Psychology, 15, Article 1439605. doi: 10.3389/fpsyg.2024.1439605

Tactile noticing. The mothers of Thea and Alex used only a little tactile noticing (Figure 4) at baseline. They both increased their use of tactile noticing during the intervention. Thea's mother continued her contingent responses to Thea's reaching gestures, which she had already used at baseline. Moreover, she began to touch the part of Thea's body that Thea had moved before she continued the play routine. Alex's mother mostly utilized this type of tactile noticing in interactions with Alex during the intervention. Specifically, when Alex made a subtle movement with his hands, legs, head, upper body, or blinking eyes, his mother touched the part or close to the part of the body that he had moved to accompany her verbal responses. Both mothers infrequently used imitation for noticing their children's actions.

Tactile anticipatory cues. All the mothers began to utilize tactile anticipatory cues (Figure 5) during the intervention. This was a change in their interactive behavior, because only Thea's mother had used some tactile anticipatory cues at baseline. The mothers' intervention-based tactile anticipatory cues occurred in connection with their verbal questions (e.g., Thea's mother would move Thea's legs or hands in the same way as in the subsequent game when she asked Thea if she would like to play it).

Moreover, the mothers used tactile anticipatory cues to inform their children about subsequent actions (e.g., Sara's mother would touch or move the part of Sara's body that she was about to touch or move next in the game). The mothers of Thea and Sara made tactile anticipatory cues through touches and movements, whereas Alex's mother utilized mainly touches for anticipating actions to Alex.

Tactile signs. The mothers did not use tactile signs at baseline. During the intervention, the mothers of Thea and Sara began to utilize tactile signs in songs (e.g., "Itsy Bitsy Spider") and sometimes to support their speech. Thea's mother mainly used coactive signing (Figure 6A) with Thea, whereas Sara's mother utilized coactive signing and body signs (Figure 6B) with Sara. Alex's mother coactively signed *DOG* for Alex in a self-created game during the intervention. Table 12 presents the mothers' results of using tactile noticing, tactile anticipatory cues, and tactile signs before, during, and after the intervention.

Table 12. Frequencies of the mothers' use of tactile noticing, tactile anticipatory cues, and tactile signs.

Categories	A1	A2	A3	A4	B5[a]	B8[a]	B12[a]	A13	A14	A15
Thea's mother										
Tactile noticing	4 (0.2)	0	3 (0.2)	3 (0.3)	20 (2.0)	37 (3.7)	10 (0.8)	17 (1.5)	17 (1.1)	14 (1.4)
Tactile anticipatory cues	2 (0.1)	1 (0.1)	0	1 (0.1)	1 (0.1)	0	5 (0.4)	4 (0.4)	6 (0.4)	6 (0.6)
Tactile signs	0	0	0	0	0	0	17 (1.4)	16 (1.5)	17 (1.1)	0
Sara's mother										
Tactile noticing[b]	-	-	-	-	-	-	-	-	-	-
Tactile anticipatory cues	0	0	0	0	4 (0.4)	5 (0.5)	4 (0.4)	8 (0.7)	13 (1.3)	6 (0.5)
Tactile signs	0	0	0	0	0	8 (0.8)	15 (1.5)	5 (0.5)	6 (0.6)	9 (0.8)
Alex's mother										
Tactile noticing	0	0	0	3 (0.3)	2 (0.2)	11 (1.0)	14 (1.4)	33 (3.3)	11 (1.1)	9 (0.9)
Tactile anticipatory cues	0	0	0	0	0	1 (0.1)	7 (0.7)	3 (0.3)	5 (0.5)	9 (0.9)
Tactile signs	0	0	0	0	0	9 (0.8)	0	0	0	0

Note: The numbers in brackets show the frequency of the phenomenon per minute.
[a] B5 refers to the session at the beginning of the intervention (B5 or B6), B8 to the session in the middle of the intervention (B8 or B9), and B12 to the session at the end of the intervention (B11 or B12).
[b] These results are not reported due to low reliability in the coding.

5.4.2 Emotional availability

The raw EA scores and means for the mothers and their children are reported in Table 13. The raw EA scores indicate positive changes in the children's and their mothers' emotional relationship during the early intervention (Research Question 5). For Thea's mother, her mean EA scores remained at the same levels from baseline to intervention. For Sara's mother, her mean EA scores for sensitivity increased from the inconsistent level to the neutral sensitivity level during the intervention. Similarly, her mean EA scores for nonintrusiveness increased from the "benign" intrusiveness level to the generally nonintrusive level. However, during the follow-up, her mean EA scores for sensitivity and nonintrusiveness regressed back to the baseline level. For Alex's mother, her mean EA scores for sensitivity increased from the inconsistently sensitive level to the neutral sensitivity level during the intervention and remained at the neutral sensitivity level during the follow-up. Her mean EA scores for structuring increased from the inconsistent structuring level to the moderately structuring level during the intervention.

The children's mean EA scores changed from baseline to intervention. For Thea, her mean EA scores for responsiveness increased from the complicated responsiveness level to the moderately optimal level of responsiveness during the intervention and remained at the moderately optimal level during the follow-up. Her mean EA scores for involvement increased from the complicated involvement level to the moderately optimal level in involving behaviors during the intervention. Sara's mean EA scores for involvement increased from somewhat non-optimal level in involving behaviors to complicated involvement during the intervention. Her mean EA scores also remained at the level of complicated involvement during the follow-up. Alex's mean EA scores for responsiveness increased from the complicated responsiveness level to the moderately optimal level during the intervention. His mean EA scores for involvement increased from the somewhat non-optimal level to the complicated involvement level during the intervention and remained at the complicated level during the follow-up.

Table 13. The means and ranges of emotional availability for the children and their mothers before, during, and after the bodily-tactile early intervention.

	Baseline	Intervention	Follow-up
THEA'S MOTHER			
Sensitivity	5.8 (5.0–6.5)	6.2 (5.5–6.5)	5.8 (5.5–6.0)
Structuring	5.9 (5.5–6.5)	6.2 (6.0–6.5)	6.0 (6.0–6.0)
Nonintrusiveness	4.6 (4.5–5.0)	5.0 (4.0–5.5)	5.0 (4.5–5.5)
Nonhostility	6.3 (6.0–7.0)	6.7 (6.0–7.0)	7.0 (7.0–7.0)
Child responsiveness	5.4 (5.0–6.5)	6.3 (6.0–6.5)	6.0 (6.0–6.0)
Child involvement	4.3 (3.0–6.0)	5.7 (5.0–6.0)	5.3 (5.0–5.5)
SARA'S MOTHER			
Sensitivity	4.8 (4.0–5.5)	5.7 (5.0–6.0)	5.3 (4.5–6.0)
Structuring	5.1 (5.0–5.5)	5.2 (5.0–5.5)	5.5 (5.5–5.5)
Nonintrusiveness	4.4 (3.5–5.0)	5.5 (5.5–5.5)	5.3 (4.0–6.0)
Nonhostility	5.8 (5.5–6.0)	6.2 (6.0–6.5)	6.0 (6.0–6.0)
Child responsiveness	4.1 (3.5–5.0)	4.7 (4.5–5.0)	5.2 (4.5–5.5)
Child involvement	3.5 (3.0–4.5)	4.0 (3.0–5.0)	4.5 (3.5–5.0)
ALEX'S MOTHER			
Sensitivity	5.1 (4.5–6.0)	5.5 (5.0–6.0)	5.7 (5.5–6.0)
Structuring	4.8 (4.5–5.0)	5.5 (5.5–5.5)	5.2 (5.0–5.5)
Nonintrusiveness	4.9 (4.5–5.5)	5.3 (5.0–6.0)	5.8 (5.5–6.0)
Nonhostility	6.3 (6.0–7.0)	7.0 (7.0–7.0)	7.0 (7.0–7.0)
Child responsiveness	4.8 (4.0–5.0)	5.8 (5.5–6.0)	5.3 (5.0–5.5)
Child involvement	3.8 (3.5–4.5)	5.3 (5.0–5.5)	4.8 (4.5–5.0)

Note: All the scales range from 1 (low) to 7 (high).

5.5 The mothers' evaluation of the intervention

All four mothers in Studies II–IV rated the intervention as very useful (5), using a scale from *not useful at all* (1) to *very useful* (5).

6 Discussion

6.1 Summary and discussion of the results

The Study I findings suggest that the mother of the child with CDB (Emma) increased tactility in her imitations during the tactile imitation guidance. Her imitative exchanges with Emma became longer at the end of the guidance, and Emma began to respond to her mother's imitations more by smiling and placing her hands on her mother's face. Moreover, Emma and her mother became emotionally more available to each other during the intervention compared to at baseline. In Studies II, III, and IV, the mothers of children with VIAD (Robin, Thea, Sara, and Alex) increased their use of the bodily-tactile modality in play routines during the intervention. They also began to utilize more tactile anticipatory cues, tactile noticing behaviors, and tactile signs in interactions with their children. Moreover, the mothers began to create more time and space for their children to take turns and to respond to their children's movements as if they were voluntary actions. The changes in the mothers' interactive behaviors increased their children's embodied participation through movements, gestures, and signs, which resulted in more reciprocity in interactions. Moreover, the EA of the children and their mothers strengthened during the early intervention. The mothers evaluated the intervention as very useful. Overall, the findings of this study suggest that the reciprocity connected to turn-taking and the emotional exchanges between mothers and their children with VIAD increased during the bodily-tactile early intervention.

6.1.1 The characteristics of the mother-child imitations after the tactile imitation guidance

The Study I findings suggest that Emma's mother imitated her expressions frequently at baseline. However, most of her imitations were vocal, and she used tactility in her imitations only once. This might be because for a sighted and hearing parent, it is natural to create a dialogue with a child through the vocal modality. When Emma's mother was introduced to tactile imitation, she began to use the tactile modality more in her imitations during the guidance. She created her personal ways of applying tactility in imitations, such as tracing her mouth movements on Emma's

hands. These findings suggest that systematic application of the tactile modality in imitations may not occur spontaneously in the parents of children with CDB, and they may benefit from tactile imitation guidance to make their non-vocal and vocal imitations more accessible to their children.

It appeared that the mother's more frequent use of tactility in imitations strengthened the tactile reciprocity, as Emma began increasingly to place her hands on her mother's face during the intervention. Escalona et al. (2002) had similar findings in studies of 3–7-year-old children with autism, who responded to adults' imitations by touching the adults. Moreover, Emma began to smile more as a response to her mother's imitations during the intervention. Smiling indicates sensitivity to being imitated in typically developing infants (Nadel et al., 2004), and it is a common response to being imitated in persons with developmental delay or VIAD (O'Neill & Zeedyk, 2006). Emma's increased smiling and tactile contact behaviors suggest that the intervention strengthened positive transactions through increased accessibility (Sameroff & MacKenzie, 2003b). Similarly, other studies have discovered that tactile imitations created positive encounters with individuals with CDB (Caldwell, 2006; Hart, 2006; Shakele et al., 2022).

Emma's mother initiated most of the imitative bouts, which usually lasted one round. Likewise, O'Neill and Zeedyk (2006) found that adults initiated most of the imitative bouts in interactions with 7–18-year-old youngsters with developmental delays, and most of the bouts did not extend beyond a single round. Emma made occasional imitations of her mother's vocal and gestural expressions as part of her expressive repertoire. Her gestural imitations occurred after she accessed her mother's gestures through the sense of touch.

The length of Emma's and her mother's imitative bouts increased in the last intervention session, which indicates that their interactions included longer episodes of turn-taking. This was an important qualitative change in their interactions because turn-taking involved Emma as an active participant in interactions and could attribute agency to her. Moreover, the early forms of turn-taking are necessary precursors for the development of more mature interactional sequences (Berducci, 2010). It is unlikely that the increase in turn-taking could have occurred due to Emma's natural development, because the intervention was implemented in a rather short time interval, and the changes in the length of the turn-taking exchanges were detected in the last intervention session. Thus, the results suggest that the tactile imitation guidance launched a process that prolonged the turn-taking exchanges over time.

This study is unique in its ability to provide scientific information about tactile imitation guidance for the mother of a child with CDB. That is, although tactile imitation has been described as a useful strategy in the CDB literature (e.g., Nafstad & Rødbroe, 2015), and it has been utilized among other strategies in an intervention for a child with CDB (e.g., Shakele et al., 2022), no other interventions have explored

the effects of tactile imitation guidance for parents of children with CDB (for a review, see Sundqvist et al., 2023). Overall, the results of Study I suggest that the mother's use of the tactile modality in her imitations made her multimodal expressions more accessible and/or interesting to Emma and resulted in her increased engagement.

Imitation provides a powerful means to create interactional reciprocity in the early phases of language development, when many other strategies might not yet be appropriate. This is because adults' imitations treat children's expressions as initiatives irrespective of whether they were originally initiations or not. Furthermore, when children with VIAD experience that they can have an impact on others' behavior and lead the dialogue, it can radically change their roles in communication and create a feeling of shared understanding with their parents. However, imitation alone is not sufficient to foster language development. Instead, it is a starting point in a dialogue that can lead to more complex co-constructed interactions (Linell, 2009). Thus, parents need to have the opportunity to learn other (tactile) strategies to foster interactions and communication with their children with VIAD.

6.1.2 The mothers' use of the bodily-tactile modality

In Studies II–IV, some of the mothers had already developed *bodily-tactile play routines* with their children at baseline, but this was not the case for all. Thus, there was individual variety in how the mothers spontaneously used the bodily-tactile modality for creating dyadic games with their children with VIAD. Furthermore, our findings suggest that the mothers increased their use of the bodily-tactile modality in the context of play during the intervention. They were able to develop new games easily, which corresponds to Stern's (1974) findings. The findings also suggest that dyadic games were developmentally easier activities for the children to join than games with toys, which supports Trevarthen's (1980) developmental theory of intersubjectivity. However, it is important to note that the mothers' increased use of the bodily-tactile modality in play routines differs from the typical developmental process in which the proportion of tactile games decreases as infants age (Crawley et al., 1978). This is due to the differences in the resources that children with and without VIAD can use for their participation over time. Overall, multimodality can manifest differently in typical and atypical interactions. However, interactions with children with VIAD may need more focus on the bodily-tactile modality to create more equal encounters.

Our findings suggest that children with VIAD could utilize non-vocal structures of the play routines in their participation. Similarly, Rogow (1982) found that children with VIAD used nonverbal structures of play routines for their initiations.

Thus, bodily-tactile play routines can be optimal activities for early intervention, and their usability may reach far beyond the first two years of life, depending on the child's abilities and needs. The games can be optimally modified for children's participation at different ages, considering their motor skills and other resources. Moreover, all the mothers in this study benefited from guidance on structuring games optimally for their children's participation. Without this part of the intervention, the focus would have been only on input for the children, which would not have been adequate to support their participation. Thus, enlarging the repertoire of bodily-tactile play routines is only a first step, and it is crucial to ensure that games are structured optimally for children's multimodal engagement.

In Studies II and IV, the mothers increased their use of *tactile noticing* during the intervention, which suggests that they began to recognize more of their children's embodied participation. This, in turn, indicates that the intervention created positive mother-child transactions (Sameroff & MacKenzie, 2003b). Tactile noticing may be an accessible form of parents' nonverbal responsiveness. In that case, tactile noticing could function like parents' gaze responsiveness, which has been found to predict the language development of typically developing infants (Wildt & Rohlfing, 2024). In Study IV, the mothers used three different types of tactile noticing behaviors in responding to their children. It is possible that these tactile responses have different effects on children's participation in the same way that mothers' diverse vocal responses have on their typically developing children (see Gros-Louis et al., 2014). Moreover, tactile noticing may express embodied mentalizing, which is the parents' capacity to read their infants' mental states (e.g., wishes) from their bodily actions and adjust their own bodily actions accordingly (Shai & Belsky, 2011). Overall, the findings of this study generate new information on tactile noticing, because previous studies have utilized tactile noticing only in interventions for people with CDB (Damen et al., 2015a).

