NICOLAUS COPERNICUS
UNIVERSITY
IN TORUŃ

Mind the gap!
Sign function emergence in the second year of life and beyond.

Uwaga na znaki!
Wyłanianie się funkcji znaku językowego u dzieci pomiędzy drugim a trzecim rokiem życia.

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Introduction

1. Child development

Child development is marked by profound changes in experience. Toddlers gain knowledge about the surrounding world by exploring their environment using different perceptual modalities (Frank et al., 2009). They get to know themselves and others by means of social interaction, relying on early communicative skills such as joint attention (Tomasello, 2005). When they approach their first year of life, they begin to understand the function of communicative intentions and exercise imitation skills in an increasingly active way (Zlatev, 2007, 2013). Such developments enable children to learn from social situations and acquire the understanding of how communication works.

Social and communicative expertise in the first years of life manifests itself in the development and use of children's language and accompanying semiotic systems: gesture, depiction or music, and combinations of these systems into polysemiotic and multimodal communication (Zlatev, 2019). Research shows that multimodal communication stimulates the brain of an infant and facilitates her social and linguistic development (Sullivan & Horowitz, 1983; Tanaka et al., 2018; Dressman, 2019). A key development occurs in the second year of life: it is the emergence of the sign function. The sign function implies the ability to understand that a particular expression, in speech, gesture, or drawing, represents (or stands for) a certain kind of object (Lenninger, 2016). It is key to the growth of other social skills of toddlers (Piaget, 1962), helps them communicate with others about the world, and provides conscious understanding and use of gathered knowledge (Zlatev, 2009).

Research in gesture is particularly informative about the cognitive skills of toddlers. Producing gestures alongside speech during an interaction helps children learn new items of vocabulary (Iverson et al., 1994; Clark & Estigarribia, 2011; Özçalışkan & Dimitrova, 2013; Novack & Goldin-Meadow, 2015), follow verbal information (Dargue et al., 2019), orchestrate attention mechanisms (Tomasello et al., 2007; Igualada et al., 2015; Wakefield et al., 2018), and lower cognitive load while performing a task (Ping & Goldin-Meadow, 2010). Speech–gesture combinations facilitate problem solving (Broaders et al., 2007; Gordon et al.,

2021), comprehension of instructions (Behne et al., 2014), and understanding abstract concepts (Goldin-Meadow et al., 2001).

Experimental research covers different periods of a child's life. When working with infants, researchers have been mostly interested in their use of pointing mechanisms in prelinguistic communication and around the age of one (Tomasello et al., 2007; Liszkowski et al., 2012), as well as speech–gesture combinations in the one-word stage (Morford & Goldin-Meadow, 1992; Özçalışkan & Goldin-Meadow, 2009), and when children use more complex structures (Capirci et al., 2005; Murillo et al., 2015). Research shows that "[i]conic hand gestures that accompany talk may communicate important semantic information" (Beattie & Shovelton, 2002: 179) to our interlocutor, especially when that interlocutor is a toddler. Some research suggests that toddlers produce pronounced iconic gestures only around their third year of life (Namy et al., 2004; Özçalıskan, 2014), which may be linked to pretend play they engage in increasingly after the age of two. Others argue that at least some iconic gestures appear much earlier, along with the sign function (Andrén, 2010; Zlatev, 2014).

The change in the function of signs in different semiotic systems in the first years of a child's life has not been examined in typically developing populations in great detail. In contrast, it is very common to look at gestures and speech in atypically developing children. For example, the most widely used academic search engine Google Scholar returns more than 50,000 publications when we type: "autism", "gesture", "children"' (three most fitting results: Anzulewicz et al., 2016; Hubbard et al., 2012), and 14,000 publications when we type" "typically developing", "children", "gesture"' (three most fitting results: Luke et al., 2020; Demir et al., 2014; Sinani et al., 2011). However, the latter query does not necessarily return papers on typically developing children, as the phrases are often used to introduce comparison. Research in speech and gesture development is crucial to our understanding of language and communication mechanisms that lie at the basis of social interaction. Looking at typical and atypical development lends perspectives on both the interplay between speech and gesture in social situations, and the ways speech and gesture influence one another in language development.

Iconic gestures, due to their ability to represent characteristics of referents such as shape or motion pattern (McNeill, 1992), are shown to be cognitively demanding and hence spark interest of many projects, this one included. Some researchers argue that comprehension of features of an object encoded in an iconic gesture follows rather than precedes speech development (Tolar et al., 2008; Ozcaliskan et al., 2015; Cartmill et al., 2017), unlike the comprehension of deictic gestures, which are already present in pre-linguistic children (Matthews et al., 2012). The so-called enacting (or imagined-object perspective) gestures, where the body of an object maps to a body in the represented event (e.g., holding a real phone and holding an imagined phone, action-related), appear to be produced before embodying (or body-part-as-object perspective, property-related) gestures, where the hand takes the place of an object (e.g., the hand becomes the phone) (Zlatev, 2014).

Representational play may testify to the internalization of sensorimotor knowledge as conceptual knowledge (McCune, 1995). It starts to flourish in the middle of the second year of a child's life, when she begins to pretend that certain objects (such as toys or body parts) represent other objects (Zlatev & McCune, 2014). This skill may be characterized as a form of "bodily mimesis": "the ability to produce conscious, self-initiated, representational acts that are intentional but not linguistic" (Donald, 1991: 168; Zlatev, 2008). Given that only in the third year of life children appear to be capable of utilizing the sign function of pictures (DeLoache, 2004; Zlatev et al., 2013), it remains possible that language as a symbolic system serves as a contributing factor. On the other hand, it is possible that understanding the sign function emerges first through gesture, and later becomes extended to language, and beyond. Although many studies address the question of gesture use and gesture–speech interplay in language production (Alibali & Goldin-Meadow, 1993; Iverson & Goldin-Meadow, 2005; Özçalışkan & Dimitrova, 2013), and show how children use and infer information from different semiotic systems (Tolar et al., 2008; Broaders & Goldin-Meadow, 2010), a question remains: in what semiotic system does the sign function appear first? Two likely candidates are language and gesture.

2. Aim of the project

In my research, I ask questions about silent gestures. Is it possible that these isolated gestures convey messages children can interpret even though the words these gestures refer to are not yet known to them? In the thesis, I look at this phenomenon and focus on speech and two kinds of iconic gestures:

- enacting gestures, and
- representing gestures

in toddlers at the ages of:

- 24 months,
- 30 months, and
- 36 months.

The goal is to trace the process of the sign function emergence based on a forced-choice guessing game task. Communicative skills of toddlers develop rapidly when they produce two-word phrases combined with gestures, or when they are about 2 years old. This advancement in their general knowledge of language functioning may lead to changes in children's perception of gestures that accompany speech. Empirical studies show that children produce speech and gestures spontaneously, that they mimic communicative behaviours of others, and that they understand and produce gestures that aid verbal communication. However, there is not much experimental evidence on the period when the shift in the sign function likely happens: when children between the ages of 2 and 3 start to perceive isolated gestures as potentially informative components of communication.

3. Research design, research questions, and hypotheses

In my research, I combined approaches from psychology, cognitive semiotics and gesture studies. I based the design of the experiment on guessing games focused on comprehension, for example Tolar and colleagues (2008) and Hodges and colleagues (2018; Chapter 2). I recruited 30 children from 3 age groups to take part in the study. The groups were 10 children each, and the age of the children in

each group was matching 2, 2.5, and 3 years. Before the children took part in the study, I asked their parents to fill in a survey on their child developmental environment, a survey on their child social skills, and a survey on the socioeconomic status of the family. This helped me decide whether the groups are uniform. The parents were asked to sign informed consents, in which they agreed for recording interactions with their children with a camera, and GDPR statements.

The main experimental study was based on a forced-choice task. First, I selected the words the children were supposed to guess in the game. I decided that there will be two groups of words: 6 easy words –taken from the Polish adaptation of the MacArthur–Bates Language Development Inventory for children under 18 months of age, and 6 difficult words –taken from outside of the Polish Inventory. This gave me a total of 12 words the children were supposed to guess in the game in three conditions, which amounted to 36 items to guess per child.

In the experiment, I investigated whether sign comprehension, defined as the ability to match an expression given in two semiotic systems changes with age. The tested semiotic systems were: (1) speech and (2) gesture. Since I wanted to see whether enacting and representing gestures are perceived differently, I had to include them in the game. To conduct the experiment, I designed a 36-pages-long book. In each page of the book, there were four images of everyday objects, as shown in Figure 1.

A ball	**A pot**	**A window**	**A flower**

Figure 1. A model-layout of a page shown to a child in the comprehension task.

Only one picture in each page was the target (correct) one. In the game, I interchangeably: (a) said the label for the target object (speech condition), (b) performed an enacting gesture label for the target object (enacting condition), or (c) performed a representing gesture label for the target object (representing condition). The task of each child was to point to one (correct) image in each

page of the book. The total number of answers for each group was 360 – 120 per condition. The total number of answers obtained in the experiment was 1 080.

I rated the answers as correct or incorrect (1 vs. 0) and made comments on the children's behaviour, such as mimicking the behaviour of the experimenter, providing incorrect answers, and other behaviours occurring during the interaction, such as symptoms of comfort, weariness, or distraction. I analyzed the data quantitatively, to see whether the number of correct and incorrect answers changes across age groups; and qualitatively, to infer the reasoning behind the children's behaviour.

In the thesis, I ask the following research questions:

- Research question 1 (RQ1) concerns the change in the perception of iconic gestures that is linked to age:

  Does the understanding of signs produced in speech and gesture change in the transition period between the ages of 24- and 36-months?

- Research question 2 (RQ2) concerns the dynamics of change in children's understanding of iconic gestures:

  Is there a difference in children's comprehension of different types of iconic gestures? More specifically, I ask if it is easier for children to comprehend one type of gesture over the other. I also ask if the change in comprehension of iconic gestures is related to age.

- Research question 3 (RQ3) concerns children's ability to understand gestures as signs prior to children's ability to understand linguistic signs:

  Does the understanding of representational expressions in speech precede or follow the understanding of iconic gestures?

4. Outline of the dissertation

The dissertation is composed of five parts. In Chapter 1, I present the fields of linguistics, psycholinguistics, and cognitive semiotics, and outline their most important assumptions in relation to research on gesture. I also define the terms that are used throughout the thesis. In Chapter 2, I first present the background on child development that I tackle in 6-month-long intervals: from birth to the third

year of a child's life. I also present the research background of the project, which is scarce with regard to gesture comprehension in children. I discuss the gap I see in the two kinds of child development models and criticize the time periods they select to make observations on children's emerging skills and abilities in terms of language and gesture. In Chapter 3, I present the design of my study and methods used in the experiment. I outline the procedure and provide a detailed description of the groups I work with. Chapter 4 is divided into two parts: in Part 1, I present the results of the quantitative analysis of the gathered data and discuss them in the summary of Part 1; in Part 2, I present the results of the qualitative analysis of the gathered video footage and look at the behaviours the children present throughout the experimental interaction. In Conclusions, I summarize the results, I close the conceptual-empirical loop with an updated table on the semiotic development of children, describe limitations of the project, and outline future directions for research in gesture studies.

Chapter 1
Theoretical framework for an interdisciplinary research

1. Introduction

The project on the development of the sign function in three age groups of children described in this thesis is interdisciplinary in nature and takes its roots in linguistics, cognitive semiotics, and adjacent fields like psychology and cognitive science. Chapter 1 describes the fields mentioned and the definitions of the core concepts in these fields. I introduce terminology from linguistics, cognitive semiotics, and gesture studies that is used throughout the dissertation. The problem I look at in the thesis stems from the gap found in experimental projects: the underrepresentation of children between the ages of 2 and 3 years in gesture-oriented research, especially that targeting gesture comprehension. My past research was primarily connected with gesture studies; therefore, in my present investigations, I stress the importance of this nonverbal tool of communication. To expand our knowledge of language acquisition and the sign function emergence—the concepts I define in the present chapter – I pose questions about the comprehension of iconic gestures in early language development.

My research is predominantly concerned with the children's ability to recognize various signs as meaning carriers. I do not comment on the trajectories of language evolution in modern gesture studies. Neither do I focus on comparison of iconic gestures and iconic signs of sign languages, even though I think they are remarkably informative to the field of linguistics. I focus on the question whether manual gestures are tools of the sign function emergence. Additionally, in this chapter, I look at the framework thematically, not historically. Therefore, I do not trace or outline the history of different disciplines in detail.

2. Language and linguistics

Linguistics is the scientific study of language: its use, evolution, development and structure (Sapir, 1929; Bloomfield, 1930; Whorf, 1940; Saussure, 1959 [1916]). It is both informative for and develops because of such fields as anthropology, culture history, sociology, psychology, philosophy, anatomy, or physiology (Sapir, 1929: 209). Its scientific stand depends on the research perspective one

adopts: it may equally belong to natural sciences and social sciences (Sapir, 1929: 213). The areas of linguistics include:

- syntax – the study of sentence structure,
- semantics – the study of meaning,
- morphology – the study of lexical processes,
- phonetics – the study of speech sounds,
- phonology – the study of sounds in a language, and
- pragmatics – the study of language use (Levinson, 1983; Halliday & Webster, 2003; Allan, 2015; Yule, 2016).

Even though the core of linguistics is often thought to be primarily descriptive (Stern, 1983; Robins, 2014: 8), there are numerous sub-fields of linguistics that increasingly focus on the quantitative approach, gathering and evaluating data relating to linguistic phenomena (Sigurd et al., 2004; Zlatev & Andrén, 2009; Bentz & Winter, 2013; Ferretti et al., 2018; Placiński, 2019; Adornetti et al., 2022; Matzinger et al., 2022; Sibierska et al., 2022). The areas of interest to the present thesis are, in particular, experimental linguistics (Davies & Elder, 2004; Hemforth, 2013) and psycholinguistics (Chapter 1; Jodai, 2011; Nordquist, 2019).

A specific language can be the object of linguistic enquiry (Sapir, 1929; Saussure, 1959; Martinet, 1960; Bauer, 2007; Agha, 2007), but linguistics is much more than that. John Lyons suggests that asking "What is language?" is similar to asking "What is life?" (1981: 1), meaning that it is both an empirical and a philosophical question. To a linguist, who is preoccupied with a scientific enquiry into the emergence, evolution, and development of this outstanding human tool and ability, "What is language?" is a question orchestrating her research. "Language" is a rich and dynamic concept that should be investigated from many different perspectives. If we look at language from a biological perspective, it appears as a number of complex, simultaneous processes of the human body and the brain (Lamb, 1998: 3). It can also be called a form of "motor behaviour", as our language apparatuses, be it lips, tongue, larynx, face, or hands, can produce linguistic signs only when set in motion (Poizner & Keg, 1992: 219; Emmorey, 2001; Downey & Rapport, 2012). Such definitions are correct, and

will be useful later on, but, overall, they are insufficient with respect to the scope of the thesis.

We need something broad that could be used to study the interaction between language and gesture. Kendon writes that language is "a vehicle for highly 'detachable' messages" (1981: 4). Edward Sapir's definition narrows down the idea: "[l]anguage is primarily a cultural or social product and must be understood as such" (1929: 214). Language is used by people for communication, and, developed by means of acquisition, is bound to social experiences and interactions (Vygotsky, 1962; Ochs & Schieffelin, 2001). But language, apart from being characterized as a social phenomenon, has a composition of its own. For some linguists, "language" equals "speech". In *Language: An Introduction to the study of speech*, Edward Sapir writes:

> Language is a purely human and noninstinctive method of communicating ideas, emotions, and desires by means of a system of voluntarily produced symbols. These symbols are, in the first instance, auditory and they are produced by the so-called "organs of speech". (2004: 5)

A definition of language in a similar tone comes from Leonard Bloomfield, who writes that language is "the situation in which the speaker utters it and the response which it calls forth in the hearer" (Bloomfield, 1933: 139). Such definitions were formulated at the time when sign languages were still not considered as true natural languages, and contributed to the view known as "oralism" – the assumption that spoken language should be taught regardless of the predispositions of its users (Branson & Miller, 1993; Figiel, 2009; Ruta & Wrześniewska-Pietrzak, 2014). Currently, signed languages are recognized as fully fledged languages whose users have their own accents, dialects, and cultures, and are receiving a rapidly increasing amount of attention in descriptive and experimental research (Maher, 1996; Stokoe, 2001; Fox, 2008; Marschark & Spencer, 2010; Pfau, 2012; Shea, 2017; Quer et al., 2021)[1].

Ferdinand de Saussure made the famous distinction between *langue* (the system of signs and their relations in a given language) and *parole* (the use of this

[1] When we type "sign language research" in Google Scholar search engine, it returns almost 6 million positions recorded after the year 2010 alone.

system in communication) (Saussure, 1959 [1916]: 77). The combination of the two is *langage:* all language-related phenomena, and the underlying ability to acquire and produce language. Saussure explains *langue* as follows:

> Language (*langue)* is a system of signs that express ideas, and is therefore comparable to a system of writing, the alphabet of deaf-mutes, symbolic rites, polite formulas, military signals, etc. But it is the most important of all these systems. (1956 [1916]: 16)

This is consistent with the definition by Humberto Maturana, who writes that "language is now used to refer to any conventional system of symbols used in communication" (1978: 55). Thus, I arrive at the definition of language used in the thesis: *language is a conventional system of signs that express ideas, which is used for communication*. Such a definition is well-suited for the purpose of a project that looks at the interaction between language (realized as speech) and gesture in child development.

3. Communication and languaging

The origin of the term "communication" has its roots in the Latin word *communis* – "common"; therefore, "to communicate" can be translated as "to make [something] common" or "to make [something] known" (Valentzas & Broni, 2014: 1). Communication can be instantaneous or stretched out in time (Valentzas & Broni, 2014). There are several components for a communicative act to take place: we need a sender of information, a message, and a receiver of that message (Shannon & Weaver, 1949; Strawson, 1964; Austin, 1975; Ingber, 1982; Stott, 2011; Laningan, 2012: 9–12; Witczak-Plisiecka, 2013; Garvey, 2014: 28). The outcome of a communicative act should cause a change in the environment or in the receiver of the message (Wilson, 1975; Hailman, 1977; Krebs & Davies, 1993: 349). Communication can be defined as an intentional process of information exchange, be it knowledge, ideas or feelings, between or among individuals (Leagans, 1961; Mehrabian, 1972; Akhtar & Martínez-Sussmann, 2007). Communication can happen by means of can be verbal, written, pictorial, manual, or computer-mediated messages, and is performed with the use of a system of signs, some of which belong to language, as defined

above. The signs of gestures and pictures, however, are not predominantly conventional, and are hence constitute distinct semiotic systems (Zlatev, 2019).

In his writings on language and communication, Karl Bühler defined a particular notion of "sign". To Bühler, a sign is a carrier of meaning (Bühler, 1990 [1934]), and therefore is central to an act of language use[2]. The "Objects" and "States of Affairs", included in Bühler's model, are what the sign represents (or denotes, Witczak-Plisiecka, 2013: 27). Bühler proposes the model for a language act which represents the relation between the sender, receiver, and the linguistic sign, the core elements of communication with the use of which a message is transferred (Witczak-Plisiecka, 2013: 27–28). The model (Figure 2 below) is comprised of three core components: a) the expression (the intention of the sender), b) the representation (what is being denoted, as noted above), and c) the appeal (the interpretation of the audience) (Bühler, 1990 [1934]).

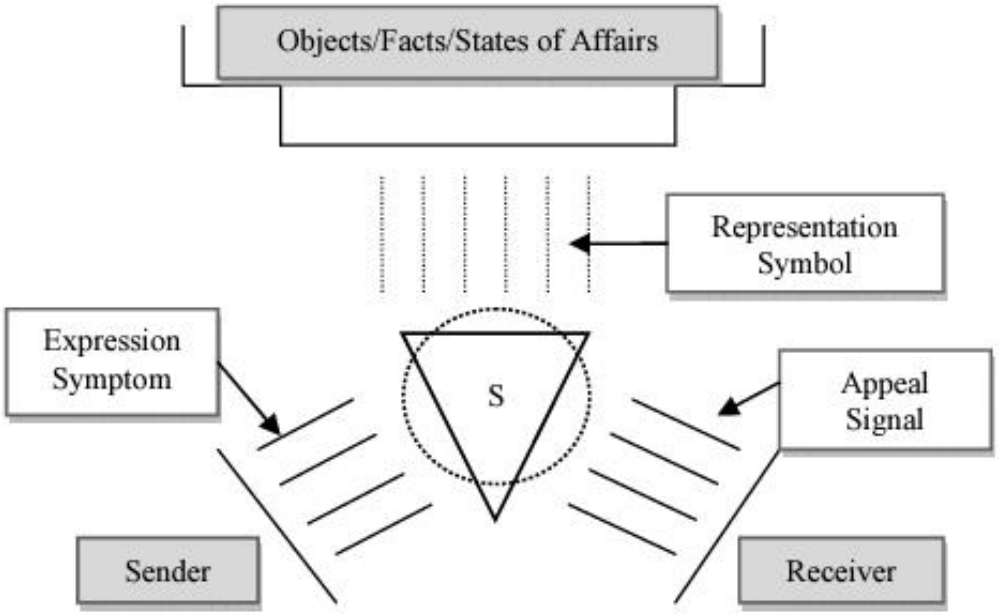


Figure 2. Bühler's "Organon Modell" for language (1990 [1934]: 28).

Language acts, intertwined with our social functioning, enable us to practice sign use and lead to language development. The signs of language

[2] Bühler (1990 [1934]) writes about "speech acts"; however, as we have seen, language use is not based on speech alone, as it can be also written or signed. Therefore, I decided to use the term "language act" to remove the focus on vocal language.

involve different sensory modalities (e.g. vision and hearing) as well as "modes" (or semiotic systems). Wei (2018) comments on the sense-related characteristics of human communication:

> Human communication has always been multimodal; people use textual, aural, linguistic, spatial, and visual resources, or modes, to construct and interpret messages. In specific communities, a primary mode may be especially featured; for instance, in the Deaf community, sign language may feature more prominently than other modes of communication, though bimodal bilingualism in both oral and sign languages can also be common. (2018: 21)

Thus, human communication involves both language and other semiotic systems, which we can perceive through various senses in various modalities (Zlatev et al., 2020). We develop the ability to put these systems and modalities together and thus to create and interpret meaning. This is a key, human-specific skill. The way to achieve this skill is through experience with objects and individuals in the world and conscious understanding of signs (see Chapter 2).

To draw attention not just the system of language but its dynamic use, a number of researchers have adopted the term "languaging", defining it as "a form of whole-body behaviour or whole-body sense-making" (Thibault, 2011: 75) that has its roots in "embodied cognition" (Varela et al., 1991; for a discussion, see: Ziemke et al., 2007; Zlatev, 2007: 297–338). Embodied cognition emerges from the interaction of the brain, the body, and the world; in the same tone, enactivists state that we obtain knowledge through the interaction of perception and environment (Varela et al., 1991). The term "languaging" was coined by Humberto Maturana to describe the human condition of existing in and with language; it promotes looking at the process of using language to communicate and make meaning in social interactions (Maturana & Varela, 1987). The notion is rooted in the dynamic nature of interaction: the possibility of coordinating behaviours by means of language use and the ability to learn based on experiences of perception (Maturana, 2000; Maturana & Poerksen, 2011). From this perspective, language development happens because we learn to perceive different phenomena in distinctive ways, and we label them based on our experience.

> The fundamental operation that an observer can perform is an operation of distinction, the specification of an entity by operationally cleaving it from a background. Furthermore, that which results from an operation of distinction and can thus be distinguished, is a thing with the properties that the operation of distinction specifies, and which exists in the space that these properties establish. (Maturana, 1978: 55)

This observation can be extended to language acquisition in children. When children learn to communicate, they observe the use of language, and practice it with a trial-and-error approach. Based on the outcome of these practices, they are able to differentiate between linguistic items, objects, or situations, even though the comprehension of the meaning behind them is highly idiosyncratic. Drawing Koffka's (1925: 666) examples, Vigneaux (2019) writes:

> [...] imagine a child who touches the flame of a candle and exclaims "ouch!" as they swiftly retract their finger. What was once distinguished as an attractive, enchanting sight is now distinguished as a dangerous source of harm and pain. Suddenly, the candle is brought forth in a new way by the child. Tied to this distinction, moving forward the child is no longer attracted to the candle and refrains from placing their finger in it again. (2019: online)

The example can be transferred beyond language to the use of gestures as meaning-carriers in communication seen daily in interaction with children: children copy behaviours of others, and, initially, they do so unconsciously (see Chapter 2). For example, they mimic deictic gestures seen in others early on. At some point, children observe a change in behaviours of others when they perform these gestures, and from that point onwards, they start to understand the role of pointing and other gestures in communication. Such a conscious understanding of a sign is impossible to reverse (Tomasello, 2009: 202). We can adapt Vigneaux's example, and state that: "[s]uddenly, the [gesture] is brought forth in a new way by the child. Tied to this distinction, moving forward the child is no longer [oblivious to the meaning of the gesture] and [understands that it is used as a sign]" (2019: online).

4. Nonverbal communication and gesture studies

4.1. Background

Darwin writes that nonverbal communication (NVC) can be defined as "the movements of expression in the face and body the purpose of which is to give vividness and energy to our spoken words" (1872: 365). Matsumoto and Hwang exclude speech from the definition, and state that "[a nonverbal act is] the transfer and exchange of messages in any and all modalities that do not involve words", which is controlled less than verbal communication (2012: 146). Thus, in addition to language, nonverbal communication is an important, universal aspect of human interaction. Scholars studying nonverbal communication are interested in (1) describing the role of non-referential content of what is said in "establishing and maintaining interaction and interpersonal relationship", (2) looking at the effect nonverbal behaviours have on communication, and (3) studying how messages are inferred from phenomena other than speech in a communicative act (Kendon et al., 1981: 3–4). The formulation of the notion of nonverbal communication in the 20th century and its examination in research since then have broadened scholarly perspective on various aspects of human communication. However, a disadvantage of the notion was that it divided communication into "words and everything else [...] that is not verbal" (Kendon, 2007: 27). Scientific enquiry into nonverbal acts encompasses elements such as body postures or distance in communication (Hall, 1982), turn-taking (Żywiczyński et al., 2017), politeness (Trees & Manusov, 1998), facial expression and gaze patterns (Kleinke, 1986), as well as gestures – be it conscious and language-related gestures (Kendon et al., 2010) or unconscious expressions of emotion (Ekman & Freisen, 1969; for aspects of research in nonverbal communication, see: Kendon et al., 1981).

Gestures constitute a significant part of nonverbal communication (Kendon, 1972; Kendon, 2007) and are distinct from signed language (Stokoe, 1960). For some scholars, they are also distinct from nonverbal communication (McNeill, 1985, 1992: 23–24). One difference between the fields of NVC and gesture is that nonverbal communication research is concerned with behaviour, while gesture studies are primarily concerned with their relation to language (Kendon, 2007: 22). The idea of gestures was of interest to psycholinguistics from the beginning, as it provided a window into thought, language acquisition, and language-related cognitive processes (McNeill, 1992: 13, 2000). However, McNeill's primary focus are gestures that happen in close synchrony with speech,

and that have potential to augment what is being said. In contrast to his approach, I do not look at gestures as bound to speech in my approach. Rather, I study how iconic gestures (see below) are comprehended without speech by means of experiment (see Chapter 3).

Leonard Bloomfield writes that "gesture accompanies speech" (1933: 39); but a somewhat contrary perspective states that "language is embedded in gesture" (Bolinger, 1975: 18). Ekman and Friesen provide the examples of language–gesture interplay: (1) when we substitute speech with a gesture, for example when waving hello; (2) when we reinforce our spoken words with gestures, for example a child saying "big" and spreading out her arms; or (3) when we stress particular elements of an utterance and use rhythmical beating of hands alongside speech (1969: 53–56). Another aspect that testifies to language–gesture interplay comes from the results of cognitive experiments that link gesture and lexical retrieval processes (Krauss, 1998; Kita et al., 2007; Kandana et al., 2021). Even stronger evidence can be found in research on language aphasia (Bernardis & Gentilucci, 2006; Dipper et al., 2015), which shows that when language falls apart due to lesion, gestures are also affected (Özyürek & Spencer, 2007; Green et al., 2009). The research interest in language and gesture, or gesture alone, became so rich with theory and ideas, and so inspiring to other fields that it required a field of its own.

The area of gesture studies rose to an interdisciplinary field established officially in 2002 (International Society for Gesture Studies, ISGS). It investigates the nature and function of gestures, including their relationship to cognition and culture, as well as at the ways in which gestures are used in correspondence to language to convey meaning, express emotions, and establish social relationships. It views gesture from various perspectives: from linguistics to neuroscience or computer science (Mühlau et al., 2005; Parton, 2006), and its research outcomes have implications for a selection of fields, including education (Goldin-Meadow et al., 2009), human-computer interaction (Papastratis et al., 2021), or communication disorders (Rose et al., 2013). More recently, with Gordon Hewes' (1974) inspiring contribution viewing gestures as the original human-specific semiotic system, gesture studies have taken an evolutionary trajectory (Armstrong et al., 1995; Corballis, 2002). Currently, a body of publications discusses the role of gestures in language origins (for a review, see:

Żywiczyński & Wacewicz, 2015), but there are also those examining the potential similarities between child language development and the emergence of language in our ancestors (Gullberg & De Bot, 2010; see also: protolanguage in Arbib, 2005).

The "first student of modern gesture studies", a gesture analysis expert, David Efron, used silent video-recordings as well as his own notes to describe how speech and gestures create meaning in human interaction (Kendon, 2007: 21). But the explosion of modern gesture enquiry is more often traced back to Chomsky's (1965) provocative idea of Language Acquisition Device (LAD) that made language development scholars record interaction with children for the purpose of sentence structure analysis (Kendon, 2007). In consequence, researchers interested in nonverbal communication started to observe and describe the relation between gestures of children and the words they utter (Bates et al., 1979). Gesture analysis, even though automatized nowadays by recognition techniques based on Artificial Intelligence (AI) such as Motion Capture (Namboodiripad et al., 2016), are by-and-large done by the traditional means of description and annotation by expert judges (Efron, 1941; Sowińska & Boruta, 2020; Sibierska et al., 2022; Ienaga et al., 2022), as done in Chapter 4 of the dissertation.

4.2. What kinds of gestures are there?

4.2.1. Selected classifications

Kendon claims that gestures are "so intimately connected with the activity of speaking that we cannot say that one is dependent upon the other" (Kendon, 1980: 208), but rather "speakers employed gestures in a way that suggested that the two modes of expression were integrated from the beginning" (Kendon, 2007: 25). Gestures are "vehicles for the expression of thoughts and so participate in the task of language" (Kendon, 2007: 26). They can accompany speech as unintentional information (see "adaptors" in: Ekman & Friesen, 1969), but they can be self-standing and used instead of words by people who share the same cultural background (see "emblems" in: Ekman, 1999), and then produced intentionally. Gestures can take the form of body movements (see "pantomime" in: Żywiczyński et al., 2018), facial expressions, and hand signals that are

"coordinated [and] achieve some [communicative] end" (Studdert-Kennedy, 1987: 52). If we link gestures to thought processes, we can, following Cornelia Müller, call them the tools of "visual and manual thinking" (2013: 1687).

There are several typologies used primarily in research and analysis of gestures (Boruta, 2017). For the purpose of this thesis, I enumerate and describe only those gesture classes that were crucial to the project. The typologies differ with regard to the level of intentionality of the signals created by the users of gestures. Adaptors are one such example (Ekman & Friesen8 1969: 70–82). These gestures reveal affect and are difficult to control. Examples of adaptors include scratching or cracking knuckles while in stress. They are highly idiosyncratic and non-cultural, and can be body-focused and object-focused, as in playing with an external object or objects, such as a pencil (Ekman, 1999: 43). A very different kind of gestures are emblems (Ekman, 1999: 39–41): gestures that have fixed meanings, unlike the previously described class, and can be used as word-substitutes within a culture (e.g., "OK" emblematic gesture of a thumb up). Kendon writes that emblems are used for "interpersonal control, announcement of one's current state or condition, and evaluate descriptions of the actions or appearances of another" (2004: 339).

According to Kita, there are two classes of representational gestures (2000: 162). David McNeill described them as co-speech gestures: iconic gestures, whose meaning is based on the resemblance between the form of the gesture and its reference (1992: 12–14), and deictic gestures (1992: 18), whose meaning is based on contiguity and or vectoriality between the gesture and its object (Sonesson, 1996: 136; Cienki, 2013: 670–672). Thus, deictic gestures can be related to objects in direct proximity of the speaker, but also indicate abstract phenomena such as time or ideas. Müller (2014: 1689), distinguishes iconic gestures in terms of "modes of representation" or "modes of mimesis" (Cienki, 2013: 671; Zlatev, 2005: 317). Müller's classification proposal distinguishes:

A) Molding that depicts the 3D features of an object;

B) Drawing (tracing) that reduces the object to its frames: we delineate the object in the air with the use of fingers or hands; Brown et al (2019) adds that tracing can either be static or dynamic: in the former the gesture outlines the

shape and size of an object, in the latter, the gesture re-enacts the path of motion of an object.

C) Holding that indicates only a salient part of an object; and

D) Representing that shows the material quality of an object.

Müller writes that the modes of representation can be narrowed down to two core categories: (en)acting and representing (2014: 1687). These two types of gestures are tackled separately in the sections that follow.

4.2.2. Enacting gestures

Enacting gestures have to do with movement: the body of the person performing the action acts as if the action was actually being done (Zlatev et al., 2020) and looks like an "actual manual activity" (Müller, 2013: 1687). Enacting is used to indicate doing something to an entity that is not present, or re-creating emotions associated with a particular experience (Hwang et al., 2017: 4). For example, a set of enacting gestures for "driving a car" would include sitting on an invisible driver's seat, performing a twisting motion of the wrist to indicate turning the key and starting the engine, stretching both arms in front of the chest in a gesture of holding the steering wheel, and performing a movement of turning the wheel right and left, as would be done with the actual steering wheel of the car. Thus, the enacting mode is very similar to the notion of pantomime (Żywiczyński et al., 2018), and, indeed, Zlatev and colleagues (2020) define the term "pantomimic gesture" with a number of features, one of which is the dominance of the enacting mode.

4.2.3. Representing (embodying and molding) gestures

Unlike enacting gestures, which often involve using the entire body to simulate or enact a situation, representing gestures are more static and involve primarily hands and arms to stand for a particular object (denotation) and evoke it in the mind of the addressee. Representing gestures can take many forms, such as embodying the shape of an object, in which we use hands to stand for that object; or molding the shape and size of an object, in which we use hands and arms to indicate the as-if holding or tracing the sculpture of the invisible object (Müller, 2013: 1691; Zlatev et al., 2020: 166). For example, a representing gesture for a

telephone (at least in my generation) would take the form of a fist placed next to one's ear, with the pinky finger stretched downwards, and thumb stretched upwards.

4.2.4. Pointing

Pointing is special as it "has received a prominent place in Western philosophy of language as a representative of what gesturing can do in relation to speech" (Cienki, 2013: 670). It is the first gesture to emerge in pre-verbal children (Volterra, 2005; Vallotton, 2010) at around 9 month of age (Carpenter et al., 1998; Behne et al., 2012) and is performed as a finger extension towards a person or object of interest (McNeill, 1992). Pointing is complex: to understand the meaning behind this gesture, children need to understand two aspects of its use: "that a body part projects a vector towards a particular direction" and "that the communication partner has to mentally represent the direction" (Kita, 2003: 5).

Primarily, we distinguish two kinds of pointing: imperative pointing, in which a person uses others to achieve her goal, such as getting a toy; and declarative (informative) pointing, which implies a person's interest in the referent and the need to share information about that referent with others (Cochet & Vauclair, 2010; Cochet & Vauclair, 2010a; Zlatev et al., 2013). In terms of cognitive development, comprehension and use of (at least) informative pointing entails at least a basic "Theory of Mind" or intersubjectivity (Tomasello, 1999; Tomasello & Carpenter, 2007; Cienki, 2013: 670–671; Zlatev et al., 2008). Pointing is believed to be a precursor to language in ontogeny (Butterworth & Morissette, 1996; Butterworth, 2003; Colonnesi et al., 2010) and an early indicator of the development of cognitive and social abilities such as joint attention (Murphy, 1978; Franco & Butterworth, 1996). With the use of pointing, we bring objects and people to the attention of others by directing their gaze. There are other deictic gestures, such as showing an object, which achieve a similar effect by moving the object into the regard of the addressee (Andrén, 2010).

5. Psycholinguistics and language acquisition

Psycholinguistics is an interdisciplinary study that draws on insights from psychology, linguistics, and cognitive science and neuroscience to help us

understand the relationship between language and the mind, as well as the underlying cognitive processes (Blumenthal, 1987; for a review, see: Traxler & Gernsbacher, 2011)**.** Psychology of language draws on "the use of language and speech as a window to the nature and structure of the human mind" (Scovel, 1998: 4) and asks questions about: (1) speech and language acquisition, (2) speech and language production, and (3) speech and language comprehension (Scovel, 1998: 5). The research within the field examines various aspects of language, including nonverbal phenomena that facilitate language acquisition and development (Quek et al., 1999). The outcomes of psycholinguistic enquiry have practical applications in language teaching, language therapy, and the diagnosis and treatment of language disorders (Baker et al., 2001). Even though psycholinguistic enquiry has been based on standardized tools, surveys and questionnaires, as well as naturalistic and experimental observation of language development in children, language acquisition research profits greatly from new technologies and is currently increasingly interested in eye-tracking methods, neuroimaging techniques, corpus studies, and computational modelling (Gut & Wilczewski, 2016; Placiński, 2019).

Developmental psycholinguistics is a sub-field of psycholinguistics that investigates the development of language and its components in children, with a particular emphasis on the ways in which children acquire and use language. The prime interest of developmental psycholinguistics is speech. However, Thomas Scovel writes that: "[a] common mistake of students of developmental psycholinguistics was to assume that children had no language until they uttered their first word, usually about the time of their first birthday" (1998: 8). Apart from mentioning cry as a precursor to both language and speech, Scovel pays attention to gestures used by children and discusses pointing as a pre-linguistic nonverbal sign that emerges before the first words in language acquisition (1998: 28–29; Chapter 2).

Children start to acquire language in infancy, but its onset differs among individuals, and so differ the the semiotic systems they use (e.g., spoken language vs. sign language in: Mayberry & Squires, 2006; Mayberry, 2010; Swingley, 2017). It is a process by which children develop "a sign system which bears important relationships to both cognitive and social aspects of their life", and gain the ability to recognize, understand and use it in interaction with others (Flatcher

& Garman, 1986: 9). Language acquisition processes encompass a complex interplay of genetic, cognitive, social, and environmental factors (Onnis et al., 2018).

Children are born with the capacity to learn any language, but their early experiences and exposure to a sign system are crucial in determining which language or languages they will acquire (Aghabeig et al., 2019). Infants begin to acquire language by listening to, observing, and interacting with others, and gradually learn more about the structure of their language, including grammar, and vocabulary (Vygotsky, 1978). Lev Vygotsky stresses the interactive learning component of language acquisition and writes that "learning is a necessary and universal aspect of the process of developing culturally organized, specifically human psychological function" (1978: 90). With time and experience, children's language skills become sophisticated, allowing them to understand and express increasingly complex thoughts and ideas. Language acquisition and its stages are described in detail in Sections 1–3 of Chapter 2: "Sign function emergence: from theory to practice".

6. Semiotics

While linguists focus on language, semioticians are interested in all kinds of sign systems (Chandler, 2007). Semiotics is a broad research tradition interested in the examination of sign processes and meaning-making (Sonesson, 2012a, 2012b). Semioticians seek to uncover the structures and systems that govern human communication, sign formation, and creation of meaning, but they also aim to deepen our understanding of the ways in which we make sense of the world. Semiotics investigates how our understanding of signs is shaped by culture, history, and social factors (Lewis, 1991). The field covers various modalities, including auditory, visual, or tactile modality, and is not limited to language, as it looks at different semiotic systems, such as speech, gesture, depiction, and other forms of human expression (Chandler, 1994: 12). Scholars studying meaning-making processes are interested in examining phenomena that shape our understanding of the world around us by means of research and description of the relationships between signs and the objects they represent.

The notion of "sign" is central for semiotics, but there are different, and even conflicting, definitions of it (Chandler, 2007). Narrower, and language-

oriented approaches follow the tradition initiated by Saussure (1916), understanding the sign as a pairing of a signifier and a signified, both essentially mental, and with an "arbitrary" link between them. More popular are broader definitions of the sign, inspired by Charles Sanders Peirce, who defined the sign as follows:

> [a] sign, or *representamen*, is something which stands to somebody for something in some respect or capacity. It addresses somebody, that is, creates in the mind of that person an equivalent sign, or perhaps a more developed sign. The sign stands for something, its *object*. It stands for that object, not in all respects, but in reference to a sort of idea which I have sometimes called the *ground* of the representamen. (Peirce 1931–58: 2.229)

This is reminiscent of the definition of sign offered by Bühler (see above), with the object as what is being represented and what is created in the mind of the interpreter (the "appeal" for Bühler) was called by Peirce the "interpretant". According to Peirce, semiosis implies "the idea of an infinite process of interpretation" (Eco, 1984: 2) since the interpretant can be a new sign, with its own object and interpretant, and, in principle, the process can continue for ever.

The signs, or, more properly, the representamen, can be expressed and perceived in any sensory modality. The ground that relates them to their object (referent) can, according to Peirce, as interpreted by Sonesson (2012a), be of three kinds:

A. Iconic: the representamen, such as a realistic picture or iconic gesture (see above), resembles its object. This resemblance can be either very strong, as in a photograph (imagistic iconicity) or schematic, as in diagram (diagrammatic iconicity).

B. Indexical: the representamen stands in a relation of contiguity to its object. The connection can be causal, as between smoke and fire, or intentionally produced, for example by placing a marker on a container or pointing to it—to communicate to the addressee that there is a reward inside (Zlatev et al., 2013).

C. Symbolic: the link between representamen and object is based on a shared convention, that is common knowledge between communicator and addressee. The signs of language are thus properly called symbolic since they are grounded in such conventions. However, since the three semiotic grounds are not mutually exclusive (Bellucci, 2021: 174–176), symbolic signs can have degrees of iconicity and indexicality (Jakobson, 1965), and are thus not fully arbitrary.

7. Cognitive semiotics

7.1. Basic concepts

Despite its name, cognitive semiotics is not a sub-field of semiotics, but a new discipline that integrates methods and theories from cognitive science, linguistics, and semiotics (Zlatev, 2015; Zlatev et al., 2016; Konderak, 2018). Thus, it has the potential to integrate ideas from the fields reviewed in the previous sections. But to avoid eclecticism in such integration, most researchers in cognitive semiotics adopt concepts and methods from phenomenology, a school of philosophy founded by Edmund Husserl over a century ago, based on "the careful description of what appears to consciousness precisely in the manner of its appearing" (Moran, 2005: 1). In other words, everything that is meaningful for human beings, and at least some non-human animals, must be grounded in first-person, subjective experience.

A basic concept is that of intentionality, the directedness of consciousness towards the world. This implies that what appears to the mind is always subjective, but this does not make us "locked in" a mental bubble (Sokolowski, 2000), as what we experience is in fact the world itself, albeit the world of experience, called the "lifeworld" (Zlatev, 2010; Menon, 2014). In the words of Sonesson (2012b: 858), "everything, which, in the normal course of events, is available to (at least human) consciousness is present to this consciousness as something being outside of it".

Some forms of intentionality, like perception and imagination, are focally conscious. Others are only marginally conscious but can be made fully conscious when we direct our attention to them, as explained by Depraz:

> … a functional (*fungierend***)** habitual intentionality includes a part of automaticity, what Husserl calls individual *Habitualität* and collective *Sedimentierung*; but unlike what happens at the neurocomputational level, where neural processes are to be found, I have the ability to *reactivate*, as Husserl says, such an unconscious functionality so as to become aware of it. (2001: 171–172)

Zlatev and Konderak (2022) argue that the concept of intentionality and that of semiosis, understood as meaning making, and not as sign use, should be conceived of as reciprocal: while intentionality looks outward, meaning "points" back to the subject of experience herself. Importantly, there are different levels of meaning/intentionality: while functional and perceptual intentionality are direct, others are semiotically mediated, by signs or signals. Sonesson (2007) defines the sign (function) as follows:

> there is a *differentiation* between expression and content in the double sense… that they *do not go into each other in time and/or space*, and they are perceived to be *of different nature*. (Sonesson, 2007: 93, original emphasis)

This implies that if a given subject (e.g., an infant or a non-human primate) would attempt to eat a painting of an apple, he would not be seeing it as a sign, since he would be collapsing the distinctions between the expression and the content, or object, using the terminology of Peirce.

Another important distinction made by many in cognitive semiotics is that between signs and signals. Both of these semiotic elements imply non-direct intentionality, unlike perception and imagination. Both can be defined as pairings of expressions and meanings, but only signs are used to denote things, properties, or events (i.e., intentional objects). In their version of "the sign function"; Zlatev, Zywiczynski & Wacewicz, 2020: 160) propose the following definition:

> A sign <E, O> is used (produced or understood) by a subject S, if and only if: (a) S is made aware of an intentional object O by means of expression E, which can be perceived by the senses. (b) S is (or at least can be) aware of (a).

Signals, for example the link between yawn and tiredness, involve only (a) and not (b), while sign use requires both, and thus least a degree conscious awareness of this relation in both producers and receivers. This is also consistent with

Sonesson's definition cited above, since (b) guarantees that expression and object are "perceived to be of different nature."

Words, pictures, and gestures—as used by people, and some linguistically trained animals (Savage-Rumbaugh & Lewin, 1994)—thus operate as signs. Both signs and signals form systems, consisting of the signs or signals of a particular type, and their interrelations. Thus, language, gesture and depiction (i.e. picture making or interpreting) are sign systems, while (spontaneous) facial expressions, are signal systems. The latter are closed as opposed to open systems, which can be constantly extended with new signs and sign combinations (Arbib, 2005).

But while cognitive semioticians have made such distinctions, they also point out that they need to be integrated. For example, Zlatev and colleagues (in press) write:

> Human communication is very seldom *monosemiotic*, i.e., based on a single sign system, for example in practices that involve (pictureless) books, uncommented paintings, or completely silent pantomime. In fact, unless some particular genre-based constraints are imposed, human communication is as a rule *polysemiotic*: it combines fluently different semiotic systems, both sign systems and signal systems.

This implies that the combination of speech and gesture is a form of polysemiotic communication, and not just of languaging.

7.2. Phenomenological triangulation and conceptual-empirical loop

The dominant methodology used in cognitive semiotics is known as phenomenological triangulation, also called pheno-methodological triangulation (Pielli & Zlatev, 2020) or simply methodological triangulation (Zlatev, 2015) in previous research. In any case, the basic idea is the need to combine three different perspectives on the phenomenon under study: (a) the first-person perspective of the reflective researcher, (b) the second-person perspective of the empathetic observer and participant, and (c) the third-person perspective of the detached analyst. Figure 3 shows these combined in a recursive loop, with examples from the present research.