The findings of Studies II and IV suggest that the mothers' use of *tactile anticipatory cues* increased during the intervention. Similarly, Chen et al. (2007) discovered that parents of children with VIAD increased their use of diverse anticipatory cues, including touch cues, during an early intervention and found them useful for communicating better and understanding the needs of their children with VIAD. Tactile anticipatory cues can help children with VIAD anticipate activities, recognize and comprehend target words, and develop communication through objects (Chen et al., 2007; Goold & Hummel, 1993). Moreover, they may lower behaviors indicating stress and increase children's active participation (Nelson et al., 2013). These positive findings indicate that tactile anticipatory cues can provide access to adults' intentions and create better sequential structuring of interactions, which facilitate children's participation (Axelsson et al., 2014; Fantasia et al., 2019).

Our results from Studies II and IV suggest that the intervention helped the mothers adapt *tactile signs* into play routines and support key words during their speech. Moreover, the results of Study II suggest that Robin began to imitate two new signs and made one of them spontaneously, which indicates that the intervention created positive transactions. It is likely that these new skills in signing occurred because Robin was already making signs at baseline and was developmentally at a higher stage than the children in Study IV. Overall, the present study resulted in new information about the potential of an early intervention to help the parents of children with VIAD learn tactile signs. To our knowledge, only Shakele et al. (2022) have addressed this topic and reported the positive effects of an intervention on the tactile signing of a 3-year-old girl with CDB and her family members.

The findings regarding Robin's signs suggest that learning signs through coactive signing can be useful for children with VIAD at the beginning of their sign acquisition and can provide them with access to manual sign acquisition. However, although tactile signing is described in the AAC literature (e.g., von Tetzchner & Martinsen, 1999, p. 41), this system is rarely addressed in AAC research or clinical practice. This may be because the deafblind field and the AAC field are not well connected. This study aimed to bridge the gap between these fields by demonstrating that tactile signing and tactile strategies in general may be useful tools for SLPs to support the communication development of children with VIAD.

This doctoral study is one of the first to explore mothers' use of tactile strategies in early interactions with their 1–3-year-old children with VIAD. The results suggest that the mothers increased their use of tactile strategies with their children with VIAD during the interventions. It is unlikely that these changes would have occurred spontaneously or were due to any factor other than the interventions because tactile strategies are specific means of multimodal communication that are not usually observed in systematic use in parent-child interactions. To use tactile strategies, the mothers needed to take on a learner's role and acquire new skills in the bodily-tactile modality. Moreover, they needed to reflect on what it was like to perceive the world from a tactile perspective and sensitize themselves in perceiving their children's subtle movements and gestures. This learning process could accomplish more equal and co-constructed interactions with their children with VIAD, as they were learning from each other (see Hart, 2010, p. 66). Accessibility has not been the focus of previous early interventions designed for young children with VIAD. Thus, this study raises new perspectives and principles regarding early interventions for families with children with VIAD.

6.1.3 Children's participation and reciprocity of the mother-child interactions

In Study I, Emma's multimodal participation increased during the tactile imitation guidance. She engaged in longer imitative exchanges in the vocal modality and made more tactile contact gestures toward her mother compared to at baseline. Similarly, other researchers have found that adults' imitative responses enhance the participation of children with limited communication skills (Morris et al., 2021).

In Study II, we observed that Robin participated in interactions by making tactile contact with his mother using his foot. This finding offers new information as child-initiated tactile contact has been described earlier only in children with CDB and in the non-empirical literature (e.g., Nafstad & Rødbroe, 2015). Our findings suggest that children with VIAD may use tactile contact as an alternative to eye contact when their caretakers are within reach. It is essential that caretakers become more aware of tactile contact to be able to recognize it in interactions. Tactile contact is also an important strategy for adults to use in interactions with children and adults with VIAD (Damen et al., 2014).

Our findings suggest that the repetitive nature of bodily-tactile games could help children learn the nonverbal components of the games and use them for their participation. At baseline, Robin used signs connected to the song "Itsy Bitsy Spider," which he had learned through coactive signing. Moreover, the sequential analysis revealed that the negotiated sign *MAGPIE* developed from Robin's bodily-tactile play experiences. Ask Larsen (2003) described similar findings in relation to a boy with CDB who played a bodily-tactile rhyme with his mother. Furthermore, the findings of Study III suggest that some of the children's movements could mirror their bodily-tactile experiences. Similarly, Rogow (1982) found that the gestures and actions of children with VIAD mirrored their play experiences.

In Study III, the children participated in the play activities through movements that expressed their activity or enthusiasm. In addition, other researchers have found that typically developing infants (Fantasia et al., 2014; Jover et al., 2019; Reddy et al., 2013) and children with VI/VIAD (Liang et al., 2015; Preisler, 1991, 1995; Rogow, 1982) participate in interactions through physical activity. However, movement-based participation has not gained much scientific attention. This may be because movements are a momentary resource for participation in typically developing infants, and in the case of VIAD, children often receive more attention for their motor difficulties than for their embodied participation. However, it is essential that adults consider the movements of children with VIAD as their resources for participation. Participation through movements can create positive transactions (Sameroff & MacKenzie, 2003b) and launch a developmental process that advances their movements to more specific game-based bodily intentional

actions and gestural expressions (Lee & MacWilliam, 2008, p. 29; Preisler 1991, 1995; Rogow, 1982).

In Study II, the baseline observations suggest that Robin's mother did not detect most of Robin's subtle gestures. Similarly, Fraiberg (1979) found that mothers had challenges reading their blind infants' hand gestures. However, Maestas y Moores (1980) discovered that deaf parents read semantic intent from their infants' hand configurations and movements from early on, which can be related to their expertise in sign language and their understanding of hands as articulators. Thus, it is crucial to guide the parents of children with VIAD to detect and respond to their children's spontaneous gestures because they can take on sophisticated communicative functions and become their voices when recognized as such.

In Study III, we discovered that mother-child interactions had limited reciprocity at baseline. The mothers posed questions to their children with VIAD, but they did not typically expect responses from them. This might stem from the mothers' interactional experiences of not perceiving responses from their children. Instead, the mothers often responded to the questions themselves. However, this type of interaction may hinder children's communication development because it lacks their involvement. Our findings indicate that mother-child interactions became more reciprocal during the intervention. Moreover, we observed that the positive changes in reciprocity were based on changes in the mothers' interactive behaviors. Similarly, Janssen et al. (2002) discovered that positive changes in the interactive behaviors of children with CDB were gained through changes in their educators' interactive behaviors. These findings indicate that interventions focused on caretakers can make positive changes in adult-child transactions (Sameroff & MacKenzie, 2003b).

Furthermore, our findings suggest that the changes in reciprocity were closely connected to the changes in the mothers' *expectations*. That is, when the mothers began to expect bodily responses from their children, they responded to their children's movements as if they were voluntary actions. Similarly, Berducci (2010) found that parents of typically developing infants attributed agency to their infants' natural reactions that they expected (e.g., commenting "good job" after an infant's burp). We also discovered that the mothers began to treat their children's bodily actions as answers to their questions, which created sequences resembling those of typical early interactions (Berducci, 2010; Sierra, 2017; Snow, 1977; Vierijärvi, 1999). This was an important change because when the expressions of children with VIAD are embedded in turn-taking sequences, it gives them the opportunity to become more communicative and learn the discourse structure of language (cf. Berducci, 2010; Kaye & Charney, 1980). In addition, involvement in turn-taking sequences changes their roles from recipients to actors (see Smith & Fluck, 2000).

The findings of this study provide new information regarding the possibilities of fostering the participation of children with VIAD at age one. Previous studies have

not included such young participants (see Axelsson et al., 2014; Williams et al., 2020). Moreover, our results suggest that bodily-tactile early intervention may provide a means for children with VIAD to enjoy their right to participate (United Nations, 1989). This is an important finding because their rights can be easily ignored due to their disabilities, fragile health, and lack of knowledge of the strategies that they could benefit from. Furthermore, our findings suggest that children with VIAD do not need to be at any specific developmental stage to benefit from an intervention. Their participation can be fostered with their existing resources and through their parents' actions at all developmental phases.

Lastly, our results suggest that the increase in the mothers' use of the bodily-tactile modality in interactions did not decrease their children's vocalizations. Instead, Emma engaged in longer vocal imitative exchanges during the tactile imitation guidance. Overall, the children's vocalizations consisted of non-canonical vocalizations, which are typical at the early stage of vocal development. As their potential to develop speech cannot be predicted, it is necessary to provide them with alternative means of participation and communication from early on.

6.1.4 Emotional availability

The EA results suggest that the children with VIAD and their mothers became emotionally more available to each other during the two interventions. At baseline, the EA mean scores for *sensitivity* were at the neutral sensitivity level for the mothers of Robin and Thea and at the inconsistently sensitive level for the mothers of Emma, Sara, and Alex. Additionally, Campbell and Johnston (2009) found that some mothers of blind children without additional disabilities experienced challenges in sensitivity. During the interventions, the mean EA scores for sensitivity were elevated to the neutral sensitivity level for the mothers of Emma, Sara, and Alex. This is an interesting finding because the two interventions in this study were not attachment-oriented interventions like the interventions developed by Platje et al. (2018) and Dyzel et al. (2023), which did not increase parental sensitivity.

The mean EA scores for *structuring* were at the moderately structuring level for the mothers of Robin and Thea and at the level of inconsistent structuring for the mothers of Emma, Sara, and Alex at baseline. Similarly, Campbell and Johnston (2009) found that some mothers of blind children without additional disabilities experienced challenges in structuring. During the intervention, the mean EA scores for structuring were elevated to the moderately structuring level for the mothers of Emma and Alex. However, at follow-up, the mean EA score of Alex's mother decreased back to the inconsistent level of structuring, which suggests that she might have needed a longer intervention to maintain her higher level of structuring.

The mothers' mean EA scores for *nonintrusiveness* suggested that they all had "benign" intrusiveness at baseline. Interestingly, previous studies on the mothers of deaf or blind children did not report challenges in nonintrusiveness (Campbell & Johnston, 2009; Paradis & Koester, 2015). Our findings could be explained from a transactional perspective. That is, the mothers could have tried to compensate for the lack of participation of their children by increasing their stimulation and guidance. Our findings also suggest that during the intervention, the mean EA scores for nonintrusiveness rose to the generally nonintrusive level for the mothers of Emma, Robin, and Sara. However, the mean EA scores for nonintrusiveness for the mothers of Robin and Sara decreased back to the level of benign intrusiveness at follow-up, which indicates the need for a longer intervention.

The children's mean EA scores for the *child responsiveness* were at the level of complicated responsiveness at baseline. During the intervention, the mean EA scores of Emma, Robin, Thea, and Alex for responsiveness reached the moderately optimal level. As the guidance focused on the mothers, the findings on child responsiveness imply that the interventions created positive transactions (Sameroff & MacKenzie, 2003b). Positive transactional processes were also found in the *child involvement*. The mean EA scores of Emma, Sara, and Alex for involvement were at the somewhat non-optimal level at baseline and were elevated to the level of complicated involvement during the intervention. The mean EA scores of Robin and Thea for involvement corresponded to complicated involvement at baseline. Thea's mean EA scores were elevated to the moderately optimal level in involving behaviors during the intervention but decreased back to complicated involvement at follow-up.

Our findings suggest that the mothers' increased use of touch during the intervention was positively related to EA in the mother-child interactions. Similarly, Pipp-Siegel et al. (1998) and Paradis and Koester (2015) found that the mothers' touch was positively associated with EA in interactions with their deaf or hard-of-hearing children. Moreover, the EA results suggest that VIAD does not automatically cause problems in attachment relationships. However, VIAD challenges interactional reciprocity; therefore, adaptive responsiveness to a child's perceived needs is important. Our findings indicate that adaptive responsiveness entails parents' systematic use of the bodily-tactile modality in interactions with their children with VIAD and their ability to notice and respond to their children's bodily expressions.

It is important to consider EA when implementing communication interventions for families of children with VIAD. Focusing solely on tactile strategies does not guarantee emotionally available interactions if the child's cues and the emotional aspect of interaction are dismissed (cf. Barfoot et al., 2017). It is vital that professionals consider EA in their interactions with children with VIAD. Professionals can, for example, reflect on their own emotional connectedness with

children with VIAD and their responsiveness to the child's initiatives. Emotionally available early interactions are essential for the well-being of children with VIAD and their parents and may prevent children with VIAD from developing emotional and behavioral problems later in childhood.

6.2 Discussion of the methods

Conducting a study requires making several choices about methods, which have their strengths and limitations. As this study is a multiple case study, the results cannot be generalized to the population of children with VIAD and their mothers. For instance, it could be that the mothers who volunteered to participate in the study had more resources and motivation to develop their interactions with their children than the mothers of children with VIAD in general. However, as Yin (2014) argues, instead of generalizing the results to populations (statistic generalization) the findings of case studies can be generalizable to theoretical propositions (analytic generalization).

The case study design had many advantages. It allowed us to gain information about transactional *processes* and explained *how* the interventions worked, which could be difficult to reveal using other methods, such as questionnaires or randomized controlled trials. However, the design of Study I provided limited information and control over the characteristics of the mother-child imitations at baseline. The longitudinal designs of Studies II–IV were more robust and enabled the control of variables during a longer period and the detection of changes in mother-child interactions during different phases of the study. However, although the number of baseline recordings increased from three to four in Study IV, there could have been even more to increase control over the variables.

Another limitation of Study I is the lack of a follow-up period. Thus, it is not known whether Emma's mother continued using the tactile modality in her imitations after the tactile imitation guidance. Moreover, the follow-up periods of Studies II–IV are rather short, so it remains unclear whether the mothers continued to use tactile strategies with their children with VIAD. However, a longer baseline and follow-up require an extended time for data collection, which would have been challenging to carry out in this doctoral study because only one researcher collected the data. Moreover, even if the mothers were to continue using tactile strategies in interactions with their children with VIAD for a longer time, they may not be able to support the communicative development of their children on their own. Whatever the case, they could benefit from other interventions in which tactile strategies are rehearsed and adapted to their children's new skills and needs.

It was found to be a good decision to implement the interventions at home and collect the data through video recordings. Considerable amounts of information

regarding the interactions could have been lost if the data had been collected in other ways, such as through questionnaires or interviews. Moreover, triadic work was shown to be a concrete and rewarding way to implement the intervention, which corresponds to the findings of Metell (2015). Besides theoretical knowledge, being able to intervene in patterns of interaction may require modeling and close collaboration with parents (cf. Rensfeldt Flink et al., 2023). However, the two interventions in this study also included an element of discussion and video feedback, and we cannot know which part of the intervention was the most effective and useful for the mothers.

Mixed methods were used to analyze the video data from different perspectives, which can be regarded as a strength of this study. First, the imitation coding procedure, the bodily-tactile coding procedure, and multimodal CA provided a bottom-up approach for the data, whereas the EA Scales assessed the interactions from a top-down perspective. Second, the bodily-tactile coding procedure evaluated individual behaviors, whereas multimodal CA and the EA Scales could be used for investigating dyadic interactions. The imitation coding procedure provided information on both individual behaviors and dyadic interactions. Third, where longitudinal CA and the imitation coding procedure captured changes in turn-taking, the EA Scales measured changes in emotional reciprocity. It was found that the imitation coding procedure and the bodily-tactile coding procedure were useful methods for measuring changes in accessibility. Similarly, longitudinal CA and EA Scales were appropriate methods for investigating changes in reciprocity. The findings with different methods provided similar outcomes of positive changes in mother-child interactions during the interventions, which strengthens the construct validity of this study (see Yin, 2014, pp. 45–47). Moreover, the findings related to different methods provided a deeper understanding of the changes in mother-child interactions than any single method could have provided alone.