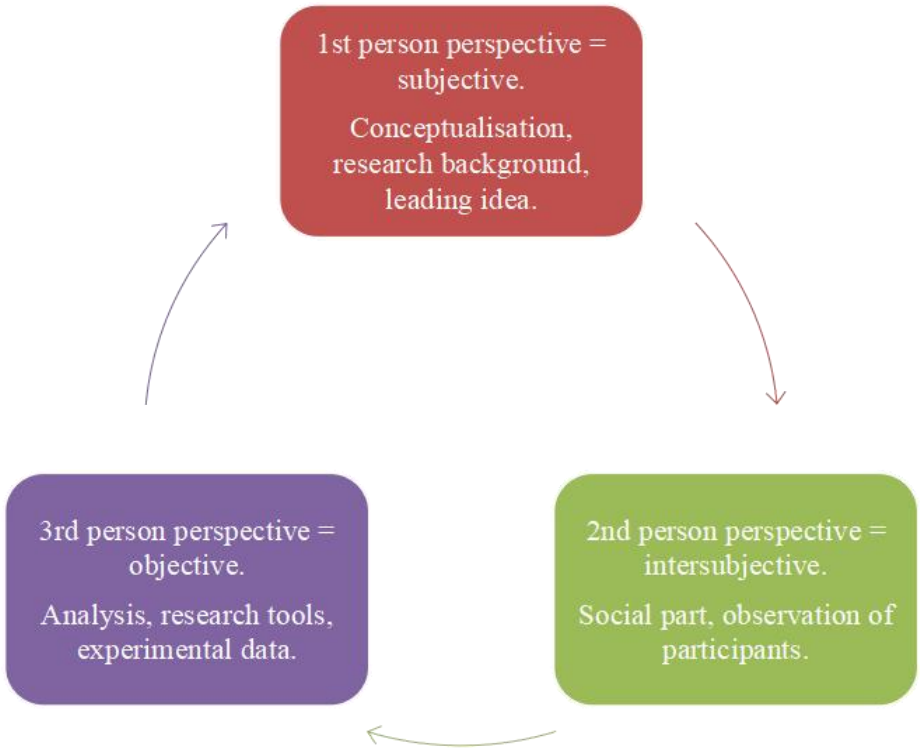


Figure 3. Methodological triangulation: a visualization and its application to the dissertation.

The structure of the theoretical and experimental work I conduct in the present project corresponds to the following aspects of this methodological principle:

A) First-person perspective: my understanding of the key concepts, based on both the literature and my personal experience as a language and gesture user; the formulation of research questions that are as clear and motivated as possible. This perspective is covered in Chapters 1–3.

B) Second-person perspective: my interaction with children and their caregivers during the experiment, efforts to make the interaction as natural and empathetic as possible. See Chapter 3.

C) Third-person perspective: the experimental design I have prepared to gather data from the participants of the research (both the parents and the children), based on the tools of psycholinguistic research such as written surveys and experimental method based on comprehension (pointing task). This perspective is also relevant to the analysis of the data gathered in the

experiment and its description with the use of selected research tools coming from qualitative and quantitative methods. See Chapter 4.

As pointed out, phenomenological triangulation is meant to be recursive: the results obtained from the analysis allow us to draw conclusions about the experiment and gather new insight about the phenomenon. This is done in the Summary of the dissertation.

The recursive nature of the investigation is reflected even more explicitly in the second methodological principle of the conceptual-empirical loop (Zlatev, 2015), shown in Figure 4. The loop is composed of two types of questions: "What is X?" (e.g., "What is language/gesture/iconicity/sign function?") and "How does X operate?" (e.g., "How do iconic gesture lead to sign emergence?") The loop is necessary to formulate research questions and hypotheses the thesis aims to answer, and ultimately to help understand the phenomena of language, gesture, and sign use better.

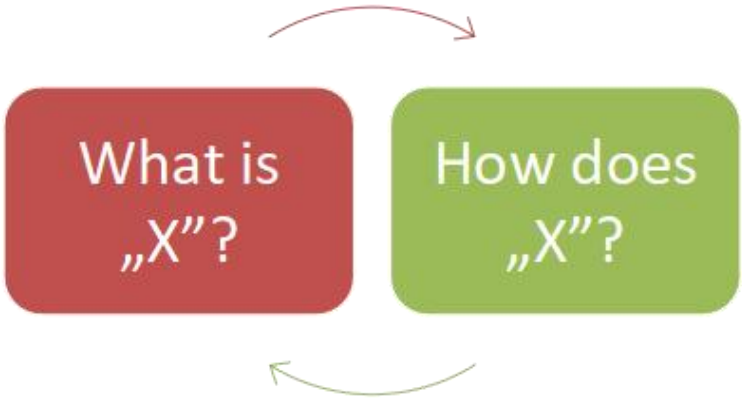


Figure 4. A simplified version of the conceptual-empirical loop, with X being any semiotically relevant concept, such as language, gesture, sign, metaphor, or narrative.

In my research, I ask how the sign function comes about in children: whether its origin should be sought in speech or gesture, and how the sign perception given in different semiotic systems changes with age: whether there are differences in sign comprehension across the three age groups I look at.

8. Key aspects of the project

8.1. International research in the field of gesture studies

The first descriptions of gestures appeared in the 16th and 17th century scholarship (Bulwer, 1644; Wollock, 2002; Kendon, 2007). At that time, the signs of signed languages were regarded as gestures, which sparked off interest in the gestural communication of "deaf-mutes" (Mallery, 1972). However, it was only in 1900 when linguists and psychologists started to go their separate ways in the study of gestures with Wundt's influential publication *Die Sprache* [*Language*] (1973). Wundt's interest and work in the link between psychology and linguistics gave rise to many insights that still inspire modern scholars. Wundt noticed that gestures are an important part of human communication and provide a window into cognitive processes in language acquisition and language production (Wundt, 1973: 247; Wundt, 2010: 83). While Darwin studied gestures in terms of expression of emotions, Wundt linked gestures to processes of language acquisition. On his view, "language is explained as beginning in expressive gestures" (Blumenthal, 1987: 316); hence, gestures may be regarded as the first signs produced by children whereby they develop the ability to associates meanings with communicative forms (cf. Zlatev et al., 2005).

Nowadays, a lot of researchers study how gestures support speech development. In particular, there are many projects on language-gesture acquisition in atypical development, such as Autism Spectrum Disorder (ASD), Specific Language Impairment (SLI), Down Syndrome (DS), or Attention Deficit Hyperactivity Disorder (ADHD) (Botting et al., 2010; Mainela-Arnold et al., 2014; Te Kaat-van den Os et al., 2015; Bautista et al., 2015; Perrault, 2019; Choi et al., 2020). These lines of research have shown that gesture use can help establish early diagnosis of these developmental atypicalities (Manwaring et al., 2018) and predict the trajectory of later language learning in individuals diagnosed with them (Wang et al., 2004). Co-speech gestures are able to aid such individuals in focusing on, understanding, and producing linguistic signs. This facilitatory influence stems from the fact that speech and gesture share pathways of common neural systems, and their recognition and production can activate similar brain regions (Ahlsen, 1991; Bates & Dick, 2002; Enrici et al., 2011; for an overview see: Akbıyık et al., 2018), for example the inferior frontal gyrus and

the superior temporal sulcus (Xu et al., 2009; Lindenberg et al., 2012). A strong indicator of the link between the two communicative systems is the fact that people with damage to the brain's language loci find it difficult to produce co-speech gestures (Cicone et al., 1979; Ferré, 2021). Another piece of evidence that shows this link relates to the way gestures facilitate word retrieval and speech production in, for instance,patients with aphasia (Preisig et al., 2018; Özçalişkan et al., 2013). Gesture studies are also informative of the development of the sign function in typically and atypically developing children. International research often focuses on neurodivergent individuals, but also looks at typically developing children's abilities, while in Poland, where the present project was conducted, comparative research on gestures in typical and atypical development and diagnostic research is scarce.

Gestures and pantomimes are commonly used in experiments within evolutionary linguistics, which brings together insights from multiple disciplines and offers a broad perspective on the origins, nature, and evolution of language (Gong et al., 2014; Żywiczyński & Wacewicz, 2015; Żywiczyński, 2018). Research on the role of gestures in language acquisition is also informative to the field of language origins, where scholars investigate similarities and differences between communicative abilities of our hominin ancestors (Slobin, 2014), our closest living relatives—non-human great apes (Tomasello, 2018) and children. Pantomimic and gestural experiments have become an established methodology in language origins, as they have the potential to identify "language universals" and "linguistic fossils" in communication of modern humans (Greenberg 1975, Ferretti et al. 2017, Żywiczyński et al. 2021). Bootstrapping communication in the lab is often done by providing participants with the task to communicate with one another without the use of any linguistic conventions (Fay et al., 2013). Naturalistic observation is more common than experimental approach in research with children, which focuses on spontaneous communicative behaviours of pre-linguistic infants and toddlers (e.g. in ASD in: Stone & Caro-Martinez, 1990). Such studies are an important source of insight into the problem of how language evolved in the hominin line.

There are many more lines of scientific enquiry that could be developed based on insights from child development. However, there is still a lot to be discovered within the field itself. While preparing the project, I noticed that

gestures are widely described in child communication, but certain gestures that are investigated more extensively than others (e.g., pointing over iconic gesture). Moreover, researchers tend to focus on certain age groups of children and on developmental atypicalites, such as ASD or Down Syndrome (see above). There is also a large disproportion in the number of publications on comprehension- and production-oriented research on toddler gestural development. For example, the "production task children gestures" query in the Google Scholar search engine returns almost 600,000 matches, while if the word "production" is changed into "comprehension", the engine returns less than half of this number (most recent search was conducted on 14 April 2023). Using gestures in communication with children as well as early practice in gesture comprehension facilitate language acquisition (Özçalışkan et al., 2017; see Chapter 2) and lead to a better understanding of developmental neurodiversity (see above). Children are great observers: research into typical vs. atypical development shows that children understand and know much more than they can communicate linguistically (Oshima-Takane, 1988; Goldin-Meadow, 2000; Gopnik, 2010). Gestures are a resource to help investigate this area of the children's knowledge and, on the applicative side, they facilitate linguistic development (Ekman, 1981; Casell et al., 1999; Cook et al., 2012).

8.2. Research on gesture and language acquisition in Poland

Internationally, linguistics is very interested in gesture, particularly in the areas of language acquisition, clinical as well as rehabilitatory practice. There is, however, little research into these phenomena in Poland. The most in-depth work on gesture and language acquisition in Polish children is probably Magdalena Grochowalska's publication from 2002, which is not available in English. International projects look at gestures from the perspective of motor skills in language-impaired and healthy populations, including children (Capirci et al., 1998; Goodwyn et al., 2000; Mayberry & Nicoladis, 2000; Vukovic et al., 2010; Watson et al., 2013) to improve early diagnosis as well as language therapy of a number of disorders and conditions resultant from brain lesions. To the best of my knowledge, there is only one recent study on Polish children with ASD that draws attention to the importance of gesture and that has been communicated to international audience (Niedźwiedzka & Pisula, 2022). More generally, there are

only three comprehensive works on nonverbal communication of young children in the Polish literature. One of them is *Gestykulacja i mowa* [*Gesticulation and speech*] (2002) by Magdalena Grochowalska, a very informative monograph on nonverbal behaviours of preschoolers in Poland. The other two monographs are authored by Agnieszka Lasota: *Świat gestów i symboli w komunikacji dziecięcej* [*The world of gestures and symbols in child communication*] (2010) and *Jak małe dziecko poznaje rzeczywistość* [*How the child gets to know the world*] (2012). The author conducted her research with nursery children (18–30 months) and reports gestures in object manipulation and staged interactions. The Google Scholar search engine does not provide any information about any gesture-related research with typically developing Polish children which has been conducted in the past 10 years. Given the importance of the subject, such an underrepresentation of Polish research on gesture in children is difficult to understand.

8.3. The age gap in research with toddlers

Stage models of children's development vary depending on age division. It is common to provide a detailed description of child general development in the first 12 months of life in 2-3-month-long intervals, and provide more general comments on child development in the following 24 months. Zlatev and Andrén propose a set of semiotic stages in child development that are based on children's semiotic capacities (2009), shown in Table 1. These capacities act as ratchets (Tomasello 1999: 37-41), i.e. skills that cannot be undone or forgotten, and that serve as preconditions for the further semiotic development of children.

Table 1. Stages and transitions in semiotic development of children. Adapted from Zlatev and Andrén (2009: 383).

	Label	**Novel capacity**	**Cognitive/ communicative skills**	**Approx. age**
1	**Proto-mimesis**	Mapping between exteroception and proprioception	-emotional and attentional contagion -neonatal imitation -mutual gaze	**0-8 m**
2	**Dyadic mimesis**	Volition and representation	-imitation -imperative pointing -shared attention	**9-13 m**

3	**Triadic mimesis**	Communicative signs	-declarative pointing -iconic gestures -(full) joint attention	**14-19 m**
4	**Protolanguage**	Conventionality/ normativity	-one-word utterances -holophrases	**20-27 m**
5	**Language**	Semiotic systematicity	-spoken or signed language	**28 m-**

Zlatev and Andrén present an overview of general communicative skills children develop at early stages of their lives with 5–8-month-long intervals. The problem, however, is the age range selected for their description. It only marginally includes 3-year-olds, the study of whom is valuable to the understanding of the cognitive processes behind the formation of language. For example, it is after the third year of life when children start to pass the false belief task (Perner et al., 1987; Appleton & Reddy, 1996), which is a standard tool to measure the development of the theory of mind: a crucial component of social and linguistic skills at every stage of human life (Baron-Cohen et al., 1985).

An updated model of developmental stages by Zlatev and McCune (2014) can serve as another exemplification of the problem of developmental stages. The authors propose a 6-stage model of semiotic development, which extends from birth to the third year of life. Zlatev and McCune set off with a statement that children's cognitive development is closely related to their semiotic development where intersubjectivity plays an enabling role in sign understanding and social interaction (2014). The two authors focus on different aspects of this process: McCune looks at changes in mental representations manifested in children's naturalistic play (2014: 61-63); Zlatev is concerned with how intersubjectivity, imitation, and gesture use change along speech development (2014: 62-64). McCune offers a dynamic systems model for the development of linguistic reference: the ability that is manifested as the referential ability. Zlatev views semiotic development from the lens of the acquisition of, and further development of bodily mimesis (Donald 1991). He proposes two interacting dimensions of meaning: representational capacity, i.e. the ability to understand and produce signs meaningfully, and intersubjectivity, i.e. the ability to engage with the self and others. These two types of cognition are preconditions for the general capacity to form mimetic schemas: "dynamic, concrete and pre-verbal

representations, involving the body image, accessible to consciousness and pre-reflectively shared in a community" (Zlatev, 2005: 334).

Despite difference in focus, the two scholars' approaches seem complementary: McCune's analysis show how children's representational capacity emerges in the first year of life; Zlatev explains this emergence in term of progression from sensorimotor to representational stages of children's development. McCune and Zlatev's joint effort resulted in a 6-stage model of semiotic development, which takes place in the first 3 years of life, as shown in Table 2.

Table 2. Semiotic development of children. A six-stages model. Adapted from Zlatev and McCune (2014: 66).

	Stage	Cognitive-semiotic skills	Approx. age
1	**Primary adualism**	- neonatal mirroring - bodily molding - affect attunement - proto-conversations	**0-4 m**
2	**Dyadic interactions (self-other, self-object)**	- social routines - social referencing - stranger anxiety - locomotion and object exploration - pre-symbolic play (Level 1)	**4-9 m**
3	**Triadic interactions (self, object, other)**	- imitation (of novel acts) - deictic gestures - context-limited words - self/other pretend play (Level 2/3)	**9-14 m**
4	**Intentional communication**	- communicative intent - communicative grunts - referential words - combinatorial representational play (Level 4)	**14-20 m**
5	**Onset of symbolic communication**	- integrating representation and intent - hierarchical representational play (Level 5) - sign combinations: words and gestures - onset of grammar	**20-24 m**
6	**Discourse and narrative**	- complex sentences - discourse - onset of narrative	**24-36 m**

When we look at the model in terms age intervals, it can be noticed that it aims at a detailed description of the first 24 months of the child's life (4–5-month-long intervals) but provides a very general overview for the 12 months described in stage 6. Moreover, the description of the last stage does not provide any information on gestures or, indeed, any aspect of nonverbal communication.

The last example of age generalisation comes from a review of gesture development for clinical and research practice that outlines norms for gesture use

in children (Capone & McGregor, 2004). The authors of the paper stress the importance of gestures in the development of symbolic abilities, stating that there is a "growing body of evidence that gesture enhances, not hinders, language development [i]n both normal and impaired populations" and reassuring that "[g]esture serves several functions, including those of communication, compensation, and transition to spoken language" (2004: 173). Capone and McGregor propose a 6-stage model of gesture development (see Table 3).

Table 3. An outline of gestural development of children adapted from Capone and McGregor (2004: 183). BPO: body part as object; IO: imaginary object (No "School age" column).

10-13 months	12-13 months	15-16 months	18-20 months	2-5 years
Showing Giving Pointing Ritualised request POINT predicts first words Other prelinguistic behaviours include eye contact	Representational gestures, play schemas First words emerge Gesture serves a complementary function to spoken forms	Gesture of vocal preference	Spoken word preference, gesture-plus-spoken combinations Significant increase in words (types, tokens) Increased pointing in combination with spoken words Transition to empty-handed play schemas	Speech-gesture integration, beat gestures emerge Gesture scaffolds spoken expression and comprehension Transition from BPO to IO gestures Iconic and beat gestures accompany longer utterances

The treatment of age intervals is similar to that presented in the models discussed above: the authors are specific about the 10–20-month period, while the period after the age of 2 is given as a very general overview of gesture development.

Further, Zlatev and Andrén write that the concept of "stage model" has been criticised in the past twenty years (or thirty, now) for not being able to anticipate cognitive performance of children at different times of their development (2009: 380). The authors are right that this criticism necessitates further enquiry into child development and improvement of the proposed stages of development (2009: 308). Therefore, one of the questions examined in my project concerns how gestures and speech change in a 12-month-long period between the ages of 2 and 3.

Chapter 2
Towards the sign function - an outline of child development

1. Introduction

Chapter 2 outlines the theories of language acquisition. It presents the core factors that contribute to child development and stresses the importance of adding the role of gesture into child development models. It presents child development from birth up to the age of 3 from the perspectives of speech and gesture based on developmental handbooks, and is enhanced with results of research for the described age groups. The focus is placed primarily on the ages of 2-, 2.5- and 3 years, as the children recruited for the study matched exactly these age groups. The Chapter is concluded with results of research projects that served inspiration for the present thesis.

2. Perspectives on language acquisition

Language is a very dynamic "beast", to quote Rudolf Botha (2000). It is difficult to study language if we limit ourselves to one field and one perspective, as the very term may bear multiple meanings and have many dimensions, as discussed in Chapter 1. Below, I present a selection of approaches to language acquisition – the theme of the present dissertation—and close the discussion with a comment on gesture studies and the role of gesture in the development of linguistic skills.

Following Charles Darwin (1871), Steven Pinker takes a nativist's perspective and posits that language is "the product of a well-engineered biological instinct" (2003: 19; cf. Fisher, 2006) to learn and use language. A child can hear environmental sounds, including the language spoken by her mother, already in the womb (Birnholz & Benacerraf, 1983; Moon et al., 2013). After a child is born, her perception is engaged in speech and enables her to discriminate between speech and non-speech sounds (Cheour-Luhtanen et al., 1995; Pena et al., 2003). We learn our respective languages without training, we use them without thinking about them (Friederici, 2017), and no other animal presents such an intuition for acquiring and dismantling sounds (Fisher, 2006). This unique "human trait" (Perani et al., 2011: 16056) emerges as a result of our interaction with the environment, which is possible due to various, complex brain networks

and their functional organisation; this human trait crystalises and strengthens over the first years of a child's life (Dehaene-Lambertz & Pena, 2001; Brauer et al., 2011; Perani et al., 2011).

Human babies start to acquire language when their brains are still undergoing maturation and growth. The human brain "forms its connections after birth [...] but [these connections] can't talk to each other until they form neural connections that allow electric impulses to flow between them" (Kuhl, 2002: 13), and since it happens up to age 3, with the first year being the most crucial (Friedmann & Rusou, 2015), these first 3 years of a child's life become a very important time for language development (Lenneberg, 1967; Newport, 2006). This "sensitive period", described above, is the time in early postnatal life when "the development and maturation of functional properties of the brain, its 'plasticity', is strongly dependent on experience or environmental influences" (Sengpiel, 2007: R742). There is no one critical period for all brain functions, but rather "there are different critical periods for different brain functions, for example binocular vision or language acquisition" (Sengpiel, 2007: R742).

Our knowledge of specific brain functions, their development, and their structures expanded significantly over the last 100 years. When speaking about language, neuroscientists focus on two specific loci: Broca's area (partaking in speech production) and Wernicke's area (partaking in speech perception) (Damasio, 1992). Even though both these regions were described as related to language in the 19th century (Nasios et al., 2019), some scientists have seen language as a "mental organ [...] and a computational module" (Pinker, 2003: 12) that contains grammatical structures children decode when they are exposed to language (Chomsky, 1965; Litchfield & Lambert, 2011). The most well-known example of such a nativist approach is probably the idea of a Language Acquisition Device (LAD) proposed by Noam Chomsky to explain why toddlers can learn their respective language with such ease (Logan, 2007). Chomsky famously argued that a child has a set of innate mental properties that are the basis for language acquisition (1965: 36). To acquire a language "a child must devise a hypothesis compatible with presented data—he must select from the store of potential grammars a specific one that is appropriate to the data available to him" (1965: 36). Decoding grammatical parameters of a language does not seem enough for a human to master that language.

Aitchison writes that language is one of the "aspects of human behaviour" (Aitchinson, 1998: 19), which is in line with psychological approach to language and with the way analysis of language development were conducted in the experimental psychology of the 20th century (e.g., Watson, 1913; Sapir, 1927; Skinner, 1957; Mowrer, 1980; Ribes, 1986 [2014]). Watson outlined behavioural psychology as an "objective branch of natural science" (Watson, 1913: 158) that is based on observation of an organism in its natural environment with little focus on its background (Watson, 1913). In this view, organisms learn from observation and association, they are conditioned to behave in a certain way, they copy the behaviours of others in certain situations, and learn how to react. Language was seen as an imitative social habit that can be conditioned and built upon structures (e.g., sets of syllables) that a child knew already (Watson, 1924: Chapter 10). Conditioning was especially important as it played a part in "teaching children those habits, which are involved, not alone in the understanding, but also in the *use* of words" (Mowrer, 1980: 4, original emphasis). Such an approach failed to explain language development because (1) it did not apply to the way all children learn languages—after all, children who are not conditioned to use particular sounds for particular objects do acquire their respective languages, but also because (2) it was reductionistic to the point at which it did not take into consideration factors other than the input form the immediate environment. However, there is an insightful idea behind the behaviouristic approach—environmental input does help language development.

Neuropsychologist Merlin Donald (1998) and anthropologist Robin Dunbar (1998a, 1998b) share the view that language is a social and a cognitive process. Donald writes that language is "a gigantic meta-task, requiring the co-ordination of an entire hierarchy of subtasks and sub-subtasks, regulated from working memory" (Donald, 1998: 56). The execution of these "subtasks and sub-subtasks, regulated from working memory" requires the conscious use of linguistic knowledge and the ability to match it with the requirements of a situation. The process that leads to language development is bound to existence in a social group (Dunbar, 1998a) that forces infants to "combine a powerful set of domain-general computational and cognitive skills with their equally extraordinary social skills" (Kuhl, 2010: 715) to master the rules of language use. Research on extreme cases of children who are deprived of social contact best

exemplifies that language—the special "human skill" (Donald, 1998: 58)—must be exercised among others if an infant is to expand her language knowledge (Conboy et al., 2008).

The most well-known case of social deprivation in psychological and linguistic research is the case of "the Wild Boy"—Victor of Aveyron (Shattuck, 1980), whose "deficiency of social and mental stimulation [...] could have been sufficient to cause his „retarded condition" (Cayea, 2006: 10). Another aspect of Victor's social and linguistic problems was that his caregiver, Jean Marc Gaspard Itard, a French doctor, "overlooked Victor's need to socialize with others of his age and engage in more kinds of spontaneous play" (Cayea, 2006: 18; Bandura & Walters, 1963; Neis, 2020), which is natural for children and facilitates language exchange. The same situation was described in the case of Genie, another example of social isolation that led to a range of developmental complications but—with unfolding methods of examination, knowledge on language acquisition, and a team of linguists and psychologists willing to work with her—Genie was gradually able to exercise her linguistic skills and build some limited language comprehension and use, which, at least compared to the case of Victor, was a success (Curtiss et al., 1974; Cayea, 2006). The researchers invented visual and tactile games, total physical response tasks, mix-and-match assignments, and a reward system: all these were to keep Genie active and to engage her in play and language use. Their "motivation for designing such teaching methods, to help Genie learn language, [was] to aid her in her social relations with the world in which she live[d]" (Curtiss et al., 1974: 532).