The imitation coding procedure was useful for detecting changes in the imitative exchanges between Emma and her mother. However, more precision in the coding could have clarified the results. For instance, some of the mother's vocal-tactile imitations included a non-imitative tactile element (e.g., the mother would touch Emma's nose with her own nose during her vocal imitation), and some provided the same imitative information in the vocal and tactile modality (e.g., the mother imitated Emma's vocalization by "speaking to her hand" in such a way that Emma could perceive her articulatory movements in a tactile way). It could have been useful to separate the two types of vocal-tactile imitations to explore the potential differences in Emma's responses to these imitations. For instance, the analysis could have revealed whether the increase in Emma's responsiveness was due to her mother's increased use of touch in general or the possibility of perceiving her mother's imitations in two modalities.

The bodily-tactile coding procedure captured changes in the mothers' use of tactile strategies. It is unlikely that any other procedure could have been used in the coding because the categories were data-based and sensitive to the content of the intervention. The fact that the categories were data-based also strengthens the validity of the bodily-tactile coding procedure. However, a limitation of the coding procedure is that the categories themselves did not reveal how the mothers were able to convey the intended meanings to their children through the tactile strategies. The results provide only suggestive information on this point.

The CA-based findings on turn-taking and sequence organization in typical conversations provided a valuable perspective for analyzing and understanding atypical interactions. The knowledge of typical parent-infant interactions was especially fundamental as an aid to understanding how sequences are created in early interactions. Without this knowledge, analyzing atypical interactions would have been challenging. The sequential analysis revealed changes in turn-taking during the intervention. It uncovered that the mothers also began to apply their intrinsic conversational rules in the bodily-tactile modality when they became more aware of this resource during the intervention. Moreover, the sequential analysis was able to demonstrate the characteristics of the children's bodily expressions and how these expressions were co-constructed in the multimodal interactions. In early intervention studies, it is essential to find methods that have the potential to capture the effects of the interventions. Longitudinal CA provides a means for this as the microanalysis can capture small changes in reciprocity over time. Detecting changes in turn-taking could be easily lost with other methods, which often evaluate individual behaviors instead of interactions. Thus, although CA is a time-consuming method, it is a tool for discovery and is useful for planning interventions and demonstrating their effects (e.g., Warnicke et al., 2024).

The flexibility of the EA Scales made it a useful method to investigate changes in the "emotional climate" of the participants over different phases of the study. Another strength of the EA Scales is that the assessment is not overly time-consuming. However, the EA Scales may not detect micro-level changes in multimodal interactions between children with VIAD and their parents. It is also important that the EA assessor is familiar with the assessed group, the characteristics of the participants, and the therapeutic strategies to avoid incorrect results and conclusions. Overall, EA appears to be a useful construct for the VI field. So far, studies have mainly identified challenges in the social-emotional development of children with VI/VIAD and used questionnaires for data collection (see Alimovic, 2013; Dale et al., 2014; Lang et al., 2017). The EA Scales provide an observational tool to measure the quality of adult-child interactions. Moreover, the EA framework is helpful for planning emotional support for families of children with VIAD.

Overall, the reliability of the results was good. In Study IV, the low reliability connected to the coding of tactile noticing for Sara's mother could be due to her personal way of using frequent touch in interactions with Sara. In future studies, the reliability of tactile noticing could be improved by encouraging mothers to use more articulated touches for noticing in interactions with their children with VIAD.

6.3 Theoretical significance of the study

The validity of the theories behind this study, especially Trevarthen's theory of intersubjectivity (Trevarthen, 1979; Trevarthen & Hubley, 1978) and the transactional model of development (Sameroff & Chandler, 1975) can be evaluated against our findings (see Marková, 2011; Yin, 2014). First, the findings indicate that it is possible to assess and enhance primary intersubjectivity in interactions between children with VIAD and their mothers. Damen et al. (2014) drew similar conclusions in their study, in which they evaluated the effects of a high-quality communication intervention for an adult with CDB. Second, the findings suggest that the intervention aimed at mothers resulted in positive changes in their children's participation, which provides evidence for the value of transactional processes (Sameroff & MacKenzie, 2003b). Moreover, the results highlight the importance of sensory accessibility for increasing positive transactions between children with VIAD and their parents. Our results suggest that positive transactions increase when children with VIAD can access contextual information in interactions and their parents' expressions through the bodily-tactile modality, and their parents acknowledge their children's bodily resources for participation. These findings also support Bruner's (1975) theory of pragmatic language development and the theoretical foundations of tactile strategies (e.g., Chen & Downing, 2006). Overall, our findings shed empirical light on the theoretical principles related to *accessibility* in designing early interventions for children with VIAD and their families.

In this study, the concept of interactional reciprocity was theoretically understood to include two dimensions: turn-taking and emotional reciprocity. Reciprocity was investigated from a holistic theoretical perspective, which is unique to this study, whereas in earlier studies, reciprocity was mainly studied from a single perspective. Interestingly, our findings suggest that bodily-tactile early intervention increased both dimensions of reciprocity. Thus, the results supported our theoretical understanding of reciprocity and revealed a potential means to enhance it in encounters with children with VIAD. Our findings also contribute to EA theory. In parent-child interactions, it can be challenging for children with VIAD to access their parents' facial expressions, such as smiling, which necessitates conveying emotional expressions through other modalities. As the vocal modality alone may not be sufficient to convey emotions to children with VI (Dyck et al., 2004; Minter et al.,

1991), children's access to parents' expressions and actions through the bodily-tactile modality may increase EA in parent-child interactions. Moreover, parents need to be aware of their children's bodily means of expressing their emotions and engagement.

Lastly, theoretically, this study provides information on children with VIAD and their mothers as interactive units. It presents a dialogical perspective on their interactions and clarifies how the actions of the participants are interdependent in sense-making (Marková et al., 2020). Hence, the findings of this study also contribute to the theory of dialogism in that they support the idea of extended dialogism (Linell, 2017), which acknowledges that exchanges between individuals are not limited to verbal or sign language. Extended dialogism considers several types of sense-making activities, such as bodily-tactile play routines. Our findings challenge presumptions related to the asymmetry of interactions (Linell, 2017). That is, although there are asymmetries in maturity, skills, and sensory-perceptual and cultural access to the world between children with VIAD and their parents, our findings suggest that their participation in interactions does not necessarily need to be asymmetrical if they are provided with support for interactions from early on.

6.4 Clinical implications

The findings of this study suggest that the participation and communication of children with VIAD develop from within dyadic and multimodal parent-child interactions, which is in line with previous studies (e.g., Gregersen, 2018; Preisler, 1991, 1995). Thus, the findings underline the relevance of family-directedness and collaboration with parents in implementing interventions for children with VIAD (see Breemer, 2025). The individual variation between children with VIAD indicates that it is challenging to use norm-based or group-based intervention approaches in interventions. Instead, there is a need to base and individualize the intervention with reference to the most robust research-based and theoretical *principles* that operate in early communicative development. We and other researchers (Metell, 2015; Rogow, 1982) found early play routines to be useful contexts for developing turn-taking between children with VIAD and their mothers. However, parents may not have implicit knowledge of how to use play routines or tactile strategies systematically in interactions with their children with VIAD. Therefore, learning these strategies can empower parents and provide them with new insights into their children's resources.

Our findings indicate that it is important to initiate home-based intervention at an early age. However, as none of the participants had received *systematic* home-based support for the parent-child interactions, the results suggest that currently, the interventions may begin too late. There may be several reasons for this, including low expectations of professionals, children's fragile health, lack of knowledge of the

strategies that children with VIAD could benefit from, limited opportunities for specialization in different fields, and a small number of children with VIAD, all of which challenge specialization. The findings of this study call for changes in current practices. An intervention that is provided early enough can help children with VIAD to participate and use their full potential in their development. This right belongs to them, just like any other child (United Nations, 1989). The optimal time for early intervention is during the first months when the earliest interactive behaviors of children with VIAD are challenging to interpret, and their parents feel a need for support (Cress & Marvin, 2003). Parents should be the first caretakers involved in the intervention for children with VIAD because they are typically the most important people in their children's lives and have the greatest impact on their development. Moreover, infancy is likely to be the easiest time for a home-based intervention because typically, one of the parents takes care of the child at home. When the immediate environments of children with VIAD change, and they become a part of larger social contexts in day care, the support naturally needs to include this situation.

Our results indicate the importance of early intervention focusing on the *participation* of children with VIAD through all their resources. What is crucial in this process is that the intervention helps children with VIAD develop their roles from observers to actors (cf. Ratner & Bruner, 1978; Smith & Fluck, 2000). Providing a young child with VIAD with an actor's role is a strong base for their communication and language development and later (AAC) interventions (Smith & Fluck, 2000), and it may prevent them from developing a passive role in communication (Cress & Marvin, 2003). However, it would be useful to know children's level of participation in early social games and their play skills before using an intervention (see Smith & Fluck, 2000). Otherwise, there is a risk that the strategies will not be appropriate for children's "zone of proximal development" (Vygotsky, 1978). Currently, there does not appear to be such an assessment tool for evaluation. Nevertheless, the recently developed layered communication model (Wolthuis et al., 2019) and the Tactile Working Memory Scale (Nicholas et al., 2019) can provide important information on the abilities and needs of children with VIAD. Moreover, the findings of this study indicate that multimodal CA could be a useful method in clinical work for gaining information about turn-taking in parent-child interactions and analyzing children's expressions that are challenging to interpret. However, when considering clinical work, the transcription method should be considerably simplified.

The findings of this study raise serious concerns about current clinical practices in Finland. First, there appears to be no systematic way to *identify* children with CDB. Only by identifying CDB can the families of children with CDB be treated equally in terms of services, regardless of which part of the country they live in. In

addition, it would be critical to identify children with less severe dual sensory loss and other children with VIAD who need tactile strategies as a means to develop their participation, voice, and cognition (United Nations, 1989). Currently, these children may be classified as children with multiple disabilities, children with ID, children with profound intellectual and multiple disabilities, or something else. Under these broad classifications, children with VIAD and their families are provided with general services, and their special needs are easily lost. Professionals providing interventions for children with ID or multiple disabilities may also lack knowledge about tactile strategies, which restricts the content of the support they can provide. Moreover, parents of children with VIAD may not be aware of the expertise related to tactile strategies or have the resources to request it. Second, it appears that the national healthcare services do not have units or centers with expertise in providing systematic guidance for the use of tactile strategies for families of children with VIAD. Some third-sector providers (e.g., the Finnish Deafblind Association) have knowledge of tactile strategies, but it appears to be coincidental which families find their way to these services. Moreover, the children who are under their services are often older than 3 years, so this type of support rarely covers the earliest years of childhood. Third-sector providers play an important role in providing complementary services, but they are not responsible for organizing early interventions for the families of children with VIAD.

It would be ideal if there were one or more specialized centers/units that could develop, provide, and coordinate specialized assessments related to the use of the sense of touch in communication and learning (see Andersen & Rødbroe, 2000). The assessments could provide information on whether the bodily-tactile modality is a primary or complementary sensory modality of learning for children with VIAD. The specialized centers could also include other evaluations and interventions for children with VIAD, educate professionals, and provide practical guidance for families of children with VIAD. Third, there should be more opportunities for SLPs, psychologists, vision personnel, specialists in the deafblind field, and other professionals to specialize in early intervention for children with VIAD and the use of tactile strategies. Lastly, collaboration between professionals is vital for achieving the best outcomes in assessment and early intervention (Ely et al., 2020; Ely & Ostrosky, 2018; Luo et al., 2022).

6.5 Future research

There are several areas that need to be addressed in future research. First, it is important to learn more about the early vocal development of children with VIAD and to discover how many of them can develop speech. Furthermore, their silent mouth movements during interactions deserve scientific attention. Second, the

physical activity and movements of young children with VIAD need to be studied in an interactional context. For instance, the timing and type of children's movements during play routines require in-depth analysis. Moreover, it is important to investigate the potential developmental continuum from movements to gestural expressions in longitudinal studies. Third, it is essential to learn more about the possibilities for children with VIAD to express themselves through unaided and aided AAC and to determine the best ways to learn these systems. For instance, it would be valuable to investigate whether one tactile signing system is more helpful for children with VIAD to acquire new signs than another.

As the incidence of children with VIAD is low, it is challenging to conduct intervention studies involving a large number of children. To carry out such research, collaboration between different countries is needed. However, it is equally important to conduct case studies that test the theoretical principles of this study. Longitudinal studies are also needed to capture the effect of bodily-tactile early intervention in reciprocal processes over time. In addition, future studies could investigate longer interventions at later stages of tactile communication development. Scientific research is also needed to develop assessment tools for evaluating the stage of participation of children with VIAD in early interactions with their parents. Bruner's (1975) theory of pragmatic language development provides an important basis for this type of development (see also Smith & Fluck, 2000). Further, there is a need to know more about parents' experiences related to early interventions. For instance, it is necessary to investigate whether bodily-tactile early intervention empowers parents in interactions with their children with VIAD. If so, it would be important to learn more about the process of empowerment. Lastly, the benefits of bodily-tactile early intervention and tactile strategies should be studied in other populations, such as children with multiple disabilities.

More studies are required to explore tactile strategies from different perspectives. First, it is essential to learn more about the natural use of tactile strategies by studying how blind and deaf mothers use touch in interactions with their infants and toddlers. This information would be relevant for developing guidance for parents of children with VIAD. Second, it is important to learn more about how the complexity of bodily-tactile play routines impacts the participation of children with VIAD. For example, it could be that the easiest games for children to join are play routines, which have a simple structure consisting of only one movement (e.g., swinging). Moreover, it is essential to explore how position and motor skills influence children's embodied participation (see Fiss et al., 2023). It would be useful to conduct this type of research in collaboration with physiotherapists. Third, it is important to learn more about the effects of hand-under-hand guidance on the participation and development of children with VIAD. Fourth, it is crucial to learn how joint attention can be established through the sense of touch in interactions between children with VIAD

and their caretakers. Fifth, parents' tactile noticing responses should be explored to determine whether they increase children's engagement in interactions or the intentionality of their actions. Sixth, the benefits of tactile anticipatory cues should be investigated. For instance, it is important to discern which types of tactile anticipatory cues are the most informative for children with VIAD (touch versus movement) by studying their responses.

EA between children with VIAD and their parents requires further research. First, it is important to explore whether there are changes in parent-child EA depending on the children's age or their communication skills. Second, it is essential to know whether bodily-tactile intervention for parents of older children with VIAD could foster their EA. Third, it is necessary to evaluate EA in interactions between children with VIAD and their other caretakers, such as kindergarten teachers or therapists. Lastly, it would be useful to investigate whether the coder's knowledge of children with VIAD has an impact on EA assessment.

The literature review suggests that only a little research has explored interactional sequences connected to mothers' questions to their typically developing infants, and most of the existing studies were conducted in the 1970s. Thus, it is worth refocusing on this important research topic in typical and atypical early interactions. Sequences involving parents' questions are optimal for gaining information on turn-taking patterns in parent-infant interactions.

It is critical to gain research-based knowledge of the identification of CDB in Finland. First, it is essential to know how many children have been identified as children with CDB and the criteria for identification. It is also important to gain information about the services provided to families of children with CDB and discover if normally hearing children with VIAD and their families can access them. Second, there is a need to know more about the timing and content of early interventions for children with VIAD (e.g., the children's age at the beginning of the intervention, the parents' involvement, and the guidance related to tactile strategies). Conducting an international study in which questions about identification and services for families are investigated across several countries—for instance, the Nordic countries—would make it possible to compare current practices and develop them further. This type of research is crucial for evaluating how the rights of individuals with disabilities are realized in practice —for instance, their freedom to receive information and express ideas on an equal basis with others through all forms of communication, including tactile communication (United Nations, 2007).

Finally, the United Nations Convention on the Rights of Persons with Disabilities declares that States Parties must ensure that "education of persons, and in particular children, who are blind, deaf or deafblind, is delivered in the most appropriate languages and modes and means of communication for the individual, and in environments which maximize academic and social development"(Article 42,

United Nations, 2007). This right presupposes that the teachers in kindergarten and school and the staff at specialized housing units are skilled in tactile signing and other tactile strategies. It would be illuminating to investigate how this right is realized in practice.

6.6 Conclusion

This doctoral thesis provides insight into interactional reciprocity and the potential ways to promote it in early interactions between children with VIAD and their mothers. A special goal of the two interventions was to make interactions more accessible for children with VIAD through the bodily-tactile modality and to support their mothers in reading and responding to their children's bodily and gestural expressions. The findings of Study I suggest that when a mother of a 3-year-old child with CDB added tactility to her imitations during the intervention, it positively impacted the tactile and emotional responsiveness of the child, the length of their imitative exchanges, and the EA in the mother-child interactions. Likewise, the results of Studies II–IV suggest that early intervention increased the mothers' use of the bodily-tactile modality in interactions with their children with VIAD, as well as their interactional reciprocity. The positive changes in the children's participation resulted from changes in the mothers' interactive behaviors as they began to provide more time and space for their children to take turns and to respond to their children's bodily and gestural expressions. Moreover, EA between children and their mothers increased during the interventions. Overall, the findings of this study suggest that bodily-tactile early intervention can encourage children with VIAD to participate through movements and gestures and to increase reciprocity in early interactions. Participation in reciprocal interactions provides children with VIAD an opportunity to learn the discourse structure of language, which is the basis for their further communication and language development. Moreover, the increased engagement of children in interactions is essential for their emotional well-being and quality of life—as well as that of their mothers.

Abbreviations

VI	visual impairment
VIAD	visual impairment and additional disabilities
CVI	cerebral visual impairment
CDB	congenital deafblindness
EA	emotional availability
CP	cerebral palsy
ID	intellectual disability
AAC	augmentative and alternative communication
dB	decibel
SLP	speech-language pathologist
CA	conversation analysis

List of References

Aasen, G., & Nærland, T. (2014). Enhancing activity by means of tactile symbols: A study of a heterogeneous group of pupils with congenital blindness, intellectual disability and autism spectrum disorder. *Journal of Intellectual Disabilities, 18*(1), 61–75. https://doi.org/10.1177/1744629514522142

Adamson, L. B., Suma, K., Bakeman, R., Kellerman, A., & Robins, D. L. (2021). Auditory joint attention skills: Development and diagnostic differences during infancy. *Infant Behavior and Development, 63,* Article 101560. https://doi.org/10.1016/j.infbeh.2021.101560

Ainsworth, M. D. S., Bell, S. M., & Stayton, D. J. (1974). Infant-mother attachment and social development: Socialisation as a product of reciprocal responsiveness to signals. In M. P. M. Richards (Ed.), *The integration of a child into a social world* (pp. 99–135). Cambridge University Press.

Alimovic, S. (2013). Emotional and behavioural problems in children with visual impairment, intellectual and multiple disabilities. *Journal of Intellectual Disability Research, 57*(2), 153–160. https://doi.org/10.1111/j.1365-2788.2012.01562.x

Alpi, K. M., & Evans, J. J. (2019). Distinguishing case study as a research method from case reports as a publication type. *Journal of the Medical Library Association, 107*(1), 1–5. https://doi.org/10.5195/jmla.2019.615

Als, H., Tronick, E., & Brazelton, T. B. (1980). Affective reciprocity and the development of autonomy: The study of a blind infant. *Journal of the American Academy of Child Psychiatry, 19*(1), 22–40. https://doi.org/10.1016/S0002-7138(09)60650-6

American Speech-Language-Hearing Association. (n.d.). *Degree of hearing loss.* Retrieved September 8, 2024, from https://www.asha.org/public/hearing/degree-of-hearing-loss/

Andersen, K., & Rødbroe, I. (2000). *Synnynnäisen kuurosokeuden tunnistaminen. Teemavihko 2C. Toiminnallinen kehys. Taktiilisen/kinesteettisen aistin tutkimus – kosketus ja liike.* Videnscenter for Døblindfødte.

Andersen, K., & Rødbroe, I. (2005). *A Danish survey on congenital deafblindness August 2000-December 2003.* The Danish Centre on Congenital Deafblindness.

Anderzén-Carlsson, A. (2017). A qualitative evaluation of the National Expert Team regarding the assessment and diagnosis of deafblindness in Sweden. *Scandinavian Journal of Disability Research, 19*(4), 362–374. https://doi.org/10.1080/15017419.2016.1268972

Antaki, C. (2011). Six kinds of applied conversation analysis. In C. Antaki (Ed.), *Applied conversation analysis: Intervention and change in institutional talk* (pp. 1–14). Palgrave Macmillan.

Argyropoulos, V., Kanari, C., Hathazi, A., Kyriacou, M., Papazafiri, M., & Nikolaraizi, M. (2020, June 27–29). *Children with vision impairment and multiple disabilities: Issues of communication skills and professionals' challenges* [Paper presentation]. International Conference on Education and New Developments (END 2020), Zagreb, Croatia. https://doi.org/10.36315/2020end058

Ask Larsen, F. (2003). *The washing-smooth hole-fish - and other findings of semantic potential and negotiation strategies in conversation with congenitally deafblind children* [Master's thesis, University of Aarhus]. Communication Network Update Series Number 9. Available from: https://nordicwelfare.org/en/publikationer/the-washing-smooth-hole-fish/

Ask Larsen, F. (2013). Acquisition of a bodily-tactile language as first language. In J. Dammeyer & A. Nielsen (Eds.), *Kropslig og taktil sprogudvikling - En antologi om forskellige sprogmodaliteters muligheder og umuligheder, undersøgt med afsæt i personer med medfødt døvblindhed* (pp. 91–119). Materialecentret.

Ask Larsen, F., & Damen, S. (2014). Definitions of deafblindness and congenital deafblindness. *Research in Developmental Disabilities, 35*(10), 2568–2576. https://doi.org/10.1016/j.ridd.2014.05.029

Atkinson, M. (2022). Storytelling with nurturing touch: The story massage programme. In N. Grove (Ed.), *Storytelling, special needs and disabilities: Practical approaches for children and adults* (2nd ed., pp. 120–127). Routledge.

Axelsson, A. K., Imms, C., & Wilder, J. (2014). Strategies that facilitate participation in family activities of children and adolescents with profound intellectual and multiple disabilities: Parents' and personal assistants' experiences. *Disability and Rehabilitation, 36*(25), 2169–2177. https://doi.org/10.3109/09638288.2014.895058

Ayyıldız, E., Akçin, N., & Güven, Y. (2016). Development of preverbal communication skills scale for children with multiple disabilities and visual impairment. *Journal of Human Sciences, 13*(2), 2668–2681.

Bahrick, L. E., Lickliter, R., & Flom, R. (2004). Intersensory redundancy guides the development of selective attention, perception, and cognition in infancy. *Current Directions in Psychological Science, 13*(3), 99–102. https://doi.org/10.1111/j.0963-7214.2004.00283.x

Bailey, D. B., Hebbeler, K., Spiker, D., Scarborough, A., Mallik, S., & Nelson, L. (2005). Thirty-six-month outcomes for families of children who have disabilities and participated in early intervention. *Pediatrics, 116*(6), 1346–1352. https://doi.org/10.1542/peds.2004-1239

Bakeman, R., & Adamson, L. B. (1984). Coordinating attention to people and objects in mother-infant and peer-infant interaction. *Child Development, 55*(4), 1278–1289. https://doi.org/10.2307/1129997

Bakkenget, B., & Våpenstad, E. V. (2023). Looking for the infant voice. How depth hermeneutics (scenic-narrative microanalysis) contributes to an understanding of how a child participates from the beginning of life. *Journal of Social Work Practice, 37*(4), 419–432. https://doi.org/10.1080/02650533.2022.2162492

Barfoot, J., Meredith, P., Ziviani, J., & Whittingham, K. (2017). Parent-child interactions and children with cerebral palsy: An exploratory study investigating emotional availability, functional ability, and parent distress. *Child: Care, Health and Development, 43*(6), 812–822. https://doi.org/10.1111/cch.12493

Bates, E., Benigni, L., Bretherton, I., Camaioni, L., & Volterra, V. (1979). *The emergence of symbols: Cognition and communication in infancy.* Academic Press.

Bateson, M. C. (1979). 'The epigenesis of conversational interaction': A personal account of research development. In M. Bullowa (Ed.), *Before speech: The beginning of interpersonal communication* (pp. 63–77). Cambridge University Press.

Battistin, T., Mercuriali, E., Borghini, C., Reffo, M. E., & Suppiej, A. (2024). Parental satisfaction with the quality of care in an early intervention service for children with visual impairment: A retrospective longitudinal study. *Children, 11*(2), Article 230. https://doi.org/10.3390/children11020230

Beelman, A., & Brambring, M. (1998). Implementation and effectiveness of a home-based early intervention program for blind infants and preschoolers. *Research in Developmental Disabilities, 19*(3), 225–244. https://doi.org/10.1016/S0891-4222(98)00004-3

Berducci, D. (2010). From infants' reacting to understanding: Grounding mature communication and sociality through turn-taking and sequencing. *Psychology of Language and Communication, 14*(1), 3–28. https://doi.org/10.2478/v10057-010-0001-x

Bezemer, J., & Jewitt, C. (2010). Multimodal analysis: Key issues. In L. Litosseliti (Ed.), *Research methods in linguistics* (pp. 180–197). Continuum.

Bezemer, J., & Kress, G. (2014). Touch: A resource for making meaning. *The Australian Journal of Language and Literacy, 37*(2), 77–85.

Bigelow, A. E. (2003). The development of joint attention in blind infants. *Development and Psychopathology, 15*(2), 259–275. https://doi.org/10.1017/S0954579403000142

Biringen, Z. (2008). *Emotional Availability (EA) Scales* (4th ed.). www.emotionalavailability.com

Biringen, Z., Derscheid, D., Vliegen, N., Closson, L., & Easterbrooks, M. A. (2014). Emotional availability (EA): Theoretical background, empirical research using the EA Scales, and clinical applications. *Developmental Review, 34*(2), 114–167. https://doi.org/10.1016/j.dr.2014.01.002

Biringen, Z., Fidler, D. J., Barrett, K. C., & Kubicek, L. (2005). Applying the emotional availability scales to children with disabilities. *Infant Mental Health Journal, 26*(4), 369–391. https://doi.org/10.1002/imhj.20058

Biringen, Z., Sandoval, K., Flykt, M., Joslin, S., & Lincoln, M. (2022). Emotional availability: Clinical populations and clinical applications. *Human Development, 66*(3), 192–215. https://doi.org/10.1159/000525256

Blackstone, S., Luo, F., Barker, R. M., Sevcik, R. A., Romski, M., Casella, V., & Roman-Lantzy, C. (2022). Profiles of children with cortical visual impairment who use augmentative and alternative communication: A retrospective examination. *American Journal of Speech-Language Pathology, 31*(6), 2707–2721. https://doi.org/10.1044/2022_AJSLP-22-00130

Blackstone, S. W., Luo, F., Canchola, J., Wilkinson, K. M., & Roman-Lantzy, C. (2021). Children with cortical visual impairment and complex communication needs: Identifying gaps between needs and current practice. *Language, Speech, and Hearing Services in Schools, 52*(2), 612–629. https://doi.org/10.1044/2020_LSHSS-20-00088

Bonsdorff, P. V. (2021). On equal terms? On implementing infants' cultural rights. In E. Eriksen Ødegaard & J. Spord Borgen (Eds.), *Childhood cultures in transformation: 30 years of the UN convention on the rights of the child in action towards sustainability* (pp. 37–53). Koninklijke Brill NV. https://doi.org/10.1163/9789004445666_003

Boster, J. B., McCarthy, J. W., Brown, K., Spitzley, A. M., & Blackstone, S. W. (2021). Creating a path for systematic investigation of children with cortical visual impairment who use augmentative and alternative communication. *American Journal of Speech-Language Pathology, 30*(4)*,* 1880–1893. https://doi.org/10.1044/2021_AJSLP-20-00203

Boulton, M., Haines, L., Smyth, D., & Fielder, A. (2006). Health-related quality of life of children with vision impairment or blindness. *Developmental Medicine & Child Neurology, 48*(8), 656–661. https://doi.org/10.1111/j.1469-8749.2006.tb01335.x

Braddock, B., McDaniel, J., Spragge, S., Loncke, F., Braddock, S. R., & Carey, J. C. (2012). Communication ability in persons with Trisomy 18 and Trisomy 13. *Augmentative and Alternative Communication, 28*(4), 266–277. https://doi.org/10.3109/07434618.2012.706637

Brady, N. C., & Bashinski, S. M. (2008). Increasing communication in children with concurrent vision and hearing loss. *Research and Practice for Persons with Severe Disabilities, 33*(1–2), 59–70. https://doi.org/10.2511/rpsd.33.1-2.59

Brazelton, T. B., Koslowski, B., & Main, M. (1974). The origins of reciprocity: The early mother-infant interaction. In M. Lewis & L. A. Rosenblum (Eds.), *The effect of the infant on its caregiver* (pp. 49–76). John Wiley & Sons.

Brede, K. S., & Souriau J. (2016). Let me join your tactile attention: A sign language perspective on the communicative togetherness with a child who is congenitally deafblind. *Journal of Deafblind Studies on Communication, 2*(1):4–21.

Breemer, R. v.d. (2025). Overcoming epistemic injustice in the communicative relationship between educational professionals and families with children with congenital deafblindness. In T. S. Hartshorne, M. J. Janssen & W. Wittich (Eds.), *Learning, education, and support of deafblind children and adults* (pp. 228–239). Oxford University Press. https://doi.org/10.1093/oso/9780192887221.003.0021

Brittlebank, S., Light, J. C., & Pope, L. (2024). A scoping review of AAC interventions for children and young adults with simultaneous visual and motor impairments: Clinical and research implications. *Augmentative and Alternative Communication, 40*(3), 219–237. https://doi.org/10.1080/07434618.2024.2327044

Bronfenbrenner, U., & Ceci, S. J. (1994). Nature-nurture reconceptualized in developmental perspective: A bioecological model. *Psychological Review, 101*(4), 568–586. https://doi.org/10.1037/0033-295X.101.4.568

Brown, S. E., & Guralnick, M. J. (2012). International human rights to early intervention for infants and young children with disabilities: Tools for global advocacy. *Infants & Young Children, 25*(4), 270–285. https://doi.org/10.1097/IYC.0b013e318268fa49

Bruce, S. M. (2003). The importance of shared communication forms. *Journal of Visual Impairment & Blindness, 97*(2), 106–109. https://doi.org/10.1177/0145482X0309700206

Bruce, S. M. (2005). The impact of congenital deafblindness on the struggle to symbolism. *International Journal of Disability, Development and Education, 52*(3), 233–251. https://doi.org/10.1080/10349120500252882

Bruce, S. M., Mann, A., Jones, C., & Gavin, M. (2007). Gestures expressed by children who are congenitally deaf-blind: Topography, rate, and function. *Journal of Visual Impairment & Blindness, 101*(10), 637–652. https://doi.org/10.1177/0145482X0710101010

Bruce, S. M., Nelson, C., Perez, A., Stutzman, B., & Barnhill, B. A. (2016). The state of research on communication and literacy in deafblindness. *American Annals of the Deaf, 161*(4), 424–443. https://doi.org/10.1353/aad.2016.0035

Bruner, J. S. (1975). The ontogenesis of speech acts. *Journal of Child Language, 2*(1), 1–19. https://doi.org/10.1017/S0305000900000866

Bullowa, M. (1979). Introduction: Prelinguistic communication: A field for scientific research. In M. Bullowa (Ed.), *Before speech: The beginning of interpersonal communication* (pp. 1–62). Cambridge University press.