Along the lines I have described in the case of Victor and Genie, Oliver Sacks comments on the condition of deaf children and the importance of their socialisation with peers: "[t]here are, sometimes, isolated deaf people who acquire little language of any sort, leading to intellectual, emotional and social disabilities. If communication goes awry, it will affect intellectual growth, social intercourse, language development, and emotional attitudes, all at once, simultaneously and inseparably" (Sacks, 1990: 78). Therefore, incidental learning (e.g., Rice, 2014), which takes place among peers, is a very important aspect of a natural linguistic education but also of acquisition of norms, values, and patterns of behaviour in different situations. It is crucial for psychological development and growing into a society. Robin Dunbar says that the function of language is to

"facilitate the management of social relationships" (Dunbar, 1998: 107), which cannot be done without properly developed cognitive capacities and cognitive resources (Goldstein, 2011). Language acquisition will not do without a rich environmental input from which a child gets her linguistic data and social conditions in which she can practice language use.

Each of the approaches holds insightful ideas for what language is and for how language comes about in humans. As stated in Chapter 1, language is a complex system of communication based on sign use. Humans can develop the understanding of such a system due to their brain structure, cognitive skills, as well as cultural and social practices. The system, however, is not limited to speech signs used in everyday situations: they are only a part—albeit a sizeable part—that constitutes our ability to communicate. When we think of language acquisition, it is most natural to think of speech. None of the perspectives discussed above mentions the role of another semiotic system—gestures—in language acquisition and development. Today we know that speech and gestures are both important vehicles for meaning, and they both play a role in the development of the sign function—the ability to perceive signs as meaningful units of communication. In my research, I focus on the hearing children, therefore, I do not give examples of language and gesture development in deaf toddlers. I also focus on a particular age group: the extensive description of that group stems solely from the research interest in the transition from the second to the third year of age in toddlers, and does not aim to underestimate language development milestones prior to that age.

3. An outline of language (and gesture) development in the first 3 years of life

Gesture use, similarly to speech use, is a motor act based on a sequence of movements whose aim is to achieve a particular goal (Owens, 2016: 46; Zeng et al., 2017), such as pointing to an object or uttering a sentence. Child development is marked by profound changes in motor abilities (Formiga & Linhares, 2015). It starts from control over gaze, increasingly coordinated movements of the body, orofacial expressions, imitation, object manipulation, and hand–eye coordination linked to it, and develops into imitation and other ritualised behaviours (Meltzoff & Moore, 1983), such as linguistic pointing—a milestone in social and communicative development (Goldin-Meadow, 2007). Later, as children engage

in interaction with others, such as pretend play, they develop the skill to use polysemiotic word–gesture combinations (Pleyer, 2020), which open possibilities of rapid vocabulary growth (Mervis & Bertrand, 1994).

Gesture studies enable us to look anew at the ways motor skills and language interact when children acquire language, and to assess whether the use of gestures facilitates linguistic communication with others (Capirci et al., 1998; Goodwyn et al., 2000; Mayberry & Nicoladis, 2000; Iverson & Goldin-Meadow, 2005; Özçalişkan et al., 2014). In the following sections, I present an outline of language acquisition. I focus on the age period from birth to the third year of a child's life only. The 5 initial sections outline milestones in child language development. The novelty value of the descriptions stems from their balanced focus on speech and motor abilities, such as gestures, in infant and toddler early communication. The remainder of the chapter is devoted to the description of the findings on the interplay between language and gesture of infants and toddlers the present project also aims to explore (see Chapters 3–4).

3.1. Prenatal linguistic development

Research suggests that cognitive, and especially linguistic, development of children can be affected by the environment already in the womb (Gervain, 2015; Gervain, 2018). Sounds, even though modified and filtered by the mother's body, are accessible to infants before they are born (May et al., 2011; Henriques et al., 2022). Shortly after birth, babies have a strong preference for human voices over other sounds (Vouloumanos & Werker, 2004), they also prefer voices known to them, such as the voice of their mothers or fathers (DeCasper & Fifer, 1980; Fernald, 1985; Kisilevsky et al., 2003). They discriminate between salient features and rhythmical patterns of different languages (Giordano et al., 2021; Edalati et al., 2022), and they recognise information encoded in the prosodic characteristics of an utterance (Cheng et al., 2012), such as emotions. This early exposure can impact further development of children and facilitate their language acquisition abilities (DeCasper & Spence, 1986). Unlike auditory abilities, elements of manual-visual modality, such as gestures, are accessible to babies only after birth.

It is difficult to decide in what intervals child development should be presented. Periods of 1 month are very specific: since children develop at their

own pace such frames are too narrow to provide an overview of developmental milestones. Following the insights presented in Section 8 of Chapter 1, and the age groups selected in my project: 24-, 30-, and 36-month-olds, I decided to present language development of children in 6-month-long intervals. The first period (0–6) is the richest in advancements children make, and the remaining 5 periods (6–36 months) are described from the perspective of particular milestones, such as pointing, walking, or production of first words. I should stress that the empirical focus is placed primarily on the period that is of interest to me. For this reason, in this chapter, the 24–36-months interval gets more attention than the remaining ones.

3.2. When a baby is born (0–6 mos)

Children communicate with the world soon after birth. Yet, their prenatal relationship with the mother, her movements and vocalizations, provide the earliest social experiences. Soon after birth, the child "experiences the world through perceptual processes and movements" (McCune & Zlatev, 2015: 364). Even though they do not know language yet, their cries and shouts make their communication successful: their pre-linguistic communicative competence, "the degree to which a speaker is successful in communicating", makes them achieve their needs or desires (Owens, 2016: 22). From 3 months onwards, infants "show an awareness of others as attending beings, as well as an awareness of self as an object of others' attention" (Reddy, 2003: 397), manifested in mutual gaze, intense smiling, or "calling" vocalizations. By the fourth month of age, a child is interested in observing others as they talk, but also starts to realise that her cries elicit responses (Barr et al., 2001). Practising this communicate skill, a child gains more control over her vocal apparatus (Owens, 2016: 121). This cognitive ability to attach meaning to these early signals (but not yet signs) opens possibilities of engaging in more demanding interactions with others, such as a "peekaboo" game (Montague & Walker-Andrews, 2001). Eye-tracking research shows that children recognise gaze patterns and follow them already in the first months of their lives (Walton et al., 1992; Di Giorgio et al., 2013). They are mostly interested in human faces and their expressions (Palama et al., 2018) and can smile back at them. EEG research shows that during the first months of her life, a child learns to react to familiar sounds and is able to recognise her parent's voice and her own

name (Parise et al., 2010). She starts to perform vocalisation, such as cooing, and begins to practice strings of syllable-like sounds (Owens, 2016: 106). She understands the meaning behind the tone of the voice of others and imitates their facial expressions, such as tongue protrusion or smile (Anisfeld, 1991). By 6 months, a child begins to imitate heard vocalisations and sounds, but is also interested in novel sounds (Piaget, 1962; Kessen et al., 1979). She also grows to understand that certain noises can get attention from others and learns to express attitudes in her vocalisations, be it anger or joy (Owens, 2016: 122). She becomes more playful with the use of such behaviours as "squealing, growling, yelling loudly, production of noises by blowing air, food, or saliva through a constriction in the mouth or pharynx, and nasal murmurs [...] [i]n this later form of vocal play, consonantal and vocalic elements that were prominent earlier are combined with one another in novel ways" (Stark, 1980: 74) and mark the onset of the single-word stage in language acquisition.

Children's motor development at that stage is not limited to sound imitation or gross hand movements. Children are interested in touching objects, which is clumsy at the time, and trying to manipulate and inspect them (Trevarthen, 1979) by means of, for example, putting them into their mouths or hitting other objects with them (Rochat, 1989; Williams, 2003: 363). Their interest in toy manipulation increases and causes them to interact with others more willingly. They still perform uncoordinated movements of the entire body, but their reach and grasp is becoming firm towards the end of the selected period (Witherington, 2005). They start to mimic facial expression and gestures of others, but these movements do not carry any intentional meaning and they are not copied precisely (Piaget, 1962; Meltzoff & Moore, 1977; see Figure 5).

Figure 5. A 3-week-old infant imitating an adult (“neonatal mirroring”, see Meltzoff & Moore, 1977).

By the age of 6 months, when a child can sit, she can give objects to others and practices gestural imitation, even though she does not understand the meaning behind these gestures yet (Williams, 2003). Bertenthal and colleagues (2014) also showed that between the ages of 4 and 6 months, children can already follow pointing gestures of others (see also: Schmitow et al., 2016).

3.3. Getting to communicate with others (7–12 mos)

At this stage, the child acquires the understanding of routine expressions, such as “bravo”, “hello”, or “bye-bye”, and is increasingly reactive to her name (Gleason & Weintraub, 1976). From the sixth month of life onwards, the child identifies the source of voice and discriminates between human voices as well as non-speech sounds, such as doorbell, telephone ringtone, or music (Zamira et al., 2023). When children are about 7 months old, they pay more attention to the words they know, even if these words are inserted into longer sentences (Jusczyk & Aslin, 1995). As the stage progresses, children start to gain the ability to perceive the meaning of a sound not only through its pitch or loudness—they may

to some degree begin to understand that uttered words have referents (Hollich et al., 2000; Bochner & Jones, 2003: 17–18), though not yet understand words as signs, which presupposes conscious differentiation between expression and denoted object (Zlatev et al 2020). The infant is also involved in reduplicated babbling composed of consonant-vowel series (Stark, 1980: 74), as she practices the pronunciation of simple, plosive-based, non-referential speech sounds, such as "mama", "dada", or "baba", which precede referential speech (Cruttenden, 1979: 8–9, Volterra et al., 1979: 151). She enjoys rhythm, rhymes, and songs, and tries to imitate other people's speech sounds and lip movements (Zamira et al., 2023). She prefers to listen to lists of words from her own language, which reflects both their ability to recognise familiar sounds and their increasing attentiveness to native language (Jusczyk et al., 1993). Closer to the **nineth** month, children learn the meaning behind simple expressions, such as the word „no" or „yes", that can also be presented as a head shake or a nod (Stark 1980: 74). Once again, however, this is not a denotational, sign-based, relation, as the concept is used in this thesis.

Volterra an colleagues argue about the importance of the period, stating that it is "a critical phase for the appearance of language" (1979: 156). Now, children enter the single-word stage: they are producing simple words, sometimes referred to as "holophrases", "proto-speech acts" or "proto-words", defined as primitive vocal labels, which can stand for objects, individuals, or events: "bow-wow", "mama", "yummy" (Stark, 1980: 75; Bates et al., 1975). These first "words" are often based on vocal iconicity, reduplication, and onomatopoeias (Imai & Kita, 2014; Lang, 2015). The vocal-label milestone enables children to communicate with others and practice their linguistic and social skills. The ability is also closely linked with communicative intent inferred from "nonverbal behaviour, that is, eye contact with an adult, facial expression, and the gestures of pointing, reaching, showing, and pushing away" (Stark, 1980: 89).

The most important motor advancement of the period is the ability to sit without help and to walk. It is important to note, however, that children differ in terms of their movement and sitting abilities onset, which may influence their speech onset (Clark, 2016: 89). Both sitting and walking provide new ways of perceiving objects and open a set of possibilities of exploring the environment and interacting with others. Hands are now free from holding the body over the ground when moving; therefore, the period is characterized by the increasing

participation of gesture in the pre-linguistic vocalisations of children: infants begin to show objects and reach for them (Clark, 2016: 101). Around the nineth month, children start to use gestures to inform others (Capone & McGregor, 2004; Woodward & Guajardo, 2002) and to make requests (Blake et al., 1994; Kovacs et al., 2014): they imitate a grasping motion to be given a toy or reach with their arms stretched towards a person to be picked up (Cameron-Faulkner et al., 2015). Ostensive gestures—showing and giving—are the earliest gestures in a child's nonverbal repertoire (Guevara & Rodriguez, 2023). At that stage, children know the meaning behind pointing (Krehm et al., 2014) and start to actively explore its use with an open hand or an index finger. They also begin to understand emblems used in interactional routines (Iverson et al., 1994). Adults can understand child "jargon" based on combination of sounds, gestures, and the context for their creation (Owens, 2016: 111).

3.4. Rapidly changing abilities (13–18 mos)

Eve Clark sees the first year of life as very rich in perceptual abilities: children see similarities between objects, they start to identify and categorize them, as well as know where they are kept or where they belong (e.g., a toothbrush being usually in the bathroom and cutlery being in the kitchen), they recognize faces and read facial expressions, they start to orient themselves in topographical space, and can use it as referent (2016: 7). She states that:

> [c]hildren must use prior experience to recognise objects and events, they need to set up representations of what they see, hear, touch, smell and taste so that they can recognize them as they recur. They need to keep such representations in memory to organise experience and categorize it. Such linking categories: how objects, actions and environment are linked provide a starting point for linguistic representation" in language. (Clark, 2016: 8)

It can generally be observed that toddlers enjoy music and singing songs, combine words and indexes more readily, and start to understand and use simple directives, such as "mummy kiss" or "give daddy". They can move freely and engage, alone or with adults, in explorative behaviours, such as taking their hand and guiding them to an object of their interest (Werner & Kaplan, 1963; Mahler et al., 1975). They gain experience in play initiated by adults, as they copy

behaviours, words, and gestures of adults with greater precision (Pleyer, 2020). Their symbolic behaviours are now based on words and gestures.

Bates and colleagues note that "[s]ome time around the end of the first year, normal children make the crucial discovery that things have names" (1989: 407). As children enter toddlerhood, they become increasingly communicative, and, hence, it becomes more difficult to perceive their verbal and nonverbal development separately (Bates et al. 1989: 408). Their representational capacity manifests itself in increasingly rich vocabulary and gesture use, as well as more general cognitive abilities, such as memory for objects and people, problem-solving abilities, capacity for imitation, and symbolic behaviours, such as pretend play (Piaget, 1962; Werner & Kaplan, 1963; see Section 1.5.1. below). Children make use of these advancements in recognition and recall, as they summon their knowledge first with gestures and pantomimes of events, and later with words (Clark, 2016: 7). They can also hold a proto-conversation or proto-interaction during which they share a joint focus of attention and a common ground of an activity (Clark, 2016: 27). Towards month 12, children start using gestures to iconically represent simple referents known to them, they also use onomatopoeia (Namy et al., 2000) or gesture to enact known animals, for example a bird, by spreading their arms and waving them up and down (Bochner & Jones, 2003: 18–19), as they do in activities based on pretending, such as embodying of animals in a game of charades, or in any other imitation-based game initiated by an adult.

3.4.1. Theory of mind: intersubjectivity and joint attention

By the age of 12 months, children begin to establish the "[...] the ability to produce conscious, self-initiated, representational acts that are intentional but not linguistic", which can be called "mimesis" (Donald, 1991: 168; see Section 1.5.1. below). This period marks the onset of important communicative development—theory of mind, which is the ability to separate the mental states of others from our own mental states (Liszkowski, 2013) and to perceive others as intentional agents who behave in accord with their own mental setup, rooted in beliefs, desires, aims, or feelings (Kopp & Krämer, 2021). Such a complex ability entails an understanding other people's states in various situations.

Tomasello (1995) stresses that intersubjectivity is a fundamental aspect of human cognition and communication, as it is based on human ability to engage in

collaborative activities with others, which involves understanding that they have communicative intentions that boosts language acquisition. Already around the nineth month of age, infants develop ways to demonstrate their awareness of perceiving others as communicative individuals. They notice and follow gaze patterns willingly, which is an indicator of joint attention readiness They observe how others behave towards a novel person or a novel object and imitate their behaviours (Tomasello, 1995). Bruner comments that:

> Intention, viewed behaviorally, has several measurable features; anticipation of the outcome of an act, selection among appropriate means for achievement of an end state, sustained direction of behavior during deployment of means, a stop order defined by an end state, and finally some form of substitution rule whereby alternative means can be deployed for correction of deviation or to fit idiosyncratic conditions. It can be argued from evidence that the *capacity* for all these is present from birth. (1975: 2, original emphasis)

One may not agree with Bruner with regard to the innateness of these capacities. They are all cognitively demanding acquired in the first months and refined in the first years of a child's life. Bruner is right, however, that the features of intention in a communicative act can be perceived, measured, and described.

Intersubjectivity can be broadly understood as "[...] the sharing of affective, perceptual and reflective experiences between two or more subjects, [which] can take different forms" (Zlatev 2008: 215). This skill plays a crucial role in the ability to communicate and engage in activities with others, called joint attention. The development of representational skills and intersubjectivity between a child and others is achieved through a shared experience of the external world and the use of communication through gesture, play, and language to create more complex meanings. According to Werner and Kaplan (1963), this process begins with a natural resonance with the environment and entities within it. Gaining representational mind and intersubjectivity must happen in tandem in order for the sign function to emerge in a later period (McCune & Zlatev, 2015).

Joint attention is the last of the core phenomena that I want to mention while describing communicative milestones of children at 12 months of age. Joint attention is the ability to share perception towards an object, a person, or an event in interaction with others (Moore & Dunham, 1995). It is the base of many human activities and involves following another person's gaze, pointing, or other communicative cues that allows us to focus on the same thing. Some of the

indicators of joint attention have already been described in the 0–6 mos stage, which may be misleading. The key difference is the intentional capacity children gain around the 1st year of age and start to use signs consciously, compared to what is physiological, and can be only interpreted as conscious (but is not yet) in the first 6 months of a child's life. Fiebich and Gallagher discuss different stages of joint activities (2013: 577-581; Table 4):

Table 4. Characteristics of 3 stages of joint attention development. Based on Fiebich and Gallagher (2013: 577–581).

Stage	Age	Characteristics
Simple/shared attention	0+	- paying attention to external entities - engagement in dyadic, self-other (inter)actions - following gaze of others, attending to faces - being aware that the adult is being attentive towards an object and shifting attention towards that object - partaking in shared mental focus on an external object - not yet triadic form of interaction when attending to an external object, but rather dual attending - engagement in simple attending: attending to the person being attentive towards the same entity
Joint attention	9+	- having mutual knowledge of attending to an external object or event, confirmed in behavioural communicative cues - partaking in triadic self-other-entity interaction - partaking in social referencing, asking proto-questions and seeking reassurance in others' behaviour, being an active party of an interaction, especially in ambiguous situations - presenting mutual visual attention to an object, a person, a sound or an event - signalling attentiveness to an object, a person or an event or directing other's attention to these by means of gesture, vocalisation, or other visible behaviour
Intentional joint attention	13+	- attending to an object, a person, or an event with a shared intention in mind - partaking actively in the mutual awareness of an external object - having a shared intention, which may entail the immediate common goal of maintaining joint attention - maintaining joint attention as the goal, and to coordinate our

		behavioural patterns to achieve this goal - engaging in complex joint actions in real interactive settings to obtain a common goal, such as cooperation - coordinating behaviour

Thus outlined, the differences in the trajectory of the development of joint attention can be easier to grasp.

In his book *The Cultural Origins of Human Cognition* (1999), Tomasello argues that joint attention is a crucial component of human cognitive development and social cognition (also from an evolutionary perspective). He stresses that joint attention involves not only sharing attention with another person, but also entails a shared understanding of the intentions behind that event. Tomasello suggests that joint attention requires the ability to infer the mental states of others in order to coordinate one's own mental states with the mental states of others. He seeks the meaning of joint attention in the cultural and social nature of human practices. The "ratchet effect" (1999: 36–37), which can develop based on joint interaction and the cumulative knowledge so gathered, is a key mechanism for the transmission of cultural knowledge and the development of shared cultural practices. Joint attention involves sharing a common focus on something in interaction with someone (Moore & Gunham, 1995; Tomasello, 1999: 98). The focus can be established by the use of eye contact, gestures, words, or signs (as in signed language). An example from Tomasello and Farrar's own study outlines a joint behaviour:

> … the child hands the mother a spoon, looking to her face; she places it in a cup; he takes it out, mouths it, and puts it back in the cup, looking to the mother; they continue this until some one (usually the child) shifts attention. Had the child played with these objects alone, this would not have been a joint attentional episode even if the mother was visually focused on the objects through. (1986: 1456)

Joint attention forms the environment of interaction in which a child practices her newly acquired, yet still very crude, communicative skills: sign function, intentionality, and intersubjectivity. Tomasello stresses the importance of the relation between joint attention and common ground, stating that they both "constitute the necessary intersubjective infrastructure for many other uniquely human activities" (2019: 62). Common ground is a context humans share in their

communication (Kopp & Krämer, 2021), "the sum of their mutual, common, or joint knowledge, beliefs, and suppositions" (Clark, 1992: 93). For example, a simple act of pointing to a bicycle requires the ability to understand not only "a common ground in the sense of a common context in order to be meaningful, but [...] also [...] the knowledge and commitment that the other person wants to notify something that is relevant to her" (Kopp & Krämer, 2021). Realising and reacting to such a signal testifies to an individual's cognitive capacity for representation and theory of mind.

3.4.2. Pointing: a milestone in human communication

Pointing is very special to gesture studies and language acquisition research, as it is believed to "open the door to the development of intentional communication" (Cochet & Vauclair, 2010: 129; Colonessi et al., 2010). It is also "the first [...] to appear in the process of communication skill development" (Jarmołowicz-Nowikow, 2014: 86)—to inform about and indicate the existence of an object and to orchestrate attention of others (Bates, 1979; Behne et al., 2012; Liszkowski, 2020). We can seek the origin of deictic gestures in action, clearly visible "in the progression from showing to giving to pointing", which additionally indicates "a progressive detachment from the object" (Capirci et al., 2005: 156). At the pre-verbal stage, a child is able to refer to an object, a person, or an event that is of interest to her only through pointing (Werner & Kaplan, 1963). The use of pointing can be done referentially by contiguity. Usage of pointing testifies to the development of the sign function, as children start to inform others about their perception, but it also enables a toddler to establish contact with another person and partake in a shared activity (Murphy 1978). Some scholars attribute a special role to the pointing gesture. Bruner describes pointing as a key way of establishing joint activities within which a child has a chance to rehearse and practice her communicative and linguistic skills (1975). Establishing an interaction based on joint attention, especially the "simultaneous engagement with the same external referent" (Cochet & Vauclair, 2010: 129), is key to the development of the symbolic function of pointing and the ability to actively participate in interaction with others (Carpenter et al., 1998; Tomasello et al., 2007). Intentional communication within a joint interaction is based on 3 features (see Table 5).

Table 5. Criteria used to characterize a gesture as intentional. Based on Cochet and Vauclair (2010: 130).

1	The behaviour of the signaller has to be produced and directed towards the recipient.
2	The gesture is accompanied by gaze alternation between the recipient and the object or event being pointed at.
3	The gesture is repeated if the child failed to achieve her communicative intention.

Most often, pointing gestures take one of two forms: they are either declarative or imperative (Cochet & Vauclair, 2010: 130–131). Children perform imperative points to use another individual as a tool to get an object, while they use declarative pointing to have another individual pay attention to them to, for instance, inform that individual about something (Tomasello et al., 2007: 705). Imperative gestures are shown to emerge earlier than declarative gestures, due to a child's ongoing cognitive development: the ability to retrieve an object is less complex than the ability to inform others about having interest in that object, as the latter implies theory of mind (Tomasello et al., 2007: 710). Goldin-Meadow observes that "children learning a spoken language use pointing gestures to refer to objects, people, and places" (2007: 742). The development of pointing starts with indexing inanimate objects, followed by people and animals: children start with objects in close proximity, such as food, toys, vehicles, or furniture (Goldin-Meadow, 2007: 742). Later, they develop the ability to point to the self: body parts or clothes; and even later to abstract entities, such as places and time (Tillman et al., 2017). Research shows that the more children point, the more verbal responses they receive from adults, which is beneficial to the development of their vocabulary (Kishimoto et al., 2007). In the one-word stage, which starts towards the twelfth month of age, children tend to use as many verbal labels for and object as pointing labels to denote this object (Pizzuto & Capobianco, 2005). Importantly, children who are exposed to speech–gesture combinations at the age of 12 months present richer vocabulary and better structure use at the age of 18 months (see: Igualada et al., 2015). Children engage in simple interaction such as imitation of sound, shape, or movement patterns. These activities mark the onset of mimetic schemas which are another stepping stone toward the emergence of the sign function (Zlatev 2007, Zlatev 2014). The interplay between gesture and

speech becomes increasingly important for a child to communicate with others and to create language. Gestures and speech at the age of 12 months are closely connected in terms of their representational capacity. Pizzuto and Capobianco showed that not only do pointing gestures indicate referents as often as words in the single-word stage, but also are the most frequently used polysemiotic combination at the age of 12 months (2006). When a child is ready to say "bye-bye", she is also ready to perform the gesture of hand-waving; when she is ready to say "no", she is also ready to perform the sideways hand movement with her finger stretched out (Bochner & Jones, 2003: 19)—a head gesture to indicate "no" in European cultures. Initially, the verbal and gestural labels indicate the same thing (e.g., pointing to a dog and saying "dog"). With time and experience, however, children grow to understand that pointing can be used differently: it can direct attention of others to an object or individual to establish a common ground (e.g., pointing to a dog and saying "big") (Özçalışkan & Goldin-Meadow, 2009; Van der Goot et al., 2014: 444). Picture 1 shows a toddler engaged in such pointing.

Picture 1. A child pointing to a picture in a comprehension-based task. The still comes from the video footage collected in the present study.

3.5. Interplay between speech and gesture (19–24 mos)

From the speech perspective, short phrases and sentences in child language and vocabulary spurt are the major characteristics of the period. According to Zlatev (2013) and Zlatev (2013) in is only in this period that the full acquisition of the

sign function takes place, thus explaining the vocabulary spurt. Children now know the function of signs as being able to denote objects properties and events and can produce sentences they have heard from others both in interaction with another individual and in self-play, as an entertaining language practice (Clark, 2016: 437). They also present consistent verbal patterns that are based on imitation in and outside of context, such as the use of labels for common nouns "mama", "papa" or "doggy" (Owens, 2016: 128). They follow simple, 2-step instructions (e.g., find your shoes and bring them to me), repeat utterances of others (though not perfectly), pose and answer simple questions, call others, greet them, and protest when they do not want (to do) something (Hoff, 2014: 212). Children understand sign value, they are able to hold a conversation and take account of what others know. They can tailor their utterances to match the utterances of others: ask topic-related questions and draw conclusions from the speech of their interlocutors (Clark, 2016: 27). All these are possible due to their increasing vocabulary, which is sometimes called "naming explosion" (Hoff, 2014: 145). Vocabulary spurt is the time at around 18 months of age (Benedict, 1979) when children's lexicon increases rapidly, and word learning rate goes up to ~37 words per month (Goldfield & Reznick, 1990). Children use the knowledge they have already gathered to infer the meaning of new vocabulary items; such bootstrapping helps them decipher wheat they do not know (Owens, 2016: 159). Importantly, their comprehension and production vocabularies differ significantly: research shows that at 16 months of age, toddlers have comprehension vocabularies between 92 and 321 words, while production vocabularies are estimated at 50 lexical items for the same period (Hoff, 2014: 147; Bloom, 1973). These two mental resources differ not only in size, but also in content: children comprehend more verbs than they can produce (Benedict, 1979). However, the content of child mental lexicons varies greatly depending on the circumstances and environment of acquisition, as well as exposure to more concrete words, including names of immediate referents or abstract phenomena, such as emotions (Gleitman et al., 2005). Children also use vocal iconicity readily and map it to referents easier than conventional vocalisations (Laing, 2019).

Sociability can influence child language development. Children who are more outgoing and take more risk create more opportunities to practice language than children who are more cautious about their mistakes or who are less sociable

(Slomkowski et al., 1992). At the age of 2 years, the social status of the family is reflected in a child's lexicon. Children whose parents pose more open-ended questions, read to them, and encourage interaction and discussion on various topics have richer vocabulary and use more complex structure than toddlers whose parents pose yes/no questions and spend less time interacting with their children (Hoff, 2006).

In terms of motor abilities, toddlers are confident with their movement such as walking or running (Størvold et al., 2013). Children's ability to use one-word utterances combined with pointing to get an object or to orchestrate others' attention strengthens. They gradually transition to the two-word stage and use speech–gesture combinations in their utterances (Capirici et al., 1996). Clark comments that during this period, "gestures complement first words" (2016: 101, 438). Such a statement implies that spoken words emerge earlier than gestural referents, which, as we have seen, is not the case (Iverson & Goldin-Meadown, 2005). As outlined in Section 1.4. above, it is pointing that emerges prior to first words. Therefore, it is incorrect to say that gestures accompany first words: rather, it is words that accompany first gestures, or even sounds that accompany first gestures in the pre-linguistic stage. As Hall and colleagues notes, "the use of gesture is later augmented but not replaced by spoken language" (2013: 306). Now, toddlers can understand and follow the utterances of other people and engage in dyadic and triadic activity, including imitation skills in play (Hoff, 2014: 77; see Section 1.5.1. below). Their activities are characterized by routines, in general: there is a number of familiar situations children go through daily, and based on these situations, they expand their vocabulary (Bochner & Jones, 2003: 26–27). They use repetitive gestures and routine manual actions, such as waving bye, clapping their hands, or covering their face in the "peekaboo" game spontaneously; they also initiate interaction based on known expressions, such as "blowing kisses" gesture, for example when they leave someone's house (Hoff, 2014: 78). They also observe gestures of others and rely on the these gestures while bootstrapping the meaning of a word (Pence & Justice, 2016: 160; Acredolo & Goodwyn, 1988).

In an experiment in which toddlers observed gestures of others, Carpenter and colleagues showed that, if given a chance to choose, 18-monthers imitate intentional actions rather than meaningless actions of adults (1988), which

indicates not only that they can map the actions of others onto their own body, but also that they understand intentions behind actions of others. Özçalışkan and Goldin-Meadow (2005) examined gesture–speech combinations in children up to the age of 22 months. They found that the period is characterized by a gradual increase in gesture–speech combinations, where gestures aid speech. Utterance structure was not complex in speech; for example, the children were not producing expressions with two arguments, while they were doing so in gesture already at 18 months (Özçalışkan & Goldin-Meadow, 2005: B107). The authors concluded that gesture "provides children with a tool to expand their communicative repertoire, and children use this tool to convey increasingly complex ideas. Shortly thereafter, they are able to convey these same ideas entirely within speech" (Özçalışkan & Goldin-Meadow, 2005: B110), as they use polysemiotic constructions a few months before the onset of these constructions in speech. Graham and Kilbreath, who worked with children from 14 up to 22 months, introduced toddlers with objects that had either a novel verbal or novel gestural label, or remained label-less, depending on their properties (2007). Their experiment showed that 14-monthers use word- and gesture-labels to guide their inferences about objects, while 22-monthers presented a more closed symbolic system, and treated words as privileged referential labels (2007: 1120–1122). When given a possibility to choose, children who have more experience in speech would rely on speech more than on gesture, unlike children who still use gesture for communication extensively, due to shortages in vocabulary. Bretherton and colleagues found a similar result in a comprehension and production experiment on language emergence (1981). The authors were interested in comprehension and production of signs in speech and gesture for 2 versions of familiar objects: abstract and concrete ones. In their results, they focused on production. They found that while word production increased for both abstract and concrete words, gestural production decreased over time (1981: 731). The results of this and similar studies suggest that children switch to a preferred semiotic system towards the end of the second year of life (Iverson et al., 1994; Capirci et al., 2005; Volterra et al., 2005).

3.5.1. Pretend play: a sign function rehearsal

Piaget (1962) describes an outline of gesture complexity as it changes from 1) imitation of familiar gestures, to 2) imitation of novel gestures while observed in the self and in others, to 3) imitation of novel gestures while observed in others but not in the self, to 4) imitation of familiar and novel gestures without a model (memorised schemas) (Volterra et al., 1979: 155). This transition can be seen in symbolic play with children. Pretend play develops from simple joint attention, such as looking, and changes with turn-taking and imitation practice (Bochner & Jones, 2003: 16). Pretend play is a type of imaginative play-based self-amusement, during which children engage in activities such as role-playing and pretending; play is done alone, with adults, or other children (Hutt et al., 1989; Bochner & Jones, 2003: 28). During pretend play, children take on different roles (Yawkey, 1983). Initially, the roles may be simple, and children may pretend to use everyday objects or to be animals: they show their characteristic features by means of pantomime and gesture, and make sounds to indicate what animal they are re-enacting. With progression of language and growing experience with objects, people and situations, children can imitate actions, such as pantomiming using house equipment or embodying, for example, a plane's shape, tracing its motion, and simulating its sound (Hutt et al., 1989). Later, they are able to develop entire play scenarios, whether these concern activities in the house or are based on narratives from books and cartoons known to them. Pretend play is key to child development as it allows them to practice social skills, such as turn-taking or cooperation in interaction (Lifter & Bloom, 1998). It is beneficial to general linguistic skills, as children rehearse their conversational abilities and re-create speech in interaction: the more children play, the richer their vocabulary and the better their language and narrative skills (Bergen, 2002; Weisberg et al., 2013; Lillard, 2015). Moreover, symbolic play is linked to a range of general cognitive skills such as problem solving or spatial reasoning (McCune, 1995). But the most crucial skill pretend play and language rehearsal enhance is the capacity for symbolic representation (McCune, 1995: 204).

Children gradually understand that they can volitionally use their bodies for communication (as in pantomime or gesture), but they also see information in others' use of body. The volitional use of the body, called bodily mimesis, involves:

> … a cross-modal mapping between proprioception [...] and exteroception [...] realized by bodily motion that is, or can be, under conscious control. [...] The body (part) and its motion correspond to—either iconically or indexically—some action, object or event, but at the same time are differentiated from it by the subject (representation) [...] The subject intends for the act to stand for some action, object or event for an addressee, and for the addressee to appreciate this (communicative sign function). (Zlatev et al., 2005: 5)

The next step in mimetic development is developing the perspective that our bodies can map onto the bodies of others, but also recognizing motion schemas in the bodies of others (Zlatev et al., 2005: 6; Andrén, 2010; Clark, 2020). This is what Piaget (1945 in Zlatev et al., 2005: 6) called "the symbolic function", and what I call the sign function, as "symbols" are usually understood as grounded in convention, and are only one type of sign.

Scholars seek the roots of symbolic abilities in symbolic play (Capirci et al., 2005; Pleyer, 2020). McCune-Nicolich and Carroll write that children first learn functions of objects, get to know their names, even if they are not yet able to utter them, and are able to recognize the mimetic schemas of their use (1981: 3). Symbolic play, based on the mimetic capacities of children, facilitates cognitive development and theory of mind, as it involves using (first) objects and gestures and (later) gesture-word combinations. It strengthens the ability to understand that one thing can stand for another (Weisberg, 2015). Andrén and Blomberg note that "[s]emantic representations do not emerge in a vacuum, but in the context of participation in joint activities" (2018: 34). Pretend play facilitates the development of semiotic function—the fundamental symbolic skill (Hall et al., 2013), which at early stages is acquired by means of imitation (Sherman, 1971; Bloom et al., 1974; Gärdenfors, 2006). Further, imitation calls for meta-representation: the ability to form representations of representation (Leslie, 1987). Piaget explains meta-representation stating that "the interior image precedes the exterior gesture, which is thus a copy of an 'internal model' that guarantees the connection between the real, but absent model, and the imitative reproduction of it" (1962: 279). This relation between knowledge and sign use is visible in children's interaction with others: they have information that cannot be verbalized at a young age, but can be manifested in other ways, for example by means of gesture. The ability to represent thoughts in gesture and pantomime indicates the consolidation of our physical experiences in our mental processes and incorporation of new information into existing knowledge (Piaget, 1962). Play

behaviours influence attention mechanisms, interaction and observation abilities, which provide the basis for understanding signs (Zlatev, 2008), theory of mind, and joint attention (Tomasello, 1995; Tomasello & Rakoczy, 2003; Hall et al., 2013). Together, they form representational capacity and testify to an infant's capacity for symbolic use of signs (McCune-Nicolich, 1981).

3.6. Questions, questions... and iconic gestures (25–30 mos)

In the second year of their life, children can partake in interaction and communication willingly and successfully. They can signal what they like and what they are not happy about. Their comprehension and production vocabularies increase every day—they are more flexible in their word learning. They are able to perceive similarities between objects and can categorize them based on, for example, motion, shape, or colour (Madole et al., 1993). Such a perception enables toddlers to learn vocabulary items more flexibly (Russell & Doerfel, 2021). With novel vocabulary items and rules for extracting them from context, toddlers compose simple sentences made of verbs and nouns (Hoff, 2014: 145–146). They can also understand and react to increasingly complex questions and instructions (Clark, 2016: 27). They develop the capacity to produce short conversations based on cartoons and stories familiar to them (McArthur et al., 2005). They use pronouns to refer to themselves and others (Hay, 2006), they understand possession, they also provide and remember names of objects (Yu & Smith, 2012; Ross et al., 2015), and strangers can understand their speech. They sing songs, understand and imitate sounds of the environment for communication (Motamedi et al., 2021). They make use of vocal iconicity in learning novel words (Perlman, 2017; Perry et al., 2021). At 28 months, children understand wh-type questions, and increased exposition to these questions from parents predicts their later use in children (Goodwin et al., 2012). What can be observed without experimental investigation is that towards 30 months of life, children start to ask more and more questions.

Since children have already integrated representational capacity, theory of mind, and intentionality, they know that receiving input from others enlarges their vocabulary and enhances their verbal reasoning. Rowe and colleagues (2017) indicate that the increase in wh-type questions can be linked to general cognitive processes of children, such as it provides the tools (lexical items and structure)

that toddlers can re-use, re-create, and tailor to their own communicative needs. Furthermore, as children gain answers from adults, they learn about causality and get to know how to express it. Such intense social relations, based on discussion, provide children with new lexical items and vocabulary skills; they also make them remember meanings from context of their retrieval in a social interaction (Rowe et al., 2017; Vygotsky, 1978).

Vallotton and Ayoub propose that children now use language (and gestures) not only to inform others and interact with them, they increasingly use it for self-regulation, an ability that "enables children to adapt to and gain the most from their environments" (2011: 169). The ability is often described as "a critical social-emotional skill underpinning children's abilities to act pro-socially with peers and adults, participate productively in learning activities, and adapt successfully to new or challenging situations" (Vallotton & Ayoub, 2011: 170). Self-regulation emerges in early childhood and first manifests itself as reaction to stimulus (laughter or cry), and later changes into conscious processes, such as planning or cooperation (Kopp, 1982). The interval between 24 and 30 months of a child's life is crucial to gaining awareness of social expectations and the ability to react to and conform to these expectations. It is also increasingly visible that children developed a set of internal rules that guide their behaviour and reaction to stimulus (Kopp, 1982; Vallotton & Ayoub, 2011). Asking questions is, therefore, reasonable: children are curious by nature, and they need to know "why", "who", "when", and "where" in order to react to requests and comments from others. To facilitate language and social development for toddlers, it should also be most natural for parents to provide their child with satisfactory answers.

Another important aspect of child language development at the age of 2years, somewhat related to their motor development and motor action perception, is the understanding of gestural iconicity. As they develop towards the 30th month, children become more proficient in understanding the iconic relation between hand-shapes and referents they stand for (for an overview, see: Kandana et al., 2021). Some iconic gestures are complex: the requirement to correctly map the form of an iconic gesture to its referent in order to understand the meaning behind that gesture requires perception of the salient elements of its referent—be it shape, movement pattern, or size. Children learn that gestures, just as word labels for objects, are often based on metonymy: the part–whole relation. They have to map

an element of the structure of the gesture onto the structure of the object it represents in order to understand it (Peirce, 1973; Emmorey, 2019) and they do not need to map the entire structure. While a "bunny" is a four-legged animal that has a round tail, two long teeth in the front of their mouth, and two long ears sticking up towards the sky, children are able to understand that two hands placed over one's head, with fingers stretching up, iconically represent a salient element that can be found on a bunny's head. These salient elements can be helpful in memorizing novel words, as they put pressure on neural processing of information encoded in two modalities: auditory and visual (Straube et al., 2009; Overoye & Storm, 2019). In their study, Aussems and Kita (2019) presented a group of 3-year-old children with videos of actions and iconic gestures corresponding to these actions in one of the experimental conditions and a video of action with no corresponding gesture in another. Their aim was to see whether iconic gestures influence memorizing of the seen event. The results show that 3-year-olds who were seeing iconic gestures alongside action events recognized (and hence memorized) them better than children who did not see the action+gesture condition (Aussems & Kita, 2019: 1133). The effect of iconic gesture on speech comprehension was also found in another forced-choice task by Stanfield and colleagues (2014). Children, gathered in 3 groups, from 2 to 4 years of age, were presented with iconic gestures conveying an action, accompanied by a verbal description (e.g., "I am eating" + moving cupped hands towards mouth indicating eating a sandwich). The task of each child was to match the event they saw with 1 out of 2 pictures presented to them (e.g., of a bowl and of a sandwich) (Stanfield et al., 2014: 465). These researchers found that children at the age of 3 and 4, but not yet at the age of 2, understand the meaning behind gesture and use it as a hint to spoken message in a forced-choice task (2014: 468; cf. Sekine et al., 2015).

There is also a line of inquiry looking at verbs and iconic gestures in production. Spontaneous speech and gesture production observation in longitudinal research shows that in the transition from 14 to 34 months, children produce more gestures over time (Özçalişkan et al., 2014: 1148). Not only does the number of iconic gestures increase with age, but also the number of children who use these gestures increases with time, which seems to be linked with the number of verbs children have in their lexical repertoire (2014: 1148). The

authors report that only 2 children aged 14 months produced iconic gestures, while at 26 months, it was already 22 out of 40 participants. By 34 months, 38 out of 40 children produced at least 1 iconic gesture (371 iconic gestures in total). The largest leap in verb production the authors report (from 13 to 172 per session) happened in the transition from 22 to 26 months of age (Özçalişkan et al., 2014: 1148). By 26 months, all 40 children were producing verbs. In another study on verb-gesture relation in 18-, 24-, and 30-monthers, Andrén and Blomberg found that gestures for properties and gestures for actions differ in terms of their occurrence with analogical verbs (static, such as "sleep", and dynamic, such as "fall") (2018: 22). They observed that toddlers perform deictic gestures more often with static verbs, and iconic bodily expressions with action verbs, while towards month 30, iconic expressions decreased in general, which is in line with the preferred-semiotic-system prediction discussed in Section 1.5. (Andrén & Blomberg, 2018: 29; Volterra et al., 1994).

It is more difficult now to draw a clear line between children's motor and language abilities, as they are increasingly coupled together. Purely on the side of their motor abilities, children can now run, jump, tiptoe, kick, and climb; they can throw objects and begin to walk up and down the stairs without help (Gerber et al., 2010). They can sort out puzzles, grasp objects with their fingers, stack items and carry them in their hands. They can take put on and take off (some) clothes without help, they use cutlery, wash their hands, brush their teeth, and comb their hair (Gerber et al., 2010). They enjoy drawing and painting if provided with tools. They can also imitate these simple actions outside of the context. They understand taking turns in games, cooperation with other children, and the meaning behind nonverbal behaviours (Eckerman et al., 1989; Brownell & Carriger, 1990).

Children at the age of 25–30 months produce gestures when they describe objects (Marentette et al., 2016), but use them also in communication with peers to indicate objects, for example pointing to a dog and saying "doggie", or to instruct them, for example by pointing to a handle and saying "pull" (Ashley & Tomasello, 1998; Brownell et al., 2006). Toddlers imitate actions of others (Strouse & Troseth, 2008) and draw conclusions on tool use when given opportunities to solve problems with them, such as opening and retrieving a reward from a box (McGuigan & Whiten, 2009; Novack et al., 2015). Behne and

colleagues (2014) showed that if a child is presented with a set of gestures to perform a task, for example opening a container, she will re-use gestures shown to her, but, also, will create spontaneous, nonconventional gestures on the spot to help others perform the same task already at the age of 2 years (2013: 2054). Speech that accompanied the iconic gestures children performed, such as "[Do it] like this!", testified to their communicative intent and the will to inform others (2014: 2057). The questions the authors pose at the end of their work put into doubt whether it is comprehension or production that emerges first. The question remains unresolved, as the authors notice: "a careful look at studies on early comprehension of iconic gestures reveals mixed findings" (2014: 2057). They conclude, however, that children are "generally using iconic gestures to bridge gaps in their linguistic repertoire" (2014: 2057; Namy et al., 2004) and that they use these gestures "in combination with speech, [which] marks their transition to an adult gesture–speech system, in which iconic gestures and speech are closely integrated and jointly contribute to the expression of the intended communicative meaning" (2014: 2058).

Vocabulary spurt, as mentioned earlier, refers to the rapid growth of a child's lexicon at around 18 months of life (Benedict, 1979). Some scholars report "gesture spurt" that happens later than vocabulary spurt, that is around 26 months of age (Özçalışkan & Goldin-Meadow, 2011). This late occurrence may result from that fact that the "mapping between symbol and referent is less straightforward, and therefore more cognitively demanding" than that of, for example, deictic gestures (Özçalışkan & Goldin-Meadow, 2011: 172). Özçalışkan and Goldin-Meadow (2011) looked at the production of iconic gestures in toddlers. They found that children's productive gestural repertoire expands at the age of 26 months, with both types and tokens for iconic gestures (2011: 168). The authors suggest that the sudden expansion of children's knowledge on use of gestures may come from observation of their parents' action in play that intensifies at that time. But they also observe that parents and children use different kinds of iconic gestures (observer vs. character gestures, 2011: 172), which stands in opposition to the explanation. The authors conclude that children begin to produce iconic gestures at the same time they start to understand these gestures, and call the time "a turning point in the child's grasp of the iconicity of a symbol" (2011: 172).

3.7. Let's talk! (31–36 mos)

When children approach their third year of age, they are becoming a fully-fledged party to conversation and interaction. It is difficult to find a single canonical description of their social and linguistic milestones in handbooks of child development, as their skill development is highly idiosyncratic and dependent on their home environment (Raviv et al., 2004) and temperament (Schmitz, 2001; Mink et al., 2014). It is known that children are very good observers; they can imitate movements and sounds produced by others. They continue asking for clarification when curious about how objects work. They start to understand numbers (Casey et al., 2018), they increasingly rehearse their language skills in imitative play, they like to talk to people they know, as well as to strangers (Reynolds, 2018), thy can now use a balance bike, as their proprioception allows them to control their movement and position, they can use scissors, draw from memory, and build simple structures with building blocks, for instance. As they become more independent and assertive, they can become moody or throw a tantrum (Potegal & Davidson, 2003), as their inner desires and rules come to guide them more consciously than before. They understand their own emotions and the emotions of others, also from nonverbal cues, and they begin to use words to describe how they feel (Dunn et al., 1991). Their executive functions change, they gradually learn to inhibit and control own behaviours (Zelazo et al., 2003). They also know and follow a daily routine, and some of them enter formal education; for example, they start to attend a kindergarten, which enriches their social contact and develops social skills.

I agree with Behne and colleagues' remark that "[m]uch is known about young children's use of deictic gestures such as pointing. Much less is known about their use of other types of communicative gestures, especially iconic or symbolic gestures" (2014: 2049). Even though this quote is now almost 10 years old, it remains valid. It is still difficult to find research on iconic gesture comprehension that would trace how children's perception of these gestures change with age and provide the ultimate answer about the role of iconic gestures in child development.