Bundy, A. C., & Lane, S. J. (2020). *Sensory integration: Theory and practice* (3rd ed.). F. A. Davis.

Caldwell, P. (2006). Speaking the other's language: Imitation as a gateway to relationship. *Infant and Child Development, 15*(3), 275–282. https://doi.org/10.1002/icd.456

Camaioni, L., & Laicardi, C. (1985). Early social games and the acquisition of language. *British Journal of Developmental Psychology, 3*(1), 31–39. https://doi.org/10.1111/j.2044-835X.1985.tb00952.x

Campbell, E., Casillas, R., & Bergelson, E. (2024). The role of vision in the acquisition of words: Vocabulary development in blind toddlers. *Developmental Science, 27*(4), Article e13475. https://doi.org/10.1111/desc.13475

Campbell, J., & Johnston, C. (2009). Emotional availability in parent-child dyads where children are blind. *Parenting: Science and Practice, 9*(3–4), 216–227. https://doi.org/10.1080/15295190902844456

Cans, C. (2000). Surveillance of cerebral palsy in Europe: A collaboration of cerebral palsy surveys and registers. *Developmental Medicine & Child Neurology, 42*(12), 816–824. https://doi.org/10.1111/j.1469-8749.2000.tb00695.x

Carozza, S., & Leong, V. (2021). The role of affectionate caregiver touch in early neurodevelopment and parent-infant interactional synchrony. *Frontiers in Neuroscience, 14,* Article 613378. https://doi.org/10.3389/fnins.2020.613378

Carpendale, J. I. M., & Carpendale, A. B. (2010). The development of pointing: From personal directedness to interpersonal direction. *Human Development, 53*(3), 110–126. https://doi.org/10.1159/000315168

Caselli, M. C. (1990). Communicative gestures and first words. In V. Volterra & C. J. Erting (Eds.), *From gesture to language in hearing and deaf children* (pp. 56–67). Gallaudet University Press.

Chang, M. Y., & Borchert, M. S. (2020). Advances in the evaluation and management of cortical/cerebral visual impairment in children. *Survey of Ophthalmology 65*(6), 708–724. https://doi.org/10.1016/j.survophthal.2020.03.001

Chen, D. (1996). Parent-infant communication: Early intervention for very young children with visual impairment or hearing loss. *Infants & Young Children, 9*(2), 1–12. https://doi.org/10.1097/00001163-199610000-00003

Chen, D. (Ed.). (2014). *Essential elements in early intervention: Visual impairment and multiple disabilities* (2nd ed.). AFB Press.

Chen, D., & Downing, J. E. (2006). *Tactile strategies for children who have visual impairments and multiple disabilities: Promoting communication and learning skills.* AFB Press.

Chen, D., Downing, J., & Rodriguez-Gil, G. (2000). Tactile learning strategies for children who are deaf-blind: Concerns and considerations from project SALUTE. *Deaf-Blind Perspectives, 8*(2), 1–6.

Chen, D., Klein, M. D., & Haney, M. (2007). Promoting interactions with infants who have complex multiple disabilities: Development and field-testing of the PLAI curriculum. *Infants & Young Children, 20*(2), 149–162. https://doi.org/10.1097/01.IYC.0000264482.35570.32

Chiesa, S., Galati, D., & Schmidt, S. (2015). Communicative interactions between visually impaired mothers and their sighted children: Analysis of gaze, facial expressions, voice and physical contacts. *Child: Care, Health and Development, 41*(6), 1040–1046. https://doi.org/10.1111/cch.12274

Coleman, A., Weir, K. A., Ware, R. S., & Boyd, R. N. (2013). Relationship between communication skills and gross motor function in preschool-aged children with cerebral palsy. *Archives of Physical Medicine and Rehabilitation, 94*(11), 2210–2217. https://doi.org/10.1016/j.apmr.2013.03.025

Condon, W. S., & Sander, L. W. (1974). Synchrony demonstrated between movements of the neonate and adult speech. *Child Development, 45*(2), 456–462. https://doi.org/10.2307/1127968

Crais, E., Douglas, D. D., & Campbell, C. C. (2004). The intersection of the development of gestures and intentionality. *Journal of Speech, Language, and Hearing Research, 47*(3), 678–694. https://doi.org/10.1044/1092-4388(2004/052)

Crawley, S. B., Rogers, P. P., Friedman, S., Iacobbo, M., Criticos, A., Richardson, L., & Thompson, M. A. (1978). Developmental changes in the structure of mother-infant play. *Developmental Psychology, 14*(1), 30–36. https://doi.org/10.1037/0012-1649.14.1.30

Cress, C. J., & Marvin, C. A. (2003). Common questions about AAC services in early intervention. *Augmentative and Alternative Communication, 19*(4), 254–272. https://doi.org/10.1080/07434610310001598242

Cupples, L., Ching, T. Y. C., Button, L., Leigh, G., Marnane, V., Whitfield, J., Gunnourie, M., & Martin, L. (2018). Language and speech outcomes of children with hearing loss and additional disabilities: Identifying the variables that influence performance at five years of age. *International Journal of Audiology, 57*(Suppl.2), 93–104. https://doi.org/10.1080/14992027.2016.1228127

Daelman, M. (2003). *Een analyse van de presymbolische communicatie bij blinde kinderen met een meervoudige handicap: Een aanzet tot orthopedagogisch handelen* [Unpublished doctoral dissertation]. Katholieke Universiteit Leuven.

Daelman, M., Janssen, M., Ask Larsen, F., Nafstad, A., Rødbroe, I., Souriau, J., & Visser, T. (2004). *Congenitally deafblind persons and the emergence of social and communicative interaction.* Communication Network Update Series Number 2. Nordic Staff Training Centre for Deafblind Services (NUD).

Dalby, D. M., Hirdes, J. P., Stolee, P., Strong, J. G., Poss, J., Tjam, E. Y., Bowman, L., & Ashworth, M. (2019). Characteristics of individuals with congenital and acquired deaf-blindness. *Journal of Visual Impairment & Blindness, 103*(2), 93–102. https://doi.org/10.1177/0145482X0910300208

Dale, N. J., Sakkalou, E., O'Reilly, M. A., Springall, C., Sakki, H., Glew, S., Pissaridou, E., De Haan, M., & Salt, A.T. (2018). Home-based early intervention in infants and young children with visual impairment using the Developmental Journal: Longitudinal cohort study. *Developmental Medicine & Child Neurology, 61*(6), 697–709. https://doi.org/10.1111/dmcn.14081

Dale, N. J., Tadić, V., & Sonksen, P. (2014). Social communicative variation in 1–3-year-olds with severe visual impairment. *Child: Care, Health and Development, 40*(2), 158–164. https://doi.org/10.1111/cch.12065

Damen, S., & Ask Larsen, F. (2014). Guidelines for assessment of cognition in relation to congenital deafblindness. In F. Ask Larsen & S. Damen (Eds.), *Guidelines for assessment of cognition in relation to congenital deafblindness* (pp. 18–39). Nordic Centre for Welfare and Social Issues.

Damen, S., Janssen, M. J., Huisman, M., Ruijssenaars, W. A. J. J. M., & Schuengel, C. (2014). Stimulating intersubjective communication in an adult with deafblindness: A single-case experiment. *Journal of Deaf Studies and Deaf Education, 19*(3), 366–384. https://doi.org/10.1093/deafed/enu006

Damen, S., Janssen, M. J., Ruijssenaars, W. A. J. J. M., & Schuengel, C. (2015a). Intersubjectivity effects of the high-quality communication intervention in people with deafblindness. *Journal of Deaf Studies and Deaf Education, 20*(2), 191–201. https://doi.org/10.1093/deafed/env001

Damen, S., Janssen, M. J., Ruijssenaars, W. A. J. J. M., & Schuengel, C. (2015b). Communication between children with deafness, blindness and deafblindness and their social partners: An intersubjective developmental perspective. *International Journal of Disability, Development and Education, 62*(2), 215–243. https://doi.org/10.1080/1034912X.2014.998177

Damen, S., Janssen, M. J., Ruijssenaars, W. A. J. J. M., & Schuengel, C. (2017). Scaffolding the communication of people with congenital deafblindness: An analysis of sequential interaction patterns. *American Annals of the Deaf, 162*(1), 24–33. https://doi.org/10.1353/aad.2017.0012

Dammeyer, J. (2010). Prevalence and aetiology of congenitally deafblind people in Denmark. *International Journal of Audiology, 49*(2), 76–82. https://doi.org/10.3109/14992020903311388

Dammeyer, J. (2012a). Identification of congenital deafblindness. *British Journal of Visual Impairment, 30*(2), 101–107. https://doi.org/10.1177/0264619612443882

Dammeyer, J. (2012b). Development and characteristics of children with Usher syndrome and CHARGE syndrome. *International Journal of Pediatric Otorhinolaryngology, 76*(9), 1292–1296. https://doi.org/10.1016/j.ijporl.2012.05.021

Dammeyer, J., & Ask Larsen, F. (2016). Communication and language profiles of children with congenital deafblindness. *British Journal of Visual Impairment, 34*(3), 214–224. https://doi.org/10.1177/0264619616651301

Dammeyer, J., Nielsen, A., Strøm, E., Hendar, O., & Eiriksdóttir, V. K. (2015). A case study of tactile language and its possible structure: A tentative outline to study tactile language systems among children with congentital deafblindness. *Journal of Communication Disorders, Deaf Studies & Hearing Aids, 3*(2), 1–7. https://doi.org/10.4172/2375-4427.1000133

Danker, J., Dreyfus, S., Strnadová, I., & Pilkinton, M. (2023). Scoping review on communication systems used by adults with severe/profound intellectual disability for functional communication. *Journal of Applied Research in Intellectual Disabilities, 36*(5), 951–965. https://doi.org/10.1111/jar.13133

Delafield-Butt, J. T., & Trevarthen, C. (2015). The ontogenesis of narrative: From moving to meaning. *Frontiers in Psychology, 6,* Article 1157. https://doi.org/10.3389/fpsyg.2015.01157

Delafield-Butt, J. T., Zeedyk, M. S., Harder, S., Vaever, M. S., & Caldwell, P. (2020). Making meaning together: Embodied narratives in a case of severe autism. *Psychopathology, 53*(2), 60–73. https://doi.org/10.1159/000506648

Deppermann, A., & Pekarek Doehler, S. (2021). Longitudinal conversation analysis - introduction to the special issue. *Research on Language and Social Interaction, 54*(2), 127–141. https://doi.org/10.1080/08351813.2021.1899707

Deppermann, A., & Streeck, J. (2018). The body in interaction: Its multiple modalities and temporalities. In A. Deppermann & J. Streeck (Eds.), *Time in embodied interaction. Synchronity and sequentiality of multimodal resources* (pp. 5–44). John Benjamins.

Deuce, G., & Rose, S. (2019). Sign acquisition in children who are deafblind. In N. Grove & K. Launonen (Eds.), *Manual sign acquisition in children with developmental disabilities* (pp. 175–193). Nova Science Publishers.

Dincer, B., & Erbas, D. (2010). Description of communication breakdown repair strategies produced by nonverbal students with developmental disabilities. *Education and Training in Autism and Developmental Disabilities, 45*(3), 400–409.

D'Odorico, L., & Cassibba, R. (1995). Cross-sectional study of coordination between infants' gaze and vocalizations towards their mothers. *Early Development and Parenting, 4*(1), 11–19. https://doi-org.ezproxy.utu.fi/10.1002/edp.2430040103

Dunst, C. J., & Dempsey, I. (2007). Family-professional partnerships and parenting competence, confidence, and enjoyment. *International Journal of Disability, Development and Education, 54*(3), 305–318. https://doi.org/10.1080/10349120701488772

Dyck, M. J., Farrugia, C., Shochet, I. M., & Holmes-Brown, M. (2004). Emotion recognition/understanding ability in hearing or vision-impaired children: Do sounds, sights, or words make the difference? *The Journal of Child Psychology and Psychiatry, 45*(4), 789–800. https://doi.org/10.1111/j.1469-7610.2004.00272.x

Dyzel, V., Dekkers-Verbon, P., Toeters M., & Sterkenburg, P. S. (2023). For happy children with a visual or visual-and-intellectual disability: Efficacy research to promote sensitive caregiving with

the Barti-mat. *British Journal of Visual Impairment, 41*(2), 343–362. https://doi.org/10.1177/02646196211047733

ELAN (2020). (Version 6.0) [Computer software]. Max Planck Institute for Psycholinguistics. https://archive.mpi.nl/tla/elan

ELAN (2021). (Version 6.2) [Computer software]. Max Planck Institute for Psycholinguistics. https://archive.mpi.nl/tla/elan

Ely, M. S., & Ostrosky, M. M. (2018). Applying the foundational concepts from early intervention to services provided to young children with visual impairments: A literature review. *Journal of Visual Impairment & Blindness, 112*(3), 225–238. https://doi.org/10.1177/0145482X1811200302

Ely, M. S., Ostrosky, M. M., & Burke, M. M. (2020). Self-efficacy of providers of early intervention services to young children with visual impairments and their families. *Journal of Visual Impairment & Blindness, 114*(2), 114–126. https://doi.org/10.1177/0145482X20913138

Escalona, A., Field, T., Nadel, J., & Lundy, B. (2002). Brief report: Imitation effects on children with autism. *Journal of Autism and Developmental Disorders, 32*(2), 141–144. https://doi.org/10.1023/a:1014896707002

Fantasia, V., Fasulo, A., Costall., A., & López, B. (2014). Changing the game: Exploring infants' participation in early play routines. *Frontiers in Psychology, 5,* Article 522. https://doi.org/10.3389/fpsyg.2014.00522

Fantasia, V., Galbusera, L., Reck, C., & Fasulo, A. (2019). Rethinking intrusiveness: Exploring the sequential organization in interactions between infants and mothers. *Frontiers in Psychology,* 10, Article 1543. https://doi.org/10.3389/fpsyg.2019.01543

Filipi, A. (2009). *Toddler and parent interaction: The organization of gaze, pointing and vocalization* (Vol. 192). John Benjamins Publishing Company.

Fiss, A. L., Håkstad, R. B., Looper, J., Pereira, S. A., Sargent, B., Silveira, J., Willet, S., & Dusing, S. C. (2023). Embedding play to enrich physical therapy. *Behavioral Sciences, 13*(6), Article 440. https://doi.org/10.3390/bs13060440

Flanagan, N. M., Jackson, A. J., & Hill, A. E. (2003). Visual impairment in childhood: Insights from a community-based survey. *Child: Care, Health & Development, 29*(6), 493–499. https://doi.org/10.1046/j.1365-2214.2003.00369.x

Fonagy, P., Gergely, G., Jurist, E. L., & Target, M. (2002). *Affect regulation, mentalization, and the development of the self.* Other Press.

Forsgren, G. A. G. C., Daelman, M., & Hart, P. (2018). Sign construction based on heightened tactile perception by persons with congenital deafblindness. *Journal of Deafblind Studies on Communication, 4*(1):4–23. https://doi.org/10.21827/jdbsc.4.31373

Fraiberg, S. (1971). Intervention in infancy: A program for blind infants. *Journal of the American Academy of Child Psychiatry, 10*(3), 381–405. https://doi.org/10.1016/S0002-7138(09)61746-5

Fraiberg, S. (1979). Blind infants and their mothers: An examination of the sign system. In M. Bullowa (Ed.), *Before speech: The beginning of interpersonal communication* (pp. 149–169). Cambridge University Press.

Gibson, J. J. (1962). Observations on active touch. *Psychological Review, 69*(6), 477–491. https://doi.org/10.1037/h0046962

Goldstein Ferber, S., Feldman, R., & Makhoul, I. R. (2008). The development of maternal touch across the first year of life. *Early Human Development, 84*(6), 363–370. https://doi.org/10.1016/j.earlhumdev.2007.09.019

Goodwin, C. (2013). The co-operative, transformative organization of human action and knowledge. *Journal of Pragmatics, 46*(1), 8–23. https://doi.org/10.1016/j.pragma.2012.09.003

Goold, L., & Hummell, J. (1993). *Supporting the receptive communication of individuals with significant multiple disabilities: Selective use of touch to enhance comprehension* [Number 4 of monograph series, The Royal New South Wales Institute for Deaf and Blind Children]. North Rocks Press.

Gordon-Pershey, M., Zeszut, S., & Brouwer, K. (2019). A survey of speech sound productions in children with visual impairments. *Communication Disorders Quarterly, 40*(4), 206–219. https://doi.org/10.1177/1525740118789101

Gregersen, A. (2018). Body with body: Interacting with children with congenital deafblindness in the human niche. *Journal of Deafblind Studies on Communication, 4*(1), 67–83. https://doi.org/10.21827/jdbsc.4.31374

Gros-Louis, J., West, M. J., & King, A. P. (2014). Maternal responsiveness and the development of directed vocalizing in social interactions. *Infancy 19*(4), 385–408. https://doi.org/10.1111/infa.12054

Grumi, S., Cappagli, G., Aprile, G., Mascherpa, E., Gori, M., Provenzi, L., & Signorini, S. (2021). Togetherness, beyond the eyes: A systematic review on the interaction between visually impaired children and their parents. *Infant Behavior and Development, 64,* Article 101590. https://doi.org/10.1016/j.infbeh.2021.101590

Guellaï, B., Callin, A., Bevilacqua, F., Schwarz, D., Pitti, A., Boucenna, S., & Gratier, M. (2019). Sensus communis: Some perspectives on the origins of non-synchronous cross-sensory associations. *Frontiers in Psychology, 10,* Article 523. https://doi.org/10.3389/fpsyg.2019.00523

Gui, A., Perelli, D., Rizzo, G., Ferruzza, E., & Mercuriali, E. (2023). Children's total blindness as a risk factor for early parent-child relationships: Preliminary findings from an Italian sample. *Frontiers in Psychology, 14,* Article 1175675. https://doi.org/10.3389/fpsyg.2023.1175675

Gul, H., Erol, N., Pamir Akin, D., Ustun Gullu, B., Akcakin, M., Alpas, B., & Öner, Ö. (2016). Emotional availability in early mother-child interactions for children with autism spectrum disorders, other psychiatric disorders, and developmental delay. *Infant Mental Health Journal, 37*(2), 151–159. https://doi.org/10.1002/imhj.21558

Guralnick, M. J. (2011). Why early intervention works: A systems perspective. *Infants & Young Children*, *24(1)*, 6–28. https://doi.org/10.1097/IYC.0b013e3182002cfe

Guralnick, M. J., & Bruder, M. B. (2020). Early intervention. In J. L. Matson (Ed.), *Handbook of intellectual disabilities: Integrating theory, research, and practice* (pp. 717–741). Springer.

Gustafson, G. E., Green, J. A., & West, M. J. (1979). The infant's changing role in mother-infant games: The growth of social skills. *Infant Behavior and Development, 2*(4), 301–308. https://doi.org/10.1016/S0163-6383(79)80039-9

Harder, S., Lange, T., Hansen, G. F., Væver, M., & Køppe, S. (2015). A longitudinal study of coordination in mother-infant vocal interaction from age 4 to 10 months. *Developmental Psychology, 51*(12), 1778–1790. https://doi.org/10.1037/a0039834

Harris, J. C. (2006). *Intellectual disability: Understanding its development, causes, classification, evaluation, and treatment.* Oxford University Press.

Hart, P. (2006). Using imitation with congenitally deafblind adults: Establishing meaningful communication partnerships. *Infant and Child Development, 15*(3), 263–274. https://doi.org/10.1002/icd.459

Hart, P. (2010). *Moving beyond the common touchpoint – discovering language with congenitally deafblind people* [Unpublished doctoral dissertation]. University of Dundee. https://discovery.dundee.ac.uk/en/studentTheses/moving-beyond-the-common-touchpoint-discovering-language-with-con

Hartshorne, T. S., & Schmittel, M. C. (2016). Social-emotional development in children and youth who are deafblind. *American Annals of the Deaf, 161*(4), 444–453. https://doi.org/10.1353/aad.2016.0036

Hastings, R. P., Daley, D., Burns, C., & Beck, A. (2006). Maternal distress and expressed emotion: Cross-sectional and longitudinal relationships with behavior problems of children with intellectual disabilities. *American Journal on Mental Retardation, 111*(1), 48–61. https://doi.org/10.1352/0895-8017(2006)111[48:MDAEEC]2.0.CO;2

Hatton, D. D., Ivy, S. E., & Boyer, C. (2013). Severe visual impairments in infants and toddlers in the United States. *Journal of Visual Impairment & Blindness, 107*(5), 325–336. https://doi.org/10.1177/0145482X1310700502

Heckman, J. J. (2006). Skill formation and the economics of investing in disadvantaged children. *Science, 312*(5782), 1900–1902. https://doi.org/10.1126/science.1128898

Heimann, M., & Meltzoff, A. N. (1996). Deferred imitation in 9- and 14-month-old infants: A longitudinal study of a Swedish sample. *British Journal of Developmental Psychology, 14*(1), 55–64. https://doi-org.ezproxy.utu.fi/10.1111/j.2044-835X.1996.tb00693.x

Hertenstein, M. J. (2002). Touch: Its communicative functions in infancy. *Human Development, 45*(2), 70–94. https://doi.org/10.1159/000048154

Hodapp, R. M., Goldfield, E. C., & Boyatzis, C. J. (1984). The use and effectiveness of maternal scaffolding in mother-infant games. *Child Development, 55*(3), 772–781. https://doi.org/10.2307/1130128

Hopkins, K., & Puhlman, J. (2025). Empowering families of deaf children: A qualitative study on parental experiences in early intervention. *Journal of Early Intervention.* Advance online publication. https://doi.org/10.1177/10538151241304752

Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children, 71*(2), 165–179. https://doi.org/10.1177/001440290507100203

House, S. S., & Davidson, R. C. (2000). Speech-language pathologists and children with sensory impairments: Personnel preparation and service delivery survey. *Communication Disorders Quarterly, 21*(4), 224–236. https://doi.org/10.1177/152574010002100404

Huo, R., Burden, S. K., Hoyt, C. S., & Good, W. V. (1999). Chronic cortical visual impairment in children: Aetiology, prognosis, and associated neurological deficits. *British Journal of Ophthalmology, 83*(6), 670–675. https://doi.org/10.1136/bjo.83.6.670

Häkli S., Luotonen, M., Bloigu, R., Majamaa, K., & Sorri, M. (2014). Childhood hearing impairment in northern Finland, etiology and additional disabilities. *International Journal of Pediatric Otorhinolaryngology, 78*(11), 1852–1856. https://doi.org/10.1016/j.ijporl.2014.08.007

İdil, S. A., Altınbay, D., Şahlı, E., Bingöl Kızıltunç, P., Semrin Timlioğlu İper, H., Turan, K. E., Ergintürk Acar, D., & Bektaş, F. M. (2021). Ophthalmologic approach to babies with cerebral visual impairment. *The Turkish Journal of Pediatrics, 63*(1), 1–10. https://doi.org/10.24953/turkjped.2021.01.001

International Neuromodulation Society. (n.d.). *Motor impairment.* Retrieved June 10, 2024, from https://www.neuromodulation.com/motor-impairment

Iverson, J. M., Tencer, H. L., Lany, J., & Goldin-Meadow, S. (2000). The relation between gesture and speech in congenitally blind and sighted language-learners. *Journal on Nonverbal Behavior, 24*(2), 105–130. https://doi.org/10.1023/A:1006605912965

Iverson, J. M., & Thal, D. J. (1998). Communicative transitions: There's more to the hand than meets the eye. In A. M. Wetherby, S. F. Warren, & J. Reichle (Eds.), *Transitions in prelinguistic communication* (pp. 59–86). Paul H. Brookes Publishing Co.

Iwasaki, S., Bartlett, M., Manns, H., & Willoughby, L. (2019). The challenges of multimodality and multi-sensoriality: Methodological issues in analyzing tactile signed interaction. *Journal of Pragmatics, 143,* 215–227. https://doi.org/10.1016/j.pragma.2018.05.003

Jaiswal, A., Paramasivam, A., Budhiraja, S., Santhakumaran, P., Gravel, C., Martin, J., Ogedengbe, T. O., James, T. G., Kennedy, B., Tang, D., Tran, Y., Colson-Osborne, H., Minhas, R., Granberg, S., & Wittich, W. (2024). The international classification of functioning, disability and health (ICF) core sets for deafblindness, part II of the systematic review: Linking data to the ICF categories. *European Journal of Physical and Rehabilitation Medicine, 60*(5), 893–902. https://doi.org/10.23736/S1973-9087.24.07984-X

Janssen, M. J., Riksen-Walraven, J. M., & van Dijk, J. P. M. (2002). Enhancing the quality of interaction between deafblind children and their educators. *Journal of Developmental and Physical Disabilities, 14*(1), 87–109. https://doi.org/10.1023/A:1013583312920

Janssen, M. J., Riksen-Walraven, J. M., van Dijk, J. P. M., & Ruijssenaars, W. A. J. J. M. (2010). Interaction coaching with mothers of children with congenital deaf-blindness at home: Applying the diagnostic intervention model. *Journal of Visual Impairment & Blindness, 104*(1), 15–29. https://doi.org/10.1177/0145482X1010400106

Janssen, M., & Rødbroe, I, (2007). *Communication and congenital deafblindness II: Contact and social interaction.* The Danish Resource Centre on Congenital Deafblindness and Viataal.

Jefferson, G. (1972). Side sequences. In D. Sudnow (Ed.), *Studies in social interaction* (pp. 294–338). Free Press.

Jewitt, C., Bezemer, J., & O'Halloran, K. (2025). Navigating a diverse field. In *Introducing multimodality* (2nd ed., Vol. 1, pp. 1–10). Routledge.

Johnson, N., & Parker, A. T. (2013). Effects of wait time when communicating with children who have sensory and additional disabilities. *Journal of Visual Impairment & Blindness, 107*(5), 363–374. https://doi.org/10.1177/0145482X1310700505

Jover, M., Cellier, M., & Scola, C. (2019). Infants' motor activity during a mother-infant interaction alternating silent and singing phases. *Journal of Motor Learning and Development, 7*(3), 426–436. https://doi.org/10.1123/jmld.2019-0001

Kanto, L. (2022). The development of childhood multilingualism in languages of different modalities. In A. Stavans & U. Jessner (Eds.), *The Cambridge handbook of childhood multilingualism* (pp. 38–57). Cambridge University Press.

Kaup, B., Ulrich, R., Bausenhart, K. M., Bryce, D., Butz, M. V., Dignath, D., Dudschig, C., Franz, V. H., Friedrich, C., Gawrilow, C., Heller, J., Huff, M., Hütter, M., Janczyk, M., Leuthold, H., Mallot, H., Nürk, H.-C., Ramscar, M., Said, N., Svaldi, J., & Wong, H. Y. (2024). Modal and amodal cognition: An overarching principle in various domains of psychology. *Psychological Research, 88*(2), 307–337. https://doi.org/10.1007/s00426-023-01878-w

Kaye, K., & Charney, R. (1980). How mothers maintain "dialogue" with two-year-olds. In D. R. Olson (Ed.), *The social foundations of language and thought. Essays in honor of Jerome S. Bruner* (pp. 211–230). W. W. Norton & Company.

Kent, R. D., & Miolo, G. (1995). Phonetic abilities in the first year of life. In P. Fletcher & B. MacWhinney (Eds.), *The handbook of child language* (pp. 303–334). Basil Blackwell.

Kokkinaki, T., Delafield-Butt, J., Nagy, E., & Trevarthen, C. (2023). Editorial: Intersubjectivity: Recent advances in theory, research, and practice. *Frontiers in Psychology, 14,* Article 1220161. https://doi.org/10.3389/fpsyg.2023.1220161

Konstantina, N., Eleni, F., Evangelos, K., Paraskevi, G., Vasilis, T., & Maria, S. (2014). Parental satisfaction with early intervention services for children with visual impairments and multiple disabilities in Greece. *Journal of Physical Education and Sport, 14*(1), 60–65.

Kran, B. S., Lawrence, L., Mayer, D. L., & Heidary, G. (2019). Cerebral/cortical visual impairment: A need to reassess current definitions of visual impairment and blindness. *Seminars in Pediatric Neurology, 31*, 25–29. https://doi.org/10.1016/j.spen.2019.05.005

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W. R. (2010). *Single-case designs technical documentation.* What Works Clearinghouse. https://ies.ed.gov/ncee/wwc/Document/229

Kubicek, L. F., Riley, K., Coleman, J., Miller, G., & Linder, T. (2013). Assessing the emotional quality of parent-child relationships involving young children with special needs: Applying the constructs of emotional availability and expressed emotion. *Infant Mental Health Journal, 34*(3), 242–256. https://doi.org/10.1002/imhj.21384

Kunnari, S. (2000). *Characteristics of early lexical and phonological development in children acquiring Finnish* [Unpublished doctoral dissertation]. University of Oulu.

Laakso, M., Helasvuo, M.-L., & Savinainen-Makkonen, T. (2010). Children's early actions in learning language: A study of proto-words and pointing gestures in interaction between one-year-old child and parent. *SKY Journal of Linguistics,* 23, 199–226.

Lahtinen, R. (2008). *Haptiisit ja hapteemit: tapaustutkimus kuurosokean henkilön kosketukseen perustuvan kommunikaation kehityksestä* [Doctoral dissertation, University of Helsinki]. Riitta Lahtinen.

Lake, L. M. (1985). *The effects of prompting and reinforcing on social interaction of visually and multiply handicapped young children* [Unpublished doctoral dissertation]. Texas Tech University.

Lang, M., Hintermair, M., & Sarimski, K. (2017). Social-emotional competences in very young visually impaired children. *British Journal of Visual Impairment, 35*(1), 29–43. https://doi.org/10.1177/0264619616677171

Launonen, K. (1998). *Eleistä sanoihin, viittomista kieleen. Varhaisviittomisohjelman kehittäminen, kokeilu ja pitkäaikaisvaikutukset Downin syndrooma -lasten varhaiskuntoutuksessa* [Doctoral dissertation, University of Helsinki]. Valtakunnallisen tutkimus- ja kokeiluyksikön julkaisuja 75. Kehitysvammaliitto ry.

Lee, M., & MacWilliam, L. (2008). *Learning together: A creative approach to learning for children with multiple disabilities and a visual impairment*. RNIB Publishing.

Liang, C. A., Braddock, B. A., Heithaus, J. L., Christensen, K. M., Braddock, S. R., & Carey, J. C. (2015). Reported communication ability of persons with trisomy 18 and trisomy 13. *Developmental Neurorehabilitation, 18*(5), 322–329. https://doi.org/10.3109/17518423.2013.847980

Liddle, K., Beswick, R., Fitzgibbons, E. J., & Driscoll, C. (2022). Aetiology of permanent childhood hearing loss at a population level. *Journal of Paediatrics and Child Health, 58*(3), 440–447. https://doi.org/10.1111/jpc.15738

Lindström, C. (2019). Contributing to a tactile language: Partners communicative accommodation to a bodily/tactile modality. *Journal of Deafblind Studies on Communication, 5*(1), 50–72. https://doi.org/10.21827/jdbsc.5.32574

Linell, P. (2009). *Rethinking language, mind, and world dialogically: Interactional and contextual theories of human sense-making.* Information Age Publishing.