Nielsen and Dingemanse summarize that in research on symbol recognition in gesture, 18-monthers fail to see the resemblance, while 26-

monthers can recognize the meaning behind such a sign (2021: 61; Namy et al., 2004). Further, they report a somewhat contrary result for 36-monthers, who, again, cannot guess the meaning behind iconic gestures, while 48-monthers have no problem with that (Nielsen & Dingemanse, 2021: 61; Magid & Pyers, 2017). Overall, the authors state that "the recognition of iconicity is not automatic but requires some cognitive and semiotic skills to be already in place" (2021: 61). Similarly, Boyatzis and Watson explored preschoolers' gestural representation in imitated actions without object (1993). They selected a group of children between the age of 3 and 5 years and asked them to perform 2 tasks: to pretend using an object (e.g., brush your teeth), and to copy the gesture presented to them to perform the same set of actions as before (1993: 731). The gestures the children were presented with differed from their own choices from task 1: for example, if the child pretended to hold a toothbrush, in the second condition, she would be shown a stretched finger to perform the action of brushing teeth as if the finger was the object, and *vice versa*. The authors found an age-related progression in the symbolic quality of gestural representations of children (Boyatzis & Watson, 1993: 732). The researchers saw that 3-year-olds found it easier to use body-part-as-object gestures, compared to imaginary objects (1993: 732–733; see also: Mitchell & Clark, 2015). Such a result is incongruent with later research from Marentette and colleagues (2016;), who found that both strategies are used by children as young as 2 years old in gesture elicitation task.

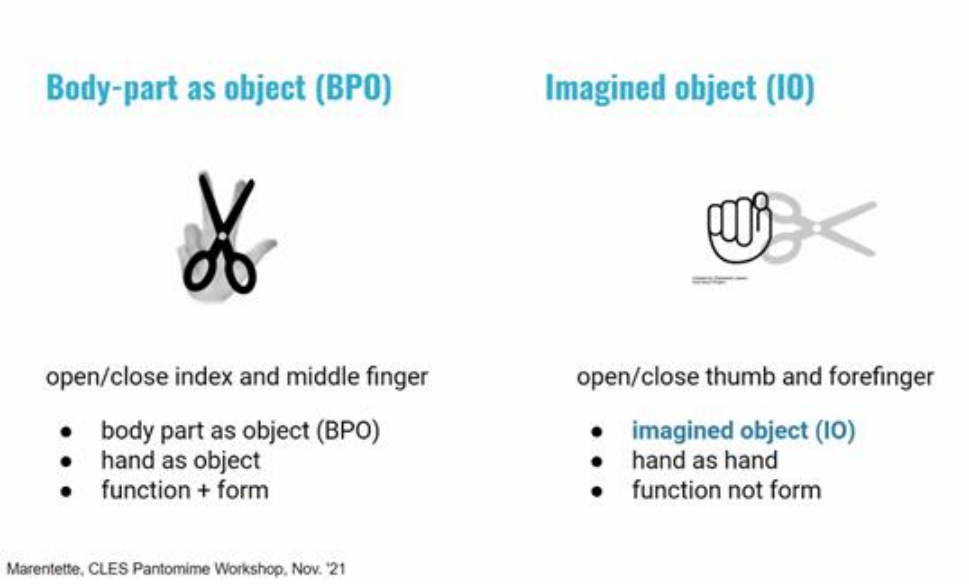


Figure 6. A slide from Paula Marentette's presentation during the workshop *Perspectives on pantomime: evolution, development, interaction*, organized by the Center for Language Evolution

(CLES) at Nicolaus Copernicus University in Toruń, 21 November 2021. Source: private communication.

Marentette's finding raises an important question: if we can see both kinds of gestures used as early as in the second year of age, can we state whether body-part-as-object (BPO, representing) or imagined-object (IO, enacting) (Figure 6) is easier to produce and, which is of interest to my research, comprehend for children? I also ask about the viewpoint, as Beattie and Shovelton (2002) write:

> The communicative power of gestures does vary greatly, and this is significantly affected by the viewpoint from which a gesture is generated, with character viewpoint gestures being more communicative than observer viewpoint gestures. (2002: 179)

The problem of viewpoint, and, crucially to the present thesis, comprehension were addressed in a study by Hodges and colleagues who wanted to test gestures that convey characteristic actions (enacting gestures) and attributes (representing gestures) (Hodges et al., 2018: 328). In their predictions, they assumed that a) children will comprehend iconic co-speech gestures conveying action and attribute around the same time, but, alternatively, they assumed that b) children would comprehend iconic co-speech gestures conveying action earlier than the ones conveying attribute. The authors hypothesized the latter to be plausible based on the insights from research on production of iconic gestures (Özçalışkan & Goldin-Meadow, 2011; Özçalışkan et al., 2014; Hodges et al., 2018: 328). The researchers invited three age groups: 2-yeal-olds, 3-year-olds and 4-year-olds to take part in the experiment. The task of each child was to select one out of two images of toys presented to them in the form of two gesture conditions: either enacting or representing. Each child was shown 12 iconic gestures representing 6 target objects twice—one per condition. Hodges and colleagues found that a) the children were getting increasingly better with age (2018: 334) and b) the children were better in recognizing the meanings behind enacting gestures (answered above chance round the age of 2; 2018: 336). A similar finding for a general skill of iconic gesture recognition in 3-year-olds, who watched pre-recorded video stimulus and live action, was found by Sekine and colleagues (2015).

A research that also served inspiration to the present thesis comes from Tolar and colleagues (2008), who were interested in the change in the comprehension of iconic gestures, in general, in children between 2.5-years-old and 5-years-old. The authors selected 36 signs from American Sign Languages and used Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997) as the basis of the forced-choice task administered to the children (Tolar et al., 2008: 228). Tolar and colleagues performed a test similar to the one by Hodges and colleagues (2018, above), but presented each child with 4 pictures and only one correct item per such a set (25% chance of correct guess; 2008: 229). The children were asked about an item in speech (e.g., "Show me a dog!") or in gesture (e.g., "Look at me [*gesturing bunny ears at the top of the head*] Which one is this?"; 2008: 230). The scholars found that 2.5-year-olds provide their answer by change, while 3.5-year-olds already possess the sign insight, and 4.5-year-olds provide "adult like answers" (2008: 234). In conclusion to their research, Tolar and colleagues note that "[t]here may be a major cognitive shift around 3 years of age that enables children to interpret the meaning of iconic gestures, pictures, and objects" (2008: 237). These results, and the results observed in the studies described earlier, lend perspectives on the emergence of sign recognition in toddlers. Yet, merging their approaches into a new research provides an exciting opportunity to extend our knowledge on sign function in young children.

4. One step further

In my research, I take inspiration from the studies presented in Section 3.7 of the present Chapter. I select enacting and representing iconic gestures for my research on comprehension abilities in children between the second and the third year of age. I test this skill by means of a forced-choice task based on a booklet of pictures. However, I take it a small step further and suggest that sign function emerges first in gesture, and only later in speech. My study is described in great detail in Chapter 3.

Chapter 3
Research design

1. Introduction

Chapter 3 discusses the aim of the thesis and outlines its research questions (RQs) as well as its research hypotheses (RHs). It presents the methods and tools selected for the project, provides detailed information about the children who took part, and outlines the procedure for their recruitment. It also discusses the experimental design, including data selection, data corroboration, and piloting. It presents the interaction outline and data collection methods. Importantly to the time period of the project, the chapter is concluded with a discussion of the impact of the COVID-19 pandemic on virtually all aspects of the research: from design and research logistics to recruitment of the families, to data collection.

2. The aim of the experiment study

As presented in Chapter 1, there are significant gaps in research on toddlers' communication. The main problems relate to the type of tasks given to children and the age groups recruited to take part in research. The design of the present study takes into consideration the underrepresentation of comprehension tasks in the second year of a child's life and beyond. It also targets a specific age group that is underrepresented in developmental research (see Chapter 2). There are two aims of the study: (a) to trace the change in the understanding of signs in two age groups of toddlers, in order to (b) provide answers to research questions and evaluate hypotheses based on these questions.

To achieve these aims, I designed an experimental procedure that investigated gesture comprehension. A forced-choice task with a single speech condition and two gesture conditions. The stimulus material was presented to children in the form of a colourful book of picture-sets. The task of each child was to match spoken or gestural representations with one of 4 pictures of objects drawn on a particular page in the book. There were 12 signs presented to the children in either the speech or the gesture conditions. The game was 3 rounds long, which resulted in each child providing 36 answers.

Information about the research questions and hypotheses, methods, tools, participants, preparation, and the course of the experiment is given the sections that follow.

2.1. Research questions and hypotheses

There are 3 research questions that this study addresses:

- Research question 1 (RQ1) concerns the change in the perception of iconic gestures that is linked to age:

  Does the understanding of signs produced in speech and gesture change in the transition period between the ages of 24- and 36-months?

- Research question 2 (RQ2) concerns the dynamics of change in children's understanding of iconic gestures:

  Is there a difference in children's comprehension of different types of iconic gestures? More specifically, I also ask if it is easier for children to comprehend one type of gesture over the other. I also ask if the change in comprehension of iconic gestures is related to age.

- Research question 3 (RQ3) concerns children's ability to understand gestures as signs prior to children's ability to understand linguistic signs:

  Does the understanding of representational expressions, i.e. the sign function, in speech precede or follow the understanding of iconic gestures?

The null hypothesis assumes there will be no preference for comprehension in any of the conditions. The experimental hypotheses are as follows:

- Hypothesis 1 (H1). As explained in Chapter 2, an increase in social experience and linguistic knowledge between the ages of 2 and 3 results in better speech and gesture comprehension. Hence, I hypothesise that **the number of correct answers will increase in the consecutive age groups irrespective of the condition** (i.e., whether the condition is speech, enacting or representing gesture);

- Hypothesis 2 focuses on iconic gestures' comprehension only, and comprises 3 sub-hypotheses. Hypothesis 2a (H2a) assumes that t**here will be a change in the guessing pattern resembling the social experience and linguistic knowledge children gain between the ages of 2 and 3, but only for items presented as gestures**. Hypothesis 2b (H2b) assumes that **the enacting gesture condition is easier for children than the representing gesture condition**. Hypothesis 2c (H2c) assumes that **the difference in the number of correct responses for the two types of iconic gestures will be decreasing with the age of the children.**

- Hypothesis 3 (H3) assumes that the children across the 3 age groups **will perform significantly better for items labelled as "difficult" in either of the gesture conditions than in the speech condition**, which would support the assumption that the sign function emerges first in gesture.

None of the research questions addresses gender differences within the groups. Such a decision is based on an extensive literature review by Rinaldi and colleagues (2021), who present that assumptions on gesture use and gender differences are inconclusive for a group of such young children.

3. Methods and tools

To address my research questions and hypotheses, I selected an experimental paradigm based on a forced-choice task that requires the participant to provide only one correct answer from a selection of 4 possibilities (Berlyne, 1957; Naefgen, 2019). The task is combined with semi-naturalistic observation of children in interaction (to later explore their behaviours), which was recorded with one camera (SONY HDR-CX405B). The interactions were additionally described in my notes. The parents were asked to fill in such documentation as GDPR consent, developmental survey, Socioeconomic survey, or COVID-19 self-assessment survey. Full documentation is attached to the project as Appendices A-C. The documentation is provided in Polish.

Experimental methods are commonly used in research on children (see Chapter 2). The strength of these lies in its "gamification": the opportunity of

turning the task into a game-like scenario (Singh, 2012). Gamification makes children take part in the activity more willingly and increases their comfort during data collection. If research is conducted in the laboratory context, gamification of the design can help the child adapt to a new environment, which translates into obtaining more reliable data compared to experimental paradigms that require formal approach. In my design, I used a forced-choice task that was presented to a child as a game of charades involving hands, in which the goal of the child was to match the gesture they saw with a correct answer selected out of 4 possibilities. The design is described in detail in further sections.

Naturalistic observation is a qualitative method in which the researcher observes spontaneous behaviours of the participants in real-life settings (Eby, 2011) without getting involved. The strength of the method lies in its directness and ecological validity, although the researcher should not generalize observations or over-interpret what they see (Mestre, 2012). Here, I adopted the "semi-naturalist" approach on the following factors of this study:

- the task given to the participants as well as the entire interaction followed a pre-planned scenario, but the children could take a break from the game as well as play or eat during the interaction;
- due to the COVID-19 restrictions, the parents were able to choose the meeting place for the experiment: either at their home or in Nicolaus Copernicus University's Baby Lab in Interdisciplinary Center for Modern Technologies (www.icnt.umk.pl/badania/zespol-zifi/lnk/babylab/). The lab was adjusted to look like a playroom; the children were given time to adapt to the new surrounding.

Combining the experimental paradigm with naturalistic observation not only provides more data on children's choices during the experiment, but also lends perspectives on their general development and their attitude to the task throughout the meeting. To deepen the understanding of the developmental stage of the children partaking in the project and to see whether the studied age groups are uniform, I interviewed each parent on their children's general skills and their developmental progress. I asked them whether their children are familiar with the

words that I used in the experiment. Additionally, I collected written reports from each parent (including GDPR consent). The reports contained questions about the family's socioeconomic status (SES) and a set of questions regarding the child's development of their:

- motor skills;
- linguistic skills;
- social and emotional skills;
- general cognitive abilities.

I did not employ diagnostic tools that would require the supervision of a psychologist. Instead, I created a very short questionnaire based on the adapted Polish version of MacArthur–Bates Communicative Development Inventories (CDI, as in: Fenson et al., 2006; Smoczyńska et al., 2015) and Rothbarth's Early Childhood Behaviour Questionnaire (ECBQ, as in: Putnam et al., 2006; Rothbart, 1981), both of which are described in the following section. In addition to the questionnaires, I conducted an interview with each parent.

Such a step was dictated by the parent's approach to the meeting and the requirements for data collection, which were both linked to the COVID-19 pandemic limitations. The university's and governmental regulations obliged me to conduct a short medical survey and take the participants' body temperature before they entered the university facility. These difficult decisions to shorten the documentation and hence the meeting were made after four families had resigned from taking part in the research due to the number of documents they had to go through and the general issues regarding health precautions (years 2020 and 2021).

3.1. Developmental Measures

Child development is marked by profound changes at many levels; hence, there is a number of tools dedicated to measure various skills at different stages of development. The MacArthur–Bates Communicative Development Inventory (CDI) is the most popular measure used to examine linguistic development of children. Google Scholar engine returns more than 500,000 mentions when asked for CDI use in research papers. Rothbart's Early Childhood Behaviour

Questionnaire (ECBQ), which evaluates the child's temperament and early personality, returns more than 400,000 results (Google Scholar, date of search: 23 February 2023). Based on these two diagnostic tools, I decided to create a very short questionnaire for the parents. The CDI and ECBQ, as well as the reasons for creating a separate tool based on them, are described in more detail below.

Another tool that provides insight into child development is the socioeconomic status (SES) questionnaire. Research shows that social and economic factors have an effect on the child's development of cognitive and social skills (Guidubaldi & Perry, 1984). SES gives basic insight in the immediate environment of the child and the stimuli the child is exposed to on a daily basis. The SES questionnaire is described in detail below.

The data obtained by means of the 2 measures mentioned above can be expressed numerically; however, parental interviews do not always provide data that are easily quantifiable. To gain a better understanding of the participants, apart from using the SES measure and the CDI- and ECBQ-based questionnaires, I asked the parents to fill in an additional questionnaire on their children. The document contains questions about:

- whether the child has siblings and, if so, what their age is;
- the child's schooling, that is, whether they attended nursery or kindergarten at the time of the experiment;
- the child's relationships within the family, including the question if it is the parents who take care of their children most of the time;
- whether the child presents developmental deficits and has received developmental treatment or therapy;
- the child's most common behaviours and routines.

I also had an informal conversation with each parent about their children. Here, my questions concerned the children's general behaviour and language skills, their daily routine, and their attitude to strangers. I also briefly talked with the parents about the vocabulary items used in the research. Overall, the parents spoke about their children willingly: they talked about their linguistic abilities and

language production, but also about their personality: whether the children are bold, shy, or easily irritated

3.1.1. Communicative Development Inventory (CDI)

Communicative Development Inventory is a research tool which serves to examine the child's general communicative ability, lexicon, and vocabulary growth from 8 months onwards (Fenson et al., 1994; Fenson et al., 2000). The Inventory is an individually administered, standardized, normative measure that relies on parental reports. It can be used to investigate communicative skills of typically and atypically developing children; it is divided into production and comprehension sections (Fenson et al., 2006). It can also be used as a diagnostic tool for language delays and language impairment screening (Hick et al., 2002; Hadley, 2006; Skarakis-Doyle et al., 2009). The task of the parent is to fill in a selection of check-lists on various thematic domains, such as extra-/nonverbal communicative behaviour, use of fixed phrases, knowledge of action words, onomatopoeias, food ailments, and so on (Hamilton et al., 2000; Fenson et al., 2006).

The advantage of using the CDI lies in its screening sensitivity and accuracy. Yet, the administrator should have background in psychometry, psychology or a related field to be able to properly interpret the results of the survey. It is more convenient to ask parents about their child's development rather than conduct an extensive observation of the child in natural situations and draw conclusions based on this observation. However, the disadvantage of the CDI is that the parents' assumptions about their child may influence results, for instance when they overstate the child's knowledge communicative skills. Parents are closest to the child, but their general education, knowledge of how children develop metalinguistic knowledge, or skills of observation differ and may affect their answers (Smoczyńska, 2015a). Therefore, the CDI should not be the only tool to trace the communicative development of children.

There are Polish adaptations of two parts of the CDI: Words and Gestures (8–18 months, Smoczyńska, 2015a) and Words and Sentences (18–30 months, Smoczyńska, 2015b), both of which were used in my research. As explained above, I did not ask the parents to fill in an entire questionnaire; instead, based on the CDI, I created a list of questions related to general communicative behaviours

of children. The answers provided me with information on general linguistic development of the participants, but were not expressly linked to my hypotheses. Rather, they shed light on the development of the linguistic abilities of their children and enabled me to assess the uniformity of the groups. Further, the answers provided by the parents allowed me to estimate whether the child's language development is the same as her peers in the group. My survey included 17 statements related to language perception and language production. The task of the parents was to decide whether their child presents or does not present a particular behaviour, for example: "The child a) uses pointing, b) does not use pointing to draw attention to objects" or "The child a) uses onomatopoeia b) does not use onomatopoeia for naming and communication". The answers were coded as "a" and "b". The score with more a's suggested language development appropriate to the child's age; the score with more b's suggested potential language delay that should be inspected more closely.

3.1.2. Early Childhood Behaviour Questionnaire (ECBQ)

Infant Behaviour Questionnaire (IBQ) and Early Childhood Behaviour Questionnaire (ECBQ) are tools that help understand the interplay between the infant's behaviour and her temperament between the ages of 3 to 12 months and 12 to 36 months (Rothbart, 1978, 1981; Putnam et al., 2014; cf. Goldsmith, 1996). These tools are research measures that are attuned to typically developing children and examine the child's early temperament and social behaviour. It is an individually administered, standardised, normative measure that relies on parental reports (Putnam et al., 2006). In ECBQ, the parents' task is to use a 7-point Likert scale to provide answers about the prevalence of a number of the child's behaviours; for example, "How often did your child 'sit quietly and watch' or how often did your child 'become sadly tearful in daily contexts' when told 'No'". The answers on the scale range from "never" to "always" (www.psychtools.info/ecbq; for more tools, visit: www.research.bowdoin.edu/rothbart-temperament-questionnaires/instrument-descriptions).

Temperament is a biologically motivated "earliest emerging characteristic within individual" (Nasvytienė & Lazdauskas, 2021: 737; Bates, 1989) which "predisposes the child to interact with the environment" (Nasvytienė &

Lazdauskas, 2021: 737) and tends to stay unchanged across one's lifetime (Bates, 1989; Goldsmith et al., 1987). Temperament "describes the initial state from which personality develops and links individual differences in behaviour to underlying neural networks" (Rothbart, 2007: 207). Aspects of temperament can interact with one another but they can also be viewed as isolated features (Goldsmith et al., 1987). These aspects include the child's: behaviour (Thomas & Ches, 1977), sensibility and resilience (Rothbart & Derryberry, 1981; Rouse, 1998; Wachs, 2006), arousal and reactivity (Kagan, 1984; related to ADHD: Miller et al., 2019), emotionality and sociability (Buss & Plomin, 1984), and general activity (e.g., vigour, motor skills, coordination; Saudino & Eaton, 1991; Campbell & Eaton, 1999). Gathering knowledge and developing the ability to reason at early stages of the child's life is connected to causal learning: observation and imitation (Huang & Charman, 2005; Ray & Heyes, 2011) as well as emotions accompanying these experiences (Calkins & Bell, 2010). We can therefore assume that "children's temperaments affect their learning and its outcomes" and that temperament "accounts for a child's ability to use what they know" (Nasvytienė & Lazdauskas, 2021: 736).

According to Bates and Wachs (1994) as well as Rothbarth (2007), there are three dimensions of personality traits that are regulated by one's temperament: Effortful control (EC), related to motor and cognitive executive functions based on attention mechanisms; Negative affectivity (NA), related to mood and emotional control; and Surgency (SU), related to vigorousness and sociability (Nasvytienė & Lazdauskas, 2021: 737). Based on these general domains and some of the questions from the ECBQ, I created a set of 12 statements related to the temperament of children. The task of the parents was to decide whether their child presents or does not present a behaviour; for example: "The child a) likes to engage in new activities, b) does not like to engage in new activities". The answers were coded as "a" and "b". The score with more a's suggested more extrovert-related traits; the score with more b's, suggested more introvert-related traits.

Parents' choices shed light on the general development of their children's temperament and enabled me to assess the uniformity of the groups, but were not linked to the hypotheses. The answers provided by the parents allowed me to estimate whether the child's dimensions of temperament are closer to that of an

introvert or an extrovert. According to Garstein and Rothbart, introvertism and extrovertism refer to the child's predisposition to respond to the environmental input, as well as estimate the interest the child shows towards her closest environment, including social contacts and physical objects (2003). Pérez-Pereira and colleagues suggest that there is a link between emotions accompanying daily experiences and language development (2016). They refer to the research from 1992 by Slomkowski and colleagues, who report that extroverted children at the ages of 2 and 3 were "more advanced in referential abilities than introverted children" (Slomkowski et al. in Pérez-Pereira et al., 2016: 12), which can be explained by the former's frequent and dynamic interactions with others. Further, a study into 24-monthers' temperament suggested a negative correlation between shyness and vocabulary production (Prior et al.; 2008; cf. research on shyness and education by Crozier & Hostettler, 2003).

3.1.3. Socioeconomic status questionnaire (the SES)

Socioeconomic status (SES) is a questionnaire widely used in sociological and psychological research, which serves to gather data on economic and social status of a person or a group of people (Baker, 2014). It is composed of questions that relate to the place of living, educational background, household income, occupation and lifestyle (Oakes & Rossi, 2003). The SES is also strongly related to the condition of health and widely used in health-related research (Baker, 2014; Sahni et al., 2017; cf. Stormacq et al., 2019). The SES questionnaire can provide insights into developmental possibilities of children (Hoff & Tian, 2005; Mondal et al., 2016; Pace et al., 2017), as they are related to their social and economic situation (Guidubaldi & Perry, 1984; DeGarmo et al., 1999).

Research linking linguistic development and socioeconomic status of families suggests that children are encouraged to speak in high-SES families as parents pose more open-ended questions and are more engaged during conversations with their children. Similarly, high-SES parents read to their children on a regular basis and establish joint attention with their children in numerous everyday activities (Hoff et al., 2002; Aikens & Barbarin, 2008; Clark, 2016; Farrant & Zubrick, 2012; Liu & Lachman, 2019). Conversely, low-SES family members often use directives and yes/no questions while talking to other members of the family. They take less time to play with their children, to read to

them, or to engage in activities that encourage joint attention (Evans, 2004; Clark, 2016: 44–46). The difference between low- and high-SES families also comes from the amount of stimulus children receive: there are differences in the amount and type of toys and everyday objects, access to media or additional activities, such as the use of swimming pool, in favour of children from higher-income families (Tandon et al., 2012), and the ability to focus attention on a particular task (Clearfield & Jedd, 2013). The poverty of stimulus can manifest itself later in the child's command of knowledge of grammatical structure of a language (Vasilyeva et al., 2008; Clark, 2016; Klucznion & Mudiappa, 2019) and vocabulary size (Highberger & Brooks, 1973; Hart & Risley, 1995; Hackman & Farah, 2009; Pace et al., 2017; Merz et al., 2020).