Linell, P. (2017). Dialogue and the birth of the individual mind: With an example of communication with a congenitally deafblind person. *Journal of Deafblind Studies on Communication, 3*(1), 59–79.

Loots, G., Devisé, I., & Jacquet, W. (2005). The impact of visual communication on the intersubjective development of early parent-child interaction with 18- to 24-month-old deaf toddlers. *Journal of Deaf Studies and Deaf Education, 10*(4), 357–375. https://doi.org/10.1093/deafed/eni036

Luo, F., Blackstone, S. W., Canchola, J., & Roman-Lantzy, C. (2022). Working with children with cortical visual impairment who use augmentative and alternative communication: Implications for improving current practice. *Augmentative and Alternative Communication, 38*(2), 91–105. https://doi.org/10.1080/07434618.2022.2085622

Maestas y Moores, J. (1980). Early linguistic environment: Interactions of deaf parents with their infants. *Sign Language Studies, 26,* 1–13. https://doi.org/10.1353/sls.1980.0003

Magee, L. E., & Kennedy, J. M. (1980). Exploring pictures tactually. *Nature, 283,* 287–288. https://doi.org/10.1038/283287A0

Mallineni, S., Nutheti, R., Thangadurai, S., & Thangadurai, P. (2006). Non-verbal communication in children with visual impairment. *British Journal of Visual Impairment, 24*(1), 30–33. https://doi.org/10.1177/0264619606060033

Marková, I. (2011, March 13–18). *Validation and generalization using single case studies: A dialogical approach.* Alumni seminar, University of Groningen, The Netherlands.

Marková, I., Zadeh, S., & Zittoun, T. (2020). Introduction to the special issue on generalization from dialogical single case studies. *Culture & Psychology, 26*(1), 3–24. https://doi.org/10.1177/1354067X19888193

Martens, M. A. W., Janssen, M. J., Ruijssenaars, W. A. J. J. M., Huisman, M., & Riksen-Walraven, J. M. (2017). Fostering emotion expression and affective involvement with communication partners in people with congenital deafblindness and intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities, 30*(5), 872–884. https://doi.org/10.1111/jar.12279

McCarty, T. V., & Light, J. C. (2023). "It's like a guessing game all the time": Parent insights on barriers, supports, and priorities for children with cortical visual impairment and complex communication needs. *Augmentative and Alternative Communication, 39*(4), 256–269. https://doi.org/10.1080/07434618.2023.2206904

McLinden, M., & McCall, S. (2016). *Learning through touch: Supporting children with visual impairment and additional difficulties.* Routledge.

Meltzoff, A. N. (1988). Infant imitation and memory: Nine-month-olds in immediate and deferred tests. *Child Development, 59*(1), 217–225. https://doi.org/10.1111/j.1467-8624.1988.tb03210.x

Meltzoff, A. N., & Borton, R. W. (1979). Intermodal matching by human neonates. *Nature, 282,* 403–404. https://doi.org/10.1038/282403a0

Meltzoff, A. N., & Moore, M. K. (1977). Imitation of facial and manual gestures by human neonates. *Science, 198*(4312), 75–78. https://doi.org/10.1126/science.198.4312.75

Mesch, J. (2001). *Tactile sign language: Turn taking and questions in signed conversations of deaf-blind people* [Doctoral dissertation, Stockholm University]. Signum-Verlag.

Metell, M. (2015). “A great moment…because of the music”: An exploratory study on music therapy and early interaction with children with visual impairment and their sighted caregivers. *British Journal of Visual Impairment, 33*(2), 111–125. https://doi.org/10.1177/0264619615575792

Miles, B. (2003, October). *Talking the language of the hands to the hands.* National Center on Deafblindness. https://www.nationaldb.org/info-center/talking-hands-to-hands-factsheet/

Miliou, A. (2024). *Concerns and priorities of families with children with visual and multiple disabilities through the "Routines-Based Interview"* [Conference session]. Low Vision Congress 2024 | Prevention – Therapies – Rehabilitation, Thessaloniki, Greece. https://premium-events.gr/en/event/low-vision-congress-2024-eng/

Minter, M. E., Hobson, R. P., & Pring, L. (1991). Recognition of vocally expressed emotion by congenitally blind children. *Journal of Visual Impairment & Blindness, 85*(10), 411–415. https://doi.org/10.1177/0145482X9108501007

Mondada, L. (2018). Multiple temporalities of language and body in interaction: Challenges for transcribing multimodality. *Research on Language and Social Interaction, 51*(1), 85–106. https://doi.org/10.1080/08351813.2018.1413878

Mondada, L. (2022, December). *Conventions for multimodal transcription.* Retrieved October 10, 2023, from https://www.lorenzamondada.net/multimodal-transcription

Morris, P., Hope, E., Foulsham, T., & Mills, J. P. (2021). The effectiveness of mirroring- and rhythm-based intervention for children with autism spectrum disorder: A systematic review. *Review Journal of Autism and Developmental Disorders, 8*(4), 541–561. https://doi.org/10.1007/s40489-021-00236-z

Nadel, J., Revel, A., Andry, P., & Gaussier, P. (2004). Toward communication: First imitations in infants, low-functioning children with autism and robots. *Interaction Studies, 5*(1), 45–74. https://doi.org/10.1075/is.5.1.04nad

Nafstad, A. V. (2015). Communication as cure. Communicative agency in persons with congenital deafblindness. *Journal of Deafblind Studies on Communication, 1*(1), 23–39.

Nafstad, A. V. (2018). The authentic communication of the congenitally deafblind. In. H. Martinsen, E. Røysamb, & K. Stadskleiv (Eds.), *På enhver mulig måte. Perspektiver på typisk og atypisk utvikling av kommunikajson og språk. Festskrift til professor Stephen von Tetzchner* (pp. 193–202). University of Oslo.

Nafstad, A., & Rødbroe, I. (1999). *Co-creating communication. Perspectives on diagnostic education for individuals who are congenitally deafblind and individuals whose impairments may have similar effects.* Forlaget Nord-Press.

Nafstad, A. V., & Rødbroe, I. B. (2015). *Communicative relations: Interventions that create communication with persons with congenital deafblindness.* Materialecentret. https://www.statped.no/globalassets/laringsressurs/dokumenter/02-bokhefte/communicative-relations-uk.pdf

Nelson, C., Greenfield, R. G., Hyte, H. A., & Shaffer, J. P. (2013). Stress, behavior, and children and youth who are deafblind. *Research & Practice for Persons with Severe Disabilities, 38*(3), 139–156. https://doi.org/10.1177/154079691303800302

Nicholas, J. (2013). Tactile cognition and tactile language acquisition - an information processing approach. In J. Dammeyer & A. Nielsen (Eds.), *Kropslig og taktil sprogudvikling - En antologi om forskellige sprogmodaliteters muligheder og umuligheder, undersøgt med afsæt i personer med medfødt døvblindhed* (pp. 47–79). Materialecentret.

Nicholas, J. T., Johannessen, A. M., & van Nunen, T. (2019). *Tactile working memory scale - A professional manual.* Nordic Welfare Centre. https://nordicwelfare.org/en/publikationer/tactile-working-memory-scale-a-professional-manual/

Nind, M., & Hewett, D. (2001). *A practical guide to Intensive Interaction.* BILD Publications.

Ninio, A., & Bruner, J. (1978). The achievement and antecedents of labelling. *Journal of Child Language, 5*(1), 1–15. https://doi.org/10.1017/S0305000900001896

Nomikou, I., Leonardi, G., Radkowska, A., Rączaszek-Leonardi, J., & Rohlfing, K. J. (2017). Taking up an active role: Emerging participation in early mother-infant interaction during peekaboo routines. *Frontiers in Psychology, 8,* Article 1656. https://doi.org/10.3389/fpsyg.2017.01656

Nordic Welfare Centre. (n.d.). *Nordic definition of deafblindness.* Retrieved August 1, 2024, from https://nordicwelfare.org/en/disability-issues/the-deafblind-field/

Näkövammaisten liitto. (n.d.). *Näkövammaisuuden määritys.* Retrieved June 6, 2024, from https://www.nakovammaistenliitto.fi/fi/nakovammaisuus#header--nakovammaisuuden-maaritys

Obretenova, S., Halko, M. A., Plow, E. B., Pascual-Leone, A., & Merabet, L. B. (2010). Neuroplasticity associated with tactile language communication in a deaf-blind subject. *Frontiers in Human Neuroscience, 3,* Article 60. https://doi.org/10.3389/neuro.09.060.2009

O'Neill, M. B., & Zeedyk, M. S. (2006). Spontaneous imitation in the social interactions of young people with developmental delay and their adult carers. *Infant and Child Development, 15*(3), 283–295. https://doi.org/10.1002/icd.458

Papoušek, M. (1995). Origins of reciprocity and mutuality in prelinguistic parent-infant 'dialogues'. In I. Marková, C. F. Graumann, & K. Foppa (Eds.), *Mutualities in dialogue* (pp. 58–81). Cambridge University Press.

Papoušek, M., & Papoušek, H. (1989). Forms and functions of vocal matching in interactions between mothers and their precanonical infants. *First Language, 9*(6), 137–158. https://doi.org/10.1177/014272378900900603

Paradis, G., & Koester, L. S. (2015). Emotional availability and touch in deaf and hearing dyads. *American Annals of the Deaf, 160*(3), 303–315. https://doi.org/10.1353/aad.2015.0026

Paz, Y., & Frenkel, T. I. (2024). Infant sensitivity to social contingency moderates the predictive link between early maternal reciprocity and infants' emerging social behavior. *Developmental Science, 27*(6), Article e13563. https://doi.org/10.1111/desc.13563

Peltokorpi, S. (2011). *Imitation in the context of play with a child with deafblindness and her parents* [Unpublished master's thesis]. University of Groningen.

Pennington, L. (2008). Cerebral palsy and communication. *Paediatrics and Child Health, 18*(9), 405–409. https://doi.org/10.1016/j.paed.2008.05.013

Pennington, L., & McConachie, H. (2001). Predicting patterns of interaction between children with cerebral palsy and their mothers. *Developmental Medicine & Child Neurology, 43*(2), 83–90. https://doi.org/10.1111/j.1469-8749.2001.tb00720.x

Pereira, E. M. (2023). Trisomy 13. *Pediatrics in Review, 44*(1), 53–54. https://doi.org/10.1542/pir.2022-005517

Pipp-Siegel, S., Blair, N. L., Deas, A. M., Pressman, L. J., & Yoshinaga-Itano, C. (1998). Touch and emotional availability in hearing and deaf or hard of hearing toddlers and their hearing mothers. *The Volta Review, 100*(5), 279–298.

Platje, E., Sterkenburg, P., Overbeek, M., Kef, S., & Schuengel, C. (2018). The efficacy of VIPP-V parenting training for parents of young children with a visual or visual-and-intellectual disability: A randomized controlled trial. *Attachment & Human Development, 20*(5), 455–472. https://doi.org/10.1080/14616734.2018.1428997

Preisler, G. M. (1991). Early patterns of interaction between blind infants and their sighted mothers. *Child: Care, Health and Development, 17*(2), 65–90. https://doi.org/10.1111/j.1365-2214.1991.tb00680.x

Preisler, G. M. (1995). The development of communication in blind and in deaf infants – similarities and differences. *Child: Care, Health and Development, 21*(2), 79–110. https://doi.org/10.1111/j.1365-2214.1995.tb00412.x

Preisler, G. (2005). Development of communication in deafblind children. *Scandinavian Journal of Disability Research, 7*(1), 41–62. https://doi.org/10.1080/15017410510032145

Rączaszek-Leonardi, J., Nomikou, I., & Rohlfing, K. J. (2013). Young children's dialogical actions: The beginnings of purposeful intersubjectivity. *IEEE Transactions on Autonomous Mental Development, 5*(3), 210–221. https://doi.org/10.1109/TAMD.2013.2273258

Rahi, J. S., & Gilbert, C. E. (2013). Epidemiology and world-wide impact of visual impairment in children. In C. S. Hoyt & D. Taylor (Eds.), *Pediatric ophthalmology and strabismus* (4th ed., pp. 1–8). Elsevier Saunders.

Ratner, N., & Bruner, J. (1978). Games, social exchange and the acquisition of language. *Journal of Child Language, 5*(3), 391–401. https://doi.org/10.1017/S0305000900002063

Rattray, J., & Zeedyk, M. S. (2005). Early communication in dyads with visual impairment. *Infant and Child Development, 14*(3), 287–309. https://doi.org/10.1002/icd.397

Rautakoski, P., af Ursin, P., Carter, A. S., Kaljonen, A., Nylund, A., & Pihlaja, P. (2021). Communication skills predict social-emotional competencies. *Journal of Communication Disorders, 93,* Article 106138. https://doi.org/10.1016/j.jcomdis.2021.106138

Reda, N. M., & Hartshorne, T. S. (2008). Attachment, bonding, and parental stress in CHARGE syndrome. *Mental Health Aspects of Developmental Disabilities, 11*(1), 1–12.

Reddy, V. (2003). On being the object of attention: Implications for self-other consciousness. *Trends in Cognitive Sciences, 7*(9), 397–402. https://doi.org/10.1016/S1364-6613(03)00191-8

Reddy, V. (2015). Joining intentions in infancy. *Journal of Consciousness Studies, 22*(1–2), 24–44.

Reddy, V., Markova, G., & Wallot, S. (2013). Anticipatory adjustments to being picked up in infancy. *Plos One, 8*(6), Article e65289. https://doi.org/10.1371/journal.pone.0065289

Rensfeldt Flink, A., Boström, P., Gillberg, C., Lichtenstein, P., Lundström, S., & Åsberg Johnels, J. (2021). Exploring co-occurrence of sensory, motor and neurodevelopmental problems and epilepsy in children with severe-profound intellectual disability. *Research in Developmental Disabilities, 119,* Article 104114. https://doi.org/10.1016/j.ridd.2021.104114

Rensfeldt Flink, A., Broberg, M., Strid, K., Thunberg, G., & Åsberg Johnels, J. (2023). Following children with severe or profound intellectual and multiple disabilities and their mothers through a communication intervention: Single-case mixed-methods findings. *International Journal of Developmental Disabilities, 69*(6), 869–887. https://doi.org/10.1080/20473869.2022.2031778

Rogers, S. J., & Puchalski, C. B. (1984). Social characteristics of visually impaired infants' play. *Topics in Early Childhood Special Education, 3*(4), 52–56. https://doi.org/10.1177/027112148400300409

Rogow, S. M. (1982). Rhythms and rhymes: Developing communication in very young blind and multihandicapped children. *Child: Care, Health and Development, 8*(5), 249–260. https://doi.org/10.1111/j.1365-2214.1982.tb00286.x

Rose, S. (2018, August 15). *Thinking about tactile sign languages* [Blog post]. https://www.steverosetherapy.com/my-publications

Rosenbaum, P., Paneth, N., Leviton, A., Goldstein, M., & Bax, M. (2007). A report: The definition and classification of cerebral palsy April 2006. *Developmental Medicine & Child Neurology, 49*(Suppl.109), 8–14. https://doi.org/10.1111/j.1469-8749.2007.tb12610.x

Rosenbaum, P., & Rosenbloom, L. (2012). *Cerebral palsy: From diagnosis to adult life.* Mac Keith Press.