There are several sets of criteria used to group the inhabitants of Poland into socioeconomic classes. The most common criteria for grouping are education-related and income-related. For the purpose of my research, I decided to look at the Household Available Income (HAI; monthly), that is the net income of a family *per capita* (Statistics Poland webpage 10.03.2023), and additionally report the education of the parents of children taking part in the experiment. The median income values for social classes are taken from a survey conducted by the Polish Economic Institute in 2019 for 24- to 64-year-old Poles. The report conducted by the Polish Economic Institute is available on their web page (Polish Economic Institute, *Klasa średnia w Polsce Report,* 02.02.2021; Figure 7)

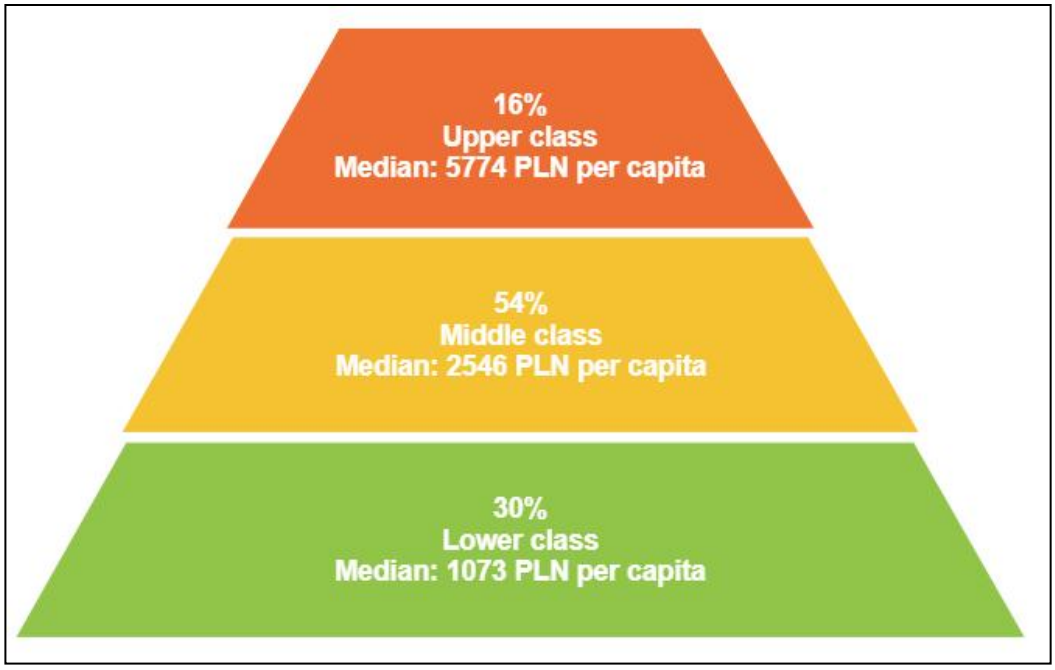


Figure 7. Social groups in Poland. Median net income per family member (Polish Economic Institute, *Klasa średnia w Polsce Report,* 02.02.2021).

The document issued by the Statistics Poland reports higher education of the members of the groups presented in Figure 7. According to the report, 0.54 of members of the upper class hold a university degree, 0.26 of the middle class hold a university degree, and 0.5 of the lower class hold a university degree (*Klasa średnia w Polsce Report* 02.02.2021).

When comparing groups of toddlers in experimental or descriptive research, looking at the socioeconomic status of their family can be a key factor in understanding the developmental dynamics of individuals we are working with. For this research, it was crucial that the groups do not come from the extreme top or bottom of the social hierarchy. Since the SES provides information on parenting methods that affect children's cognitive and social abilities, it can also inform us whether children we look at are at the same developmental stage and, hence, whether the groups created for research purposes are uniform. In this regard, the SES complements the children's performance in the experiment.

4. Selection of stimulus material and its verification

Selecting and verifying the stimulus material used in the study consisted of several steps. These steps assured the reliability of the results of the experiment. They concerned: the number of target items per page, the complexity of target

items (gestures difficult to map onto the referent), how familiar they were expected to be for children at the ages of interest (the criterion of difficulty, see below), and their representational, or better: "iconization" potential, that is, how easy it was to express them by means of iconic gestures. The last criterion was especially important as it directly reflects on the research questions of the thesis:

1. Does the understanding of signs produced in speech and gesture change in the transition period between the ages of 24- and 36-months?
2. Is there a difference in children's comprehension of different types of iconic gestures?
3. Does the understanding of representational expressions in speech precede or follow the understanding of iconic gestures in particular cases and in general?

This motivated the decision that each item should be presented to each child twice: once as an enacting gesture and once as a representing gesture.

The first step was to decide how many target items overall should be used in the study. Too many items would make the task too long and tiring for the children. Following Hodges and colleagues (2018), as well as Tolar and colleagues (2008), in consideration of the research questions, I decided that 12 items, balanced for difficulty (6 "easy" vs. 6 "difficult" items), presented in 3 consecutive rounds, should be presented to each child. A pilot conducted to determine an optimal number of items, which itself did not contain target items, with a 2-year-old, a pair of 3-year-olds, a 4-year-old, and a 6-year-old confirmed that this amount of the stimulus material was fully acceptable (the 4- and 6-year-old were the siblings of the younger children). The task of each child was to match either spoken or gestural representation with a picture from the book. The task was the most difficult for the youngest child, probably due to her lack of interest. The task took the longest to complete by one of the 3-year-olds, due to distractors and play breaks. The other 3-year-old was, on the other hand, the fastest, possibly due to her strong focus on the game. Despite these differences, all age groups were able to finish the task. However, their success rates varied, which led to the decision to insert breaks between rounds. Further, based on the

results of the pilot and insight from previous research (see Chapter 2), I decided to use 4 items per page.

The entire game consisted of 3 rounds with 12 items to match in each round. The stimulus material was provided to children in the form of a cartoon book with pictures of various items (Appendix E). The book had 36 pages and, as already mentioned, there were 4 items on each page: 1 target item and 3 distractors (Figure 8-10.). Each time the participant had 25% chance of providing a correct answer.

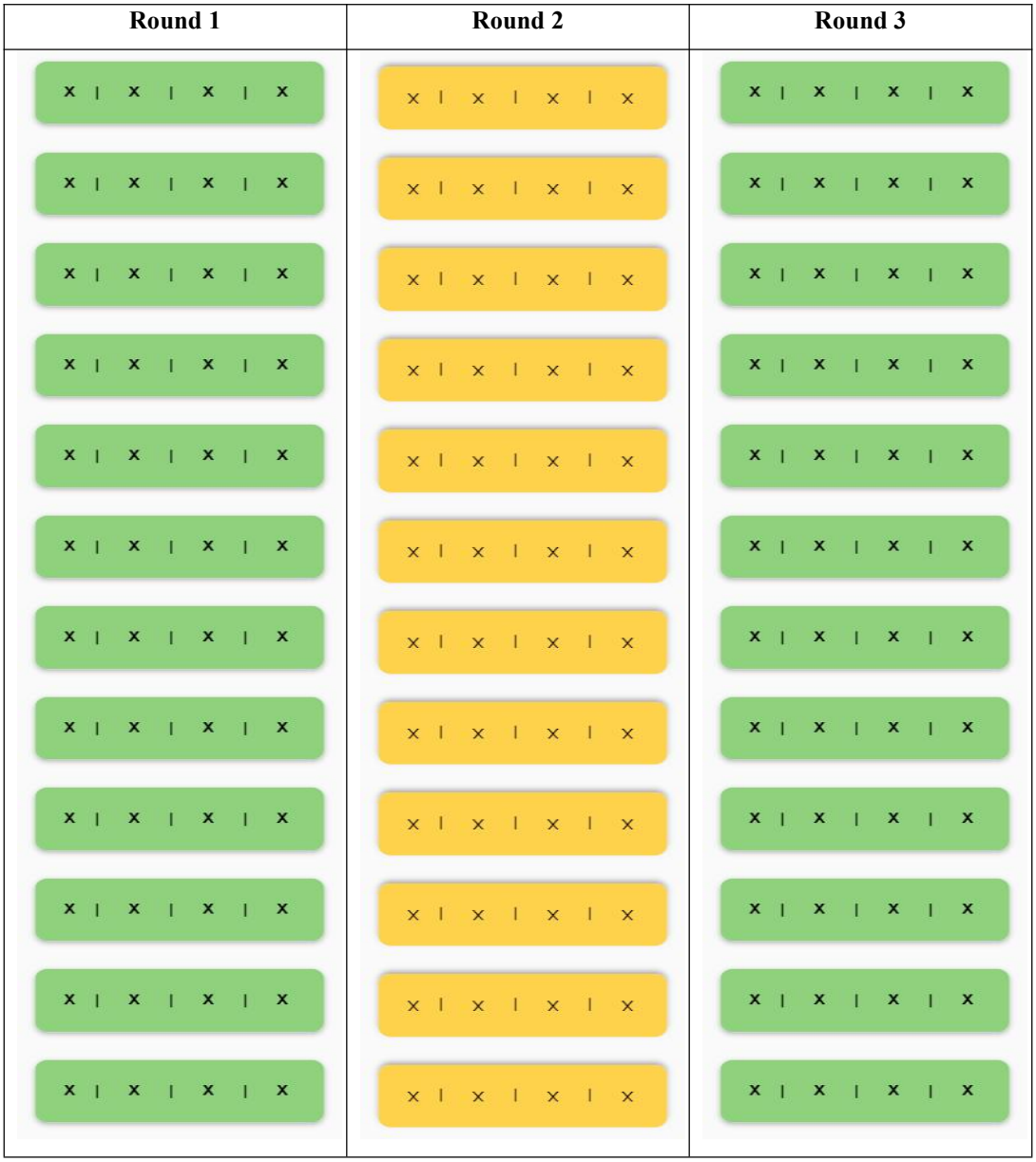


Figure 8. Layout of the material. The "X" stands for the items the child had to choose from. Only one them was the target item.

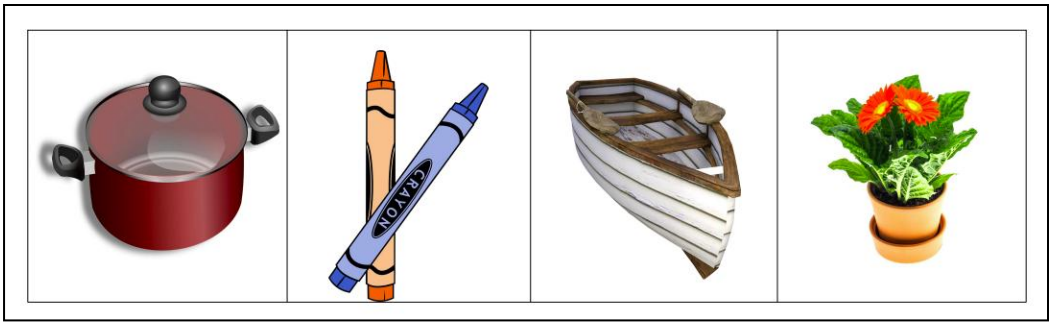


Figure 9. A sample page from the book with 4 items: 1 target item (crayons) and 3 distractors.

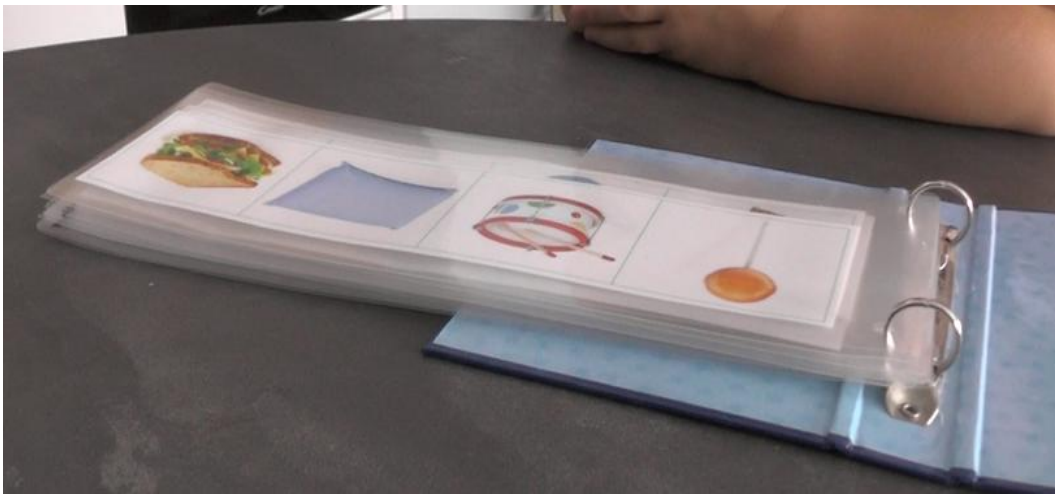


Figure 10. The book used during the experiment.

The second step was to carefully choose the target items that would match the difficulty criterion. Hypothesis 3 assumes that at least for some items (which the children may recognize, but lack word for) it will be easier to guess in the gestures conditions compared to the speech condition. In order to balance the difficulty level of the task and avoid the ceiling effect, there were 6 objects of everyday use that the children in the 3 groups should be familiar with. These 6 items were selected from the Polish adaptation of the Communicative Development Inventory: IRMiK SiG (Words and Gestures CDI for 8–18-monthers). Based on the information given in the inventory, it was assumed that children at the ages of 24- 30- and 36-months should be familiar with the following items: ball, book, crayon, glasses, rake, scissors. There were also 6 objects that children were expected to be less familiar with. These included: boat, cleaver, fishing rod, ladder, laptop, pepper mill. None of these objects are included in the Polish adaptation of the Communicative Development Inventory: IRMiK SiG (Words and Gestures CDI for 8-18-monthers), and only one of them

(ladder) appears in the Communicative Development Inventory: IRMiK SiZ (Words and Sentences CDI for 18-36-monthers) (Table 6).

Table 6. The list of target words used in the experiment. The words are grouped for difficulty.

	Easy	**Difficult**
1	ball	boat
2	book	cleaver
3	crayon	fishing rod
4	glasses	ladder
5	rake	laptop
6	scissors	pepper mill

4.1. Material verification witch children

The third step was to check children's knowledge of the selected items in speech. The entire material was verified for general familiarity with two groups of kindergarten children. The groups comprised of 3.5-year-olds and 4.5-year-olds attending one of the kindergarten facilities located in the city of Toruń, Poland. There were 15 children in each group. The material was presented to the children in the form of a guessing card game. The researcher sat on one end of the carpet and was facing the group sitting in a row on the other side of the carpet (see Figure 11-11A). All of the pictures, selected randomly, were presented to the children one after another. The task of the children was to raise their hand if they knew the word for the item they saw on the card. During the game, the researcher said: "Who knows this object, please raise your hand!". Then, the children were individually asked to provide the researcher with the name of the item. During individual naming, the researcher said: "What is the name of this object?", "What can you do with this object?", or "Where can you find this object?", in cases when the child was not sure about the correctness of her answer. Sometimes, the children used near synonyms or paraphrases for the items; for example, "laptop" was named as "computer"; „cleaver" as "knife"; "pepper mill" was described with the sentence "there is pepper inside"; and "fishing rod" with the sentence "you can catch fish with this". Such answers showed that the children knew the object shown in the image they saw.

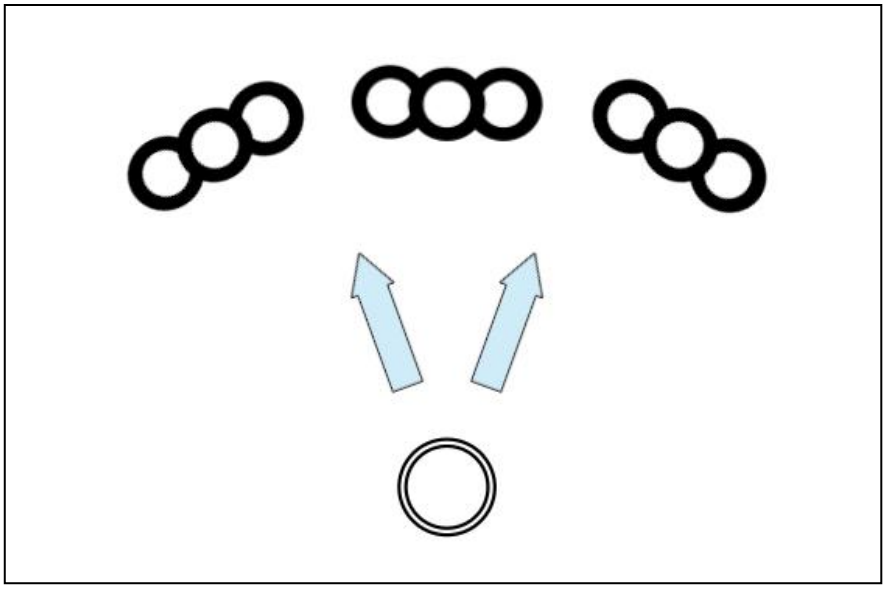
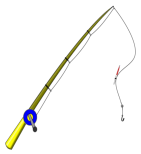


Figure 11. The setup for testing for item familiarity with a group of kindergarten children. The circle with an empty ring represent the experimenter; the smaller circles with bold rings represent the children.

Figure 11A. The cards selected for the experiment, that were shown to a group of kindergarten children.

The images used in the research were downloaded from Pixabay: a media website offering free video, music, images, graphics, and photography. This repository stocks images created in the same style and related to a large range of topical areas. All of the images have a Creative Commons license: CC0 aka "No Rights Reserved". The weblinks to the target images and the names of their authors are provided in Appendix F (Table 7). The fillers used in the book and links to them are provided in Appendix G.

Table 7. The items used in the task. The first two rows present the easy items.

ball	book	crayon	glasses	rake	scissors
					
boat	cleaver	fishing rod	ladder	laptop	pepper mill
					

The use of replicas rather than pictures as iconic sign has been shown to be easier for children in the age of 2-3 (e.g. Zlatev et al. 2013). Yet, replicas were not used in the current study for two reasons:

- they are more likely to distract children than images of objects;
- due to sanitary restrictions, they would have had to be frequently disinfected.

The easiest way to meet the epidemiological recommendations was to create a set of laminated pages that could be easily cleaned with a disinfectant between the games with different children.

4.2. Verification of stimulus material with adults: phase 1

The potential for iconic representation was another criterion for the choice of stimulus items. While preparing the stimulus material, I decided which iconic gesture should represent which item. Since I am an active user of the Polish Sign Language, my gestures could be influenced by its vocabulary. Additionally, I wanted to exclude emblems from the stimulus. For this reason, I verified my choice of gestures with non-signers.

The gestures were performed in two conditions, just as they were later performed in the task with children: *enacting*, associated with the action the

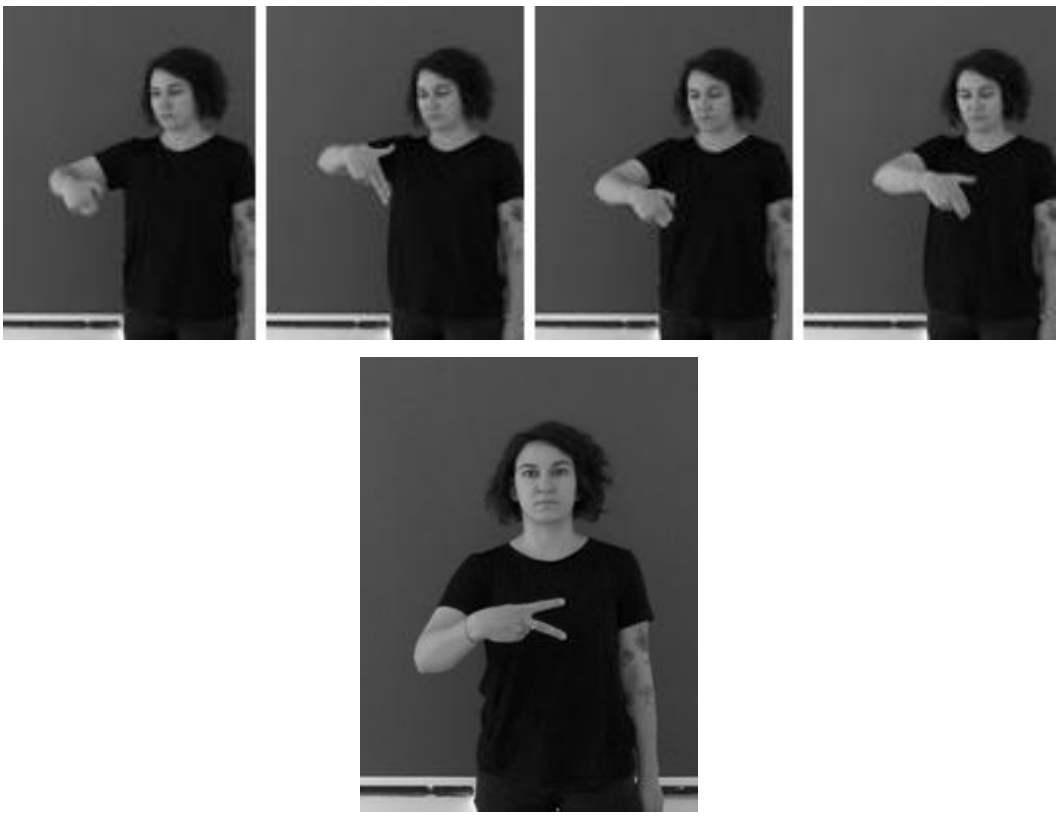
object is used for (IO, see Chapter 2) and *representing*, associated with the physical features of the object, particularly its shape (BPO, see Chapter 2). These two conditions are exemplified with a set of pictures. The actions done to/with the item or the characteristic features of these items, presented to the children in the game, can be seen in sample Pictures 2–6 below. The selection of enactments and representations was verified for appropriateness with the help of 20 adults (mean age: 31.85, median: 29.5, F=12, number of parents: 7), as I wanted to see whether it is correct that the gestures I selected would be produced by others in the same manner. Importantly, Polish women become mothers when they are ~28 years old (Frączyk, 2021) and men become fathers when they are ~33 years old (Tkaczyk, 2021). Therefore, I invited individuals whose respective age was close to these means. All of the participants had children in their families, and some of them had their own children.

Picture 2. Item: ball. Enacting gesture sequence on the left. Representing gesture on the right.

Picture 3. Item: boat. Enacting gesture sequence on the left. Representing gesture on the right.

Picture 4. Item: glasses. Enacting gesture sequence on the left. Representing gesture on the right.

Picture 5. Item: fishing rod. Enacting gesture sequence at the top. Representing gesture below.



Picture 6. Item: scissors. Enacting gesture sequence at the top. Representing gesture below.

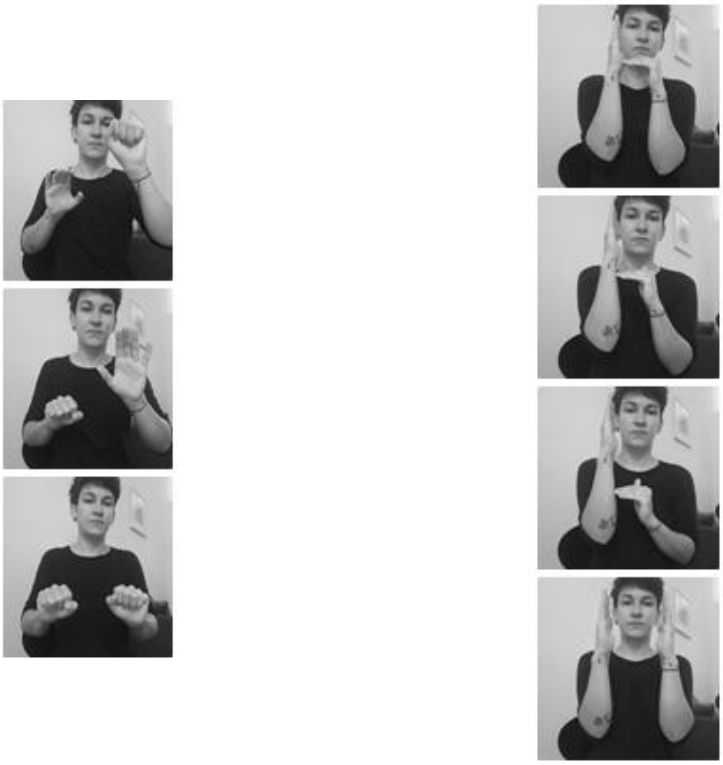
The adults who took part in the verification were requested to produce gestures in 2 conditions: (1) to communicate how to use an object solely by

means of gesture; (2) to communicate what this object looks like solely by means of gesture. This task allowed me to verify if my choices for iconic representations of the items in the two conditions were correct. The gestures produced by the adults were coded as 0–1, where 1 indicated that there was a considerable similarity between a gestural representation produced by an adult and myself. The results of the verification are shown in Table 8.

Table 8. Selected items verified for two types of iconicity with a group of 20 adults.

Item	**Enacting**	**% attested similarity**	**Representing**	**% attested similarity**
ball	20	100%	17	85%
book	20	100%	20	100%
crayon	18	90%	20	100%
glasses	18	90%	20	100%
rake	14	70%	20	100%
scissors	15	75%	20	100%
boat	20	100%	18	90%
cleaver	15	75%	20	100%
fishing rod	20	100%	20	100%
ladder	20	100%	9	45%
laptop	20	100%	17	85%
pepper mill	20	100%	16	80%

There was one case where the ratio score was below 50%: the „Ladder” - only 45% of gestures for representing “ladder” matched the gesture selected by the researcher. After discussion with my supervisors, a consensus was reached that “ladder” should be included in the stimulus material. The decision was motivated by the fact the item was included in the set of “difficult” items, which were intended to be challenging for the participants. Pictures 7 and 7A present how the item was shown in the two conditions.



Picture 7 and 7A. The gestures used for ladder: enacting (on the left) and representing (on the right). Read from bottom upwards.

4.3. Order of conditions

The material was balanced for difficulty. The material was presented to the children in the pre-established order of the conditions for the target items, as shown in Table 9. Speech was considered the easiest condition, therefore, it was equally distributed throughout the material. This was done to increase the chance of giving a correct answer, which was intended to motivate the children to keep playing the game with maximum focus. The "easy" (E) and "difficult" (D) items were distributed symmetrically throughout the material (Table 9).

Table 9. Distribution of conditions throughout the game.

Round 1	E/D	Round 2	E/D	Round 3	E/D
Speech	E	Enacting	E	Speech	E
Enacting	D	Representing	D	Enacting	D
Representing	E	Speech	D	Representing	E
Speech	D	Enacting	E	Speech	D
Enacting	D	Representing	D	Enacting	D
Representing	E	Speech	E	Representing	E

Speech	E	Enacting	E	Speech	E
Enacting	D	Representing	D	Enacting	D
Representing	D	Speech	E	Representing	D
Speech	E	Enacting	D	Speech	E
Enacting	D	Representing	D	Enacting	D
Representing	E	Speech	E	Representing	E

4.4. Verification of stimulus material with adults: phase 2

The final version of the stimulus and the procedure was developed in the wake of a second verification with a group of 10 young adults (mean age: 22.5, median: 21.5, F=6) invited to the lab of the Center for Language Evolution Studies at the Nicolaus Copernicus University in Toruń (www.cles.umk.pl). The task of the adults was to play the game with the experimenter in order to rehearse the entire procedure and check the material for mistakes and inconsistencies before the experiment proper. The adults were given the same instructions as were planned for children: they were requested to focus on a page indicated by the researcher, then focus on her gesture or speech, and, at the end, use pointing to identify a target among four cartoons shown on the page. They had to sign a written consent. Their performance was recorded with a single camera (SONY HDR-CX405B) and their output checked for identification mistakes. The mean time of the game = 3.31 minutes, median = 3.34 minutes. Table 10 shows the results as the percentage of correct answers.

Table 10. The results of the second phase of the verification procedure.

ID	Gender	Age	% correct	Mistakes
1	K	28	100%	
2	K	21	100%	
3	K	20	100%	
4	M	20	100%	
5	M	21	97%	item 36: scissors
6	M	20	94%	item 34: book; item 36: scissors
7	K	22	97%	item 36: scissors
8	K	25	100%	
9	M	20	100%	
10	M	28	100%	

5. Procedure: participants and recruitment

The acquisition and command of language and other semiotic systems develop rapidly in the third year of the child's life (see Chapter 2). Since there has not been much research into the communicative abilities of children during the transition between 2 and 3 years of age, I chose this particular time frame to examine. A total of 30 typically developing 2- to 3-year-old children participated in the forced-choice gesture task designed for this research.

The families were recruited using several ways of information sharing. About 700 people were notified about the research via a newsletter from the IMSErt Center of Excellence of the Nicolaus Copernicus University in Toruń (www.umk.pl/idub-/centra/interakcje-umysl-spoleczenstwo-srodowisko).
Additionally, email invitations were sent to local kindergartens and nurseries. One local kindergarten agreed to share research leaflets with the parents of the children from the youngest class. Invitations were also spread in the form of recommendations by the parents whose children had already taken part in the experiment. The parents were informed that they would have to fill in several documents and that the interaction throughout the task would be recorded with a single camera, but their child's personal information and appearance will be anonymized for data processing and analysis (see Chapter 4). The parents were encouraged to ask clarification questions via email and during the meeting.

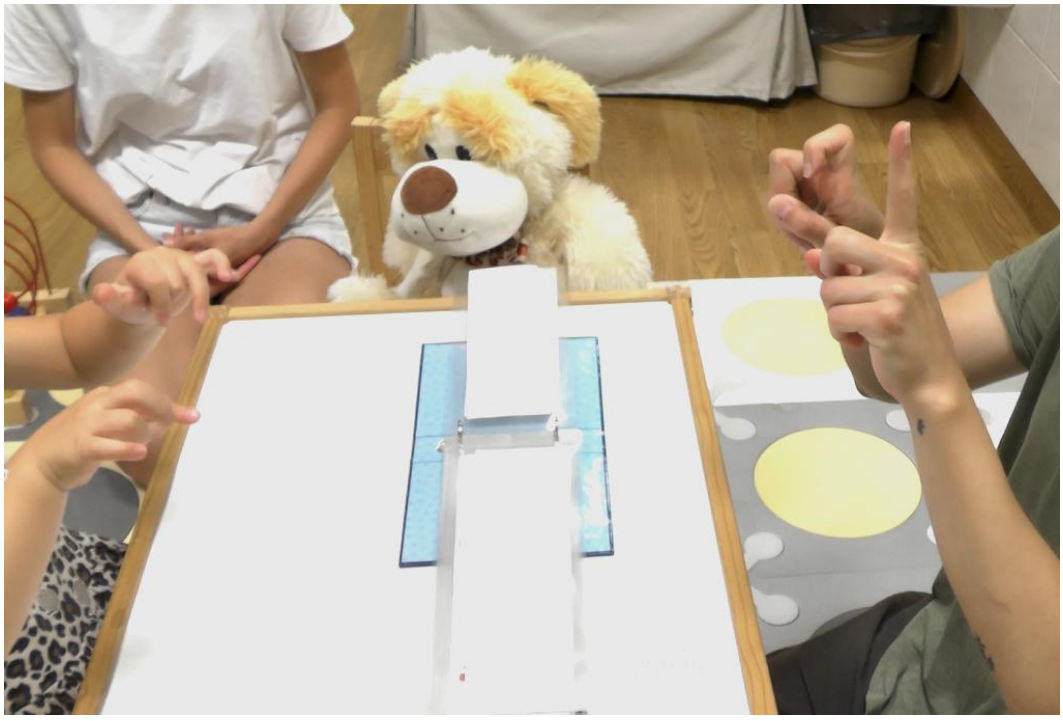
5.1. Participant preparation

The families were requested to suggest the date of the meeting via email. To maintain a relatively predictable schedule, they were asked to provide the time of the meeting that would be set after the feeding and naptime of the child. This helped me exclude additional factors that could influence the child's behaviour and attention throughout the task. The process of preparing for the experiment was twofold.

First, the parents who volunteered to take part in the research were asked to inform their child about the game and about the visit in the Lab or about the researcher's visit at home. They were also explicitly requested to tell the child that they were going to play a guessing game (Polish: *zgadywanka*) with the researcher and that they would be given a small reward for playing the game (a book, a game, and a set of stickers). No more details about the game were

disclosed to the parents and the children before the meeting. Many parents taught their children to call the researcher “aunt”, which is a common practice in Poland when referring to female acquaintances. This phase was supposed to help the child prepare for an interaction with the researcher and to make the visit less stressful.

During the second phase, before the game began, I spoke with the children and played with them for a while to see how they behave when interacting with the researcher. There was a warm-up exercise during which the children were supposed to guess the meaning of different sounds presented to them (e.g., animal sounds), which were not used at any point of the experiment proper. Throughout the task, to maintain their interest in the game, the children were encouraged to engage in activities such as arm stretching or were asked to use their nose or feet to provide answers to the questions (Picture 8). They were also allowed to ask the researcher questions in the same manner as they were posed to them.



Picture 8. Hand stretches before the game in the Lab. The stretches were performed during the warm-up exercise to help the child relax in the new environment.

5.2. Group characteristics: parental report

To grasp the differences resulting from the children’s age and daily routine and to gain an insight into their language development, I interviewed the parents of the

children divided into the 3 age groups of interest: 24-monthers, 30-monthers, and 36-monthers. There were 10 children in each group. Not all of the children attended preschool at the time of the research; there were differences between the children in terms of their extracurricular activities as well as their family structure (e.g., number of siblings). The data describing each child is presented in Tables 11–13. The child's age is provided in months, siblings are marked as B for brothers and S for sisters, and the age of sibling is given as an "-X", where the "X" stands for the age of the sibling provided in years.

Table 11. 24-monthers, characteristics based on the parental report.

ID	Gender	Age	Siblings	Daycare	Caregivers if no daycare	Other activities
1	F	24	x	v		-
2	F	24	B-4	x	parents	-
3	F	24	x	v		arts, music
4	M	27	x	x	grandmother	-
5	M	24	x	x	mother	sitting therapy
6	M	24	B-4	v		-
7	F	24	S-6	v	nanny	
8	M	24	x	x	grandmother, nanny	-
9	M	26	x	x	grandmother, mother	-
10	F	25	x	v	-	-

The data from parental reports collected for the group of 24-monthers (mean age: 24.6, median: 24, F=5) shows that not all of the children attended preschool yet, with 6 of the children given care at home either from a family member or from a professional caregiver. One child attended physiotherapy to strengthen the abdomen muscles, which was to facilitate her ability to sit properly (W-sitting, core activation). One parent stated explicitly that the crèche offered arts and music classes. Other parents selected some of extracurricular activities from the list (dancing, swimming, horse riding, music lessons, arts classes, foreign language classes), most often: music, arts, and foreign language classes, but an in-depth interview and the parents' comments in the survey indicated that what they mean are mainly home activities, such as watching cartoons in English. None of the parents reported language delays or other developmental delays. Two parents

did not agree to record the interaction with their children. In these two cases, the researcher relied on notes taken during the task.

Table 12. 30-monthers, characteristics based on the parental reports.

ID	Gender	Age	Siblings	Daycare	Caregivers if no daycare	Other activities
11	F	31	x	v	-	English
12	F	32	x	v	-	English
13	M	29	x	v	-	English
14	M	30	S-4	v	-	-
15	M	30	x	v	-	speech therapy
16	F	30	x	v	-	-
17	M	29	x	v	-	music, arts
18	F	29	x	v	-	PE, arts, English
19	M	31	x	v	-	-
20	M	30	B-5	v	nanny	music, PE (soccer)

Data from parental reports collected for the group of 30-monthers (mean age: 30.1, median: 30, F=4) that shows all of the children attended preschool. Additionally, one child was daily looked after by a professional caregiver. One child attended speech therapy at the crèche, which was to facilitate the pronunciation of particular sounds (the /r/ and /l/ distinction in Polish). Four parents stated explicitly that there were English classes organized by the facility. These classes were based on songs and nursery rhymes. Three parents stated explicitly that the crèche offered arts classes, and two parents stated that there were music classes at the crèche. Two parents added that their children took part in organized PE activities. Apart from one case of speech therapy mentioned above, none of the parents reported language delays or other developmental delays. All parents agreed to record the interaction with their children. In one case, there was a technical problem at the end of the meeting, at which point the researcher relied on notes taken during this part of the task.

Table 13. 36-monthers, characteristics based on the parental reports.

ID	Gender	Age	Siblings	Daycare	Caregivers if no daycare	Other activities

21	F	36	x	v	-	music, arts, English
22	F	36	x	v	-	swimming
23	F	39	B-5	v	-	-
24	F	38	B-5	x	grandparents, father	-
25	M	35	B-1	v	-	swimming, English
26	F	37	x	v	-	music, arts, English
27	M	39	S-6	x	nanny	-
28	F	35	B-14	v	-	swimming, English
29	M	35	x	v	-	swimming, English
30	M	35	x	v	-	English

Data from parental reports collected for the group of 36-monthers (mean age: 36.5, median: 36, F=6), shows that two children did not attended preschool at the age of 36 months, but were daily looked after by family members in one case, and a professional caregiver in the other. Four children were regularly taken to the swimming pool. Six parents stated explicitly that there were English classes organised at the kindergarten. The classes were based on songs and nursery rhymes, as well as TPR. Two parents mentioned that their children took music and arts classes at the facility. None of the parents reported language delays or other developmental delays. One parent did not agree to record the interaction with their child, in which case the researcher relied on notes taken during the task.

5.3. Group characteristics based on an adapted CDI-ECBQ survey and the SES questionnaire

Apart from the differences in age and daily routine, children may differ with regard to their communicative style and personality. These differences may also result from the social class their parents belong to. None of the research questions is strictly related to the factors enumerated above. However, if there are children from the extreme top or bottom social classes in one group, it is difficult to compare their performance with the children in non-extreme parts of the social spectrum. CDI-ECBQ gives information about individual behavioural and

communicative styles of children, while the SES sheds light the amount of linguistic and other sensory stimuli children receive daily.

To see whether there were any extreme differences between the children within each group, I used the adapted CDI-ECBQ survey as well as the SES questionnaire. The score values in the CDI range from 0–17, where 17 indicates that the child presents all of the communicative behaviours expected of her age. The score values in the ECBQ range from 0–10, where 10 indicates that the child's temperament displays all the features associated with the extrovert personality. The surveys are just indicators and approximations; in fact, there are many individual factors that influence the child's behaviour at an observed age. The SES based on income data (the SES-Income) is coded as L(ower), M(iddle), and U(pper) class. The SES-Education is coded as E(lementary), L(ower-secondary), V(ocational education), S(econdary), and H(igher).

The data from each family from the 3 age groups is presented in Tables 14–16. The age of each child is provided in months.

Table 14. 24-monthers, characteristics based on the adapted CDI-ECBQ questionnaire.

ID	Gender	Age	CDI	ECBQ	the SES: Income	the SES: Education
1	F	24	16	10	M	H/S
2	F	24	16	9	M	H/H
3	F	24	16	10	M	H/H
4	M	27	16	10	U	H/H
5	M	24	17	8	M	H/V
6	M	24	17	10	M	H/H
7	F	24	17	9	U	H/H
8	M	24	14	8	M	H/L
9	M	26	14	8	M	L/H
10	F	25	16	10	M	H/H

Data from the CDI-ECBQ adapted questionnaire as well as the SES survey collected for the group of 24-monthers, shows that the children presented similar communicative behaviours and came from a similar social background according to the Household Available Income of the families and in terms of educational

background of the parents. The majority of the families has middle-class-expected HAI, and the majority of the parents hold a university degree.

Table 15. 30-monthers, characteristics based on the DCI, ECBQ and the SES results.

ID	Gender	Age	CDI	ECBQ	the SES: Income	the SES: Education
11	F	31	16	10	M	H/H
12	F	32	17	10	M	H/H
13	M	29	17	10	U	H/H
14	M	30	17	10	M	H/H
15	M	30	16	9	M	H/H
16	F	30	15	9	M	H/H
17	M	30	15	9	M	L/-
18	F	29	17	10	U	H/H
19	M	30	17	10	M	H/L
20	M	30	17	10	M	H/H

Data from the CDI-ECBQ adapted questionnaire as well as the SES survey collected for the group of 30-monthers shows that the children presented similar communicative behaviours and came from a similar social background according to the Household Available Income of the families and in terms of educational background of the parents. There is one single-parent family in the group. The majority of the families have middle-class-expected HAI, and the majority of the parents hold a university degree.

Table 16. 36-monthers, characteristics based on the DCI, ECBQ and the SES results.

ID	Gender	Age	CDI	ECBQ	the SES: Income	the SES: Education
21	F	36	16	10	M	L/L
22	F	36	16	8	U	H/H
23	F	39	17	9	M	H/L
24	F	38	16	10	M	H/H
25	M	35	15	8	M	H/H
26	F	37	16	9	U	H/H
27	M	39	16	9	M	H/H

28	F	35	15	10	M	H/H
29	M	35	17	9	M	V/L
30	M	35	17	7	M	H/H

Data from the CDI-ECBQ adapted questionnaire as well as the SES survey collected for the group of 36-monthers shows that the children presented similar communicative behaviours and came from a similar social background according to the Household Available Income of the families and in terms of educational background of the parents. The majority of families have middle-class-expected HAI, and the majority of parents hold a university degree.

5.4. Group summary

According to the parental reports, all of the children were typically developing without any language or motor delays. None of the children attended therapy related to a developmental condition. None of the parents reported any problems that could be disclosed by regular health balance examinations during which children in Poland are screened for symptoms of atypical development. As for the crèche or kindergarten attendees, the families have access to a speech therapist and, most often, to a child psychologist working in the facility. These specialists also screen for language and developmental delays to see whether children develop in accordance with clinical expectations for their age.

To conclude, parental reports and in-depth interviews did not indicate any considerable differences within the groups. Neither were there significant differences in terms of the families' socioeconomic status or educational background of the parents within the groups.

6. Procedure: documentation and warm-up

Before the task began, the parents were asked to fill in the questionnaires: the COVID-19 health survey, the SES, the adapted CDI-ECBQ, and the informed consent to take part in the study and record the child in interaction. At this point, the parents were encouraged to ask additional questions, and the game procedure was explained to them in detail. The data gathered from the groups was of high sensitivity, therefore, the parents were also asked to sign a statement giving me permission to record their children. The parents were also informed that each type

of data that could help a third party to identify the child would be anonymized during the analysis. If the parents did not consent to have their child recorded or in case of technical problems, the experimenter noted down the children's answers and behaviours. If the participants took the experiment in the Lab, the session was preceded by a period of free play, to make the child comfortable in unfamiliar surroundings. Due to the epidemiological recommendations, the room was aired after each visit, the furniture was disinfected, and an hour break was scheduled between the meetings.

The session began with a warm-up exercise that was identical to the experimental task. The warm-up was designed to help the children familiarize themselves with the task and the procedure. Each child was invited to play a guessing game with the researcher. Toddlers were seated either in their parents' lap or alone, so as to face the experimenter during the game. The parents were instructed not to prompt, cue, or direct their infants in any way during the session. They were asked, however, to motivate their children to continue playing the game when the toddlers were becoming bored or distracted. Three warm-up trials were included to demonstrate the game to the toddlers. On these trials, the experimenter directed the child's attention to the task, saying: "[Name of the child] look at the book" or "[Name of the child] now look at these items", and then asked them to identify the target item. The experimenter first asked a question, for example, "Where is [a clock]?" or "Can you see [a clock]?" for the speech condition, and another question, for example, "Where is something like this [*performs a gesture*]?" for the gesture condition. After the warm-up phase, all the participants proceeded to the testing phase, provided that they were correct with the three warm-up images. The warm-up images were not included in the experimental set. The experimenter's questions were kept constant, and had the following forms:

1) Can you show me [word/gesture for the target]?;
2) Can you see [word/gesture for the target]?;
3) Where is [word/gesture for the target]?;
4) Where is something like this [gesture the target)]?;
5) Can you see something that looks like this [for gesture the target]?

There were 3 items the children had to guess in the warm-up exercise: one per condition. The warm-up was the same for all age groups. If the child identified the 3 items correctly, the experimental task began. If the child was not interested in the game or refused to take part in it, the experimenter stopped the procedure and the child was invited to take part in the warm-up exercise after a few minutes. If the child continued to refuse to participate in the exercise, no pressure was exerted on her. None of the children resigned from the game.

6.1. Procedure: answers and feedback

Each child's task was to provide an answer by means of finger pointing to the item they believed was the correct match. Sometimes, the children provided their answer in speech; in such cases, they were asked to point to the item anyway. The children were also allowed to use other objects to point to the items, such as a magic wand, a crayon, or a toy. In isolated cases, the children were allowed to point to the item with their feet or step on the correct answer (see Picture 9). Such an approach proved very useful especially towards the end of the game, when many children were already bored with the task.

The parents were asked to support their children with applause or expressions of joy when the child made a correct guess. If the child provided an incorrect answer, she was given feedback, such as: "I am not sure that is the correct answer" or "Is that your guess? I am not sure. Let us try another page".

Picture 9. Alternative ways of providing answers: pointing with a foot.

6.2. Procedure: task and data collection

The session took place either at the child's home or in the Nicolaus Copernicus University's Baby Lab. In either place, the camera (SONY HDR-CX405B) was set at such an angle that the recording would capture at least the hands of the child and the cartoon book. Taking aa accurate recording occasionally proved difficult as the children were allowed to move around the room and sometimes provided answers outside of the eye of the camera. In such situations, their answer was noted down by the experiment and spoken out by her, so that it could be heard in the recording. The iconic gestures were rehearsed and memorized by the experimenter to assure their uniform presentation to each child. To keep the appropriate order of the items and conditions, the experimenter had a list that she could glance at during the session (Table 17).

Table 17. The list of words for the three consecutive rounds in Polish (with English translation provided in the square brackets).

	R1		
KREDKA [crayon]	słowo [word]		
MŁYNEK [pepper mill]	czynność (rób) [enact]		
GRABIE [rake]	przedmiot [item]		
LAPTOP [laptop]	słowo [word]		
DRABINA [ladder]	czynność (rób) [enact]		
PIŁKA [ball]	przedmiot [item]		
OKULARY [glasses]	słowo [word]		
ŁÓDKA [boat]	czynność (rób) [enact]		
TASAK [cleaver]	przedmiot [item]		
KSIĄŻKA [book]	słowo [word]		
WĘDKA [fishing rod]	czynność (rób) [enact]		
NOŻYCZKI [scissors]	przedmiot [item]		

		R2	
OKULARY [glasses]		czynność (rób) [enact]	
ŁÓDKA [boat]		przedmiot [item]	
TASAK [cleaver]		słowo [word]	
KSIĄŻKA [book]		czynność (rób) [enact]	
WĘDKA [fishing rod]		przedmiot [item]	
NOŻYCZKI [scissors]		słowo [word]	
KREDKA [crayon]		czynność (rób) [enact]	
MŁYNEK [pepper mill]		przedmiot [item]	
GRABIE [rake]		słowo [word]	

LAPTOP [laptop]		czynność (rób) [enact]	
DRABINA [ladder]		przedmiot [item]	
PIŁKA [ball]		słowo [word]	

			R3
KREDKA [crayon]			przedmiot [item]
MŁYNEK [pepper mill]			słowo [word]
GRABIE [rake]			czynność (rób) [enact]
LAPTOP [laptop]			przedmiot [item]
DRABINA [ladder]			słowo [word]
PIŁKA [ball]			czynność (rób) [enact]
OKULARY [glasses]			przedmiot [item]
ŁÓDKA [boat]			słowo [word]
TASAK [cleaver]			czynność (rób) [enact]
KSIĄŻKA [book]			przedmiot [item]
WĘDKA [fishing rod]			słowo [word]
NOŻYCZKI [scissors]			czynność (rób) [enact]

After the warm-up, the child was invited to play the guessing game with the experimenter. The cartoon book was placed on the table or on the floor, and the child was asked whether she was ready to start the task. If the child wanted to engage