Rosenblum, L. D. (2008). Speech perception as a multimodal phenomenon. *Current Directions in Psychological Science, 17*(6), 405–409. https://doi.org/10.1111/j.1467-8721.2008.00615.x

Rouse, L. (2012). Family-centred practice: Empowerment, self-efficacy, and challenges for practitioners in early childhood education and care. *Contemporary Issues in Early Childhood, 13*(1), 17–26. https://doi.org/10.2304/ciec.2012.13.1.17

Rowe, M. L., & Goldin-Meadow, S. (2009). Early gesture selectively predicts later language learning. *Developmental Science, 12*(1), 182–187. https://doi.org/10.1111/j.1467-7687.2008.00764.x

Rowland, C. (1984). Preverbal communication of blind infants and their mothers. *Journal of Visual Impairment & Blindness, 78*(7), 297–302. https://doi.org/10.1177/0145482X8407800701

Rudanko, S.-L. (2007). *Visual impairment in Finnish children: Prevalence, causes and morbidity of full-term and preterm children with visual impairment born from 1972 through 1989* [Unpublished doctoral dissertation]. University of Helsinki. http://urn.fi/URN:ISBN:978-952-10-4196-9

Rødbroe, I., & Janssen, M. (2006). *Communication and congenital deafblindness I: Congenital deafblindness and the core principles of intervention.* VCDBF/Viataal.

Sacks, H., Schegloff, E. A., & Jefferson, G. (1974). A simplest systematics for the organization of turn-taking for conversation. *Language, 50*(4), 696–735. https://doi.org/10.2307/412243

Sakkalou, E., Sakki, H., O'Reilly, M. A., Salt, A. T., & Dale, N. J. (2018). Parenting stress, anxiety, and depression in mothers with visually impaired infants: A cross-sectional and longitudinal cohort analysis. *Developmental Medicine & Child Neurology, 60*(3), 290–298. https://doi.org/10.1111/dmcn.13633

Sakki, H. E A., Dale, N. J., Sargent, J., Perez-Roche, T., & Bowman, R. (2018). Is there consensus in defining childhood cerebral visual impairment? A systematic review of terminology and definitions. *British Journal of Ophthalmology, 102*(4), 424–432. https://doi.org/10.1136/bjophthalmol-2017-310694

Sameroff, A. J., & Chandler, M. J. (1975). Reproductive risk and the continuum of caretaking casualty. In F. D. Horowitz, E. M. Hetherington, S. Scarr-Salapatek, & G. M. Siegel (Eds.), *Review of child development research* (Vol. 4, pp. 187–244). The University of Chicago Press.

Sameroff, A. J., & MacKenzie, M. J. (2003a). A quarter-century of the transactional model: How have things changed? *Zero to Three, 24*(1), 14–22.

Sameroff, A. J., & MacKenzie, M. J. (2003b). Research strategies for capturing transactional models of development: The limits of the possible. *Development and Psychopathology, 15*(3), 613–640. https://doi.org/10.1017/S0954579403000312

Sauciuk, G.-A., Zlakowska, J., Persson, T., Lenninger, S., & Alenkaer Madsen, E. (2020). Imitation recognition and its prosocial effects in 6-month old infants. *PLOS One, 15*(5), Article e0232717. https://doi.org/10.1371/journal.pone.0232717

Schegloff, E. A. (1980). Preliminaries to preliminaries: "Can I ask you a question?" *Sociolgical Inquiry*, *50*(3–4)*,* 104–152. https://doi.org/10.1111/j.1475-682X.1980.tb00018.x

Shahar-Lahav, R., Sher-Censor, E., & Hebel, O. (2022). Emotional availability in mothers and their children with spinal muscular atrophy type 1 who require augmentative and alternative communication: A mixed-methods pilot study. *Augmentative and Alternative Communication, 38*(3), 161–172. https://doi.org/10.1080/07434618.2022.2124928

Shai, D., & Belsky, J. (2011). When words just won't do: Introducing parental embodied mentalizing. *Child Development Perspectives, 5*(3), 173–180. https://doi.org/10.1111/j.1750-8606.2011.00181.x

Shakele, H., Muzata, K. K., Nafstad, A., & Souriau, J. (2022). How an intervention on the bodily-tactile modality can improve communication. *Journal of Deafblind Studies on Communication, 8*(1), 5–28. https://doi.org/10.21827/jdbsc.8.40375

Sierra, S. (2017). "Buffy sings to Cody": A multimodal analysis of mother and pre-lingual-infant question-response sequences. *Journal of Pragmatics, 110,* 50–62. https://doi.org/10.1016/j.pragma.2017.01.005

Smith, C., & Fluck, M. (2000). (Re-) Constructing pre-linguistic interpersonal processes to promote language development in young children with deviant or delayed communication skills. *British Journal of Educational Psychology, 70*(3), 369–389. https://doi.org/10.1348/000709900158182

Snow, C. E. (1977). The development of conversation between mothers and babies. *Journal of Child Language, 4*(1), 1–22. https://doi.org/10.1017/S0305000900000453

Snow, C. E., Perlmann, R., & Nathan, D. (1987). Why routines are different: Toward a multiple-factors model of the relation between input and language acquisition. In K. E. Nelson & A. van Kleeck (Eds.), *Children's languag*e (Vol. 6., pp. 65–97). Lawrence Erlbaum Associates.

Sonksen, P. M., & Dale, N. (2002). Visual impairment in infancy: Impact on neurodevelopmental and neurobiological processes. *Developmental Medicine & Child Neurology, 44*(11), 782–791. https://doi.org/10.1111/j.1469-8749.2002.tb00287.x

Souriau, J. (2015). Blended spaces and deixis in communicative activities involving persons with congenital deafblindness. *Journal of Deafblind Studies on Communication, 1*(1), 5–22.

Spence, C., & Di Stefano, N. (2024). What, if anything, can be considered an amodal sensory dimension? *Psychonomic Bulletin & Review, 31,* 1915–1933. https://doi.org/10.3758/s13423-023-02447-3

Stern, D. N. (1974). The goal and structure of mother-infant play. *Journal of the American Academy of Child Psychiatry, 13*(3), 402–421. https://doi.org/10.1016/S0002-7138(09)61348-0

Stern, D. N. (1985). *The interpersonal world of the infant: A view from psychoanalysis and developmental psychology.* Basic Books.

Stevanovic, M., & Peräkylä, A. (2015). Experience sharing, emotional reciprocity, and turn-taking. *Frontiers in Psychology, 6,* Article 450. https://doi.org/10.3389/fpsyg.2015.00450

Sundqvist, A.-S., Wahlqvist, M., Anderzén-Carlsson, A., & Olsson, E. (2023). Interventions for children with deafblindness – an integrative review. *Child: Care, Health and Development, 49*(3), 407–430. https://doi.org/10.1111/cch.13060

Tadić, V., Pring, L., & Dale, N. (2010). Are language and social communication intact in children with congenital visual impairment at school age? *Journal of Child Psychology and Psychiatry, 51*(6), 696–705. https://doi.org/10.1111/j.1469-7610.2009.02200.x

Teoh, L. J., Solebo, A. L., & Rahi, J. S. (2021). Visual impairment, severe visual impairment, and blindness in children in Britain (BCVIS2): A national observational study. *The Lancet Child & Adolescent Health, 5*(3), 190–200. https://doi.org/10.1016/S2352-4642(20)30366-7

Terveyden ja hyvinvoinnin laitos. (2011). *Tautiluokitus ICD-10.* Suomalainen 3. uudistettu painos Maailman terveysjärjestön (WHO) luokituksesta ICD-10. https://urn.fi/URN:NBN:fi-fe201205085423

Trevarthen, C. (1974). Conversations with a two-month old. *New Scientist, 2* May, 230–235.

Trevarthen, C. (1979). Communication and cooperation in early infancy: A description of primary intersubjectivity. In M. Bullowa (Ed.), *Before speech: The beginning of interpersonal communication* (pp. 321–347). Cambridge University Press.

Trevarthen, C. (1980). The foundations of intersubjectivity: Development of interpersonal and cooperative understanding in infants. In D. R. Olson (Ed.), *The social foundations of language and thought. Essays in honor of Jerome S. Bruner* (pp. 316–342). W. W. Norton & Company.

Trevarthen, C., & Hubley, P. (1978). Secondary intersubjectivity: Confidence, confiding and acts of meaning in the first year. In A. Lock (Ed.), *Action, gesture and symbol: The emergence of language* (pp. 183–229). Academic Press.

Tröster, H. (2001). Sources of stress in mothers of young children with visual impairments. *Journal of Visual Impairment & Blindness, 95*(10), 623–637. https://doi.org/10.1177/0145482X0109501005

Tuomi, E., Kykyri, V.-L., Aro, T., & Laitila, A. (2021). Cognition in interaction: Challenges in assessing persons with sensory and multiple disabilities. *Journal of Deafblind Studies on Communication, 7*(1), 4–22. https://doi.org/10.21827/jdbsc.7.38208

Tuomi, E., & Lahtinen, R. (2019). Bilingual Santeri - Switching between languages. In M. Creutz, E. Melin, C. Lindström, K. S. Brede, & Buelund Selling, H. (Eds). *If you can see it, you can support it: A book on tactile language* (pp. 163–169). Nordic Welfare Centre.

United Nations. (1989, November). *Convention on the rights of the child.* https://www.unicef.org/child-rights-convention

United Nations. (2007). *Convention on the rights of persons with disabilities.* https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-persons-disabilities

Urqueta Alfaro, A., Vacaru, S., Wittich, W., & Sterkenburg, P. S. (2021). Identifying when children with visual impairment share attention: A novel protocol and the impact of visual acuity. *Infant Behavior and Development, 64,* Article 101585. https://doi.org/10.1016/j.infbeh.2021.101585

Urwin, C. (1978). The development of communication between blind infants and their parents. In A. Lock (Ed.), *Action, gesture and symbol: The emergence of language* (pp. 79–108). Academic Press.

Van keer, I., Colla, S., Van Leeuwen, K., Vlaskamp, C., Ceulemans, E., Hoppenbrouwers, K., Desoete, A., & Maes, B. (2017). Exploring parental behavior and child interactive engagement: A study on children with a significant cognitive and motor developmental delay. *Research in Developmental Disabilities, 64,* 131–142. https://doi.org/10.1016/j.ridd.2017.04.002

Vege, G., & Nafstad, A. (2022). Personal storytelling with deafblind individuals. In N. Grove (Ed.), *Storytelling, special needs and disabilities: Practical approaches for children and adults* (2nd ed. pp., 168–175). Routledge.

Vervloed, M. P. J., van Dijk, R. J. M., Knoors, H., & van Dijk, J. P. M. (2006). Interaction between the teacher and the congenitally deafblind child. *American Annals of the Deaf, 151*(3), 336–344. https://doi.org/10.1353/aad.2006.0040

Vierijärvi, H. (1999). *Vierusparien ja toimintajaksojen rakentaminen yhteistyönä äidin ja vauvan varhaisessa vuorovaikutuksessa* [Co-constructing adjacency pairs and action sequences in early mother-child interaction] [Unpublished master's thesis]. University of Helsinki.

von Tetzchner, S., & Martinsen, H. (1999). *Johdatus puhetta tukevaan ja korvaavaan kommunikointiin.* Kehitysvammaliitto.

Vonen, A. M., & Nafstad, A. (1999). The concept of natural language: What does this mean for congenitally deafblind people? In M. Daelman, A. Nafstad, I. Rødbroe, J. Souriau, & A. Visser (Eds.), *The emergence of communication - part II* (pp. 115–128). Centre National du Suresnes.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Harvard University Press.

Våpenstad, E. V., & Bakkenget, B. (2021). Pre-verbal children's participation in a new key. How intersubjectivity can contribute to understanding and implementation of child rights in early childhood. *Frontiers in Psychology, 12,* Article 668015. https://doi.org/10.3389/fpsyg.2021.668015

Warnicke, C., Schönström, K., Holmer, E., & Plejert, C. (2024). Co-construction of orientation in time and activities between an individual with deafblindness and support persons. *Scandinavian Journal of Disability Research, 26*(1), 620–634. https://doi.org/10.16993/sjdr.1146

Wildt, E., & Rohlfing, K. J. (2024). The impact of maternal gaze responsiveness on infants' gaze following and later vocabulary development. *Infant Behavior and Development, 74,* Article 101917. https://doi.org/10.1016/j.infbeh.2023.101917

Wilkinson, K. M., Elko, L. R., Elko, E., McCarty, T. V., Sowers, D. J., Blackstone, S., & Roman-Lantzy, C. (2023). An evidence-based approach to augmentative and alternative communication design for individuals with cortical visual impairment. *American Journal of Speech-Language Pathology, 32*(5), 1939–1960. https://doi.org/10.1044/2023_AJSLP-22-00397

Williams, K., Jacoby, P., Whitehouse, A., Kim, R., Epstein, A., Murphy, N., Reid, S., Leonard, H., Reddihough, D., & Downs, J. (2020). Functioning, participation, and quality of life in children with intellectual disability: An observational study. *Developmental Medicine & Child Neurology, 63*(1), 89–96. https://doi.org/10.1111/dmcn.14657

Winnicott, D. W. (2003). Mirror-role of mother and family in child development. In J. Raphael-Leff (Ed.), *Parent-infant psychodynamics: Wild things, mirrors and ghosts* (pp. 18–24). Whurr Publishers.

Wolthuis, K., Bol, G. W., Minnaert, A., & Janssen, M. J. (2019). Communication development from an intersubjective perspective: Exploring the use of a layered communication model to describe communication development in students with congenital deafblindness. *Journal of Communication Disorders, 80,* 35–51. https://doi.org/10.1016/j.jcomdis.2019.04.001

World Health Organization. (2013a). *Universal eye health: A global action plan 2014–2019.* https://www.who.int/publications/i/item/universal-eye-health-a-global-action-plan-2014-2019

World Health Organization. (2013b, October). *How to use the ICF: A practical manual for using the International Classification of Functioning, Disability and Health (ICF).* https://www.who.int/publications/m/item/how-to-use-the-icf---a-practical-manual-for-using-the-international-classification-of-functioning-disability-and-health

World Health Organization. (2021). *World report on hearing.* https://www.who.int/publications/i/item/9789240020481

Yin, R. K. (2014). *Case study research: Design and methods* (5th ed.). SAGE Publications.

Yoder, P. J., & Warren, S. F. (1998). Maternal responsivity predicts the prelinguistic communication intervention that facilitates generalized intentional communication. *Journal of Speech, Language, and Hearing Research, 41*(5), 1207–1219. https://doi.org/10.1044/jslhr.4105.1207

Zeng, F.-G., & Djalilian, H. (2010). Hearing impairment. In C. J. Plack (Ed.), *Oxford handbook of auditory science: Hearing* (pp. 325–348). Oxford University Press.

Appendix

Multimodal Transcript Conventions

The following conventions were developed by Lorenza Mondada (2018, 2022).

* *	Descriptions of embodied actions are delimited between
+ +	two identical symbols (one symbol per participant and per type of action) that are synchronized with correspondent stretches of talk or time indications.
*--->	The action described continues across subsequent lines
--->*	until the same symbol is reached.
>>	The action described begins before the excerpt's beginning.
--->>	The action described continues after the excerpt's end.
.....	Action's preparation
----	Action's apex is reached and maintained.
,,,,,	Action's retraction
the	Participant doing the embodied action is identified in small caps in the margin.
fig	The exact moment at which a screen shot has been taken
#	is indicated with a sign (#) showing its position within the turn/a time measure.
((sighs))	Transcriber's descriptions
Other	
[	Beginning of overlap
]	End of overlap
.hh	Inbreath
(0.5)	A pause and its duration in tenths of seconds
(.)	Micropause (less than 0.2 s)
°yes°	A silently pronounced word
mu:	A stretch (a colon indicates lengthening of a sound)
mum-	A cut-off word
MOVES	Bodily-tactile actions are described in capital letters.
MAGPIE	Sign or gesture
/Voi että/	The children's smiling is indicated below their bodily-tactile actions, and
/*smiles*--/	the corresponding time during their mothers' speech is marked with a slash until the end of the smiling.

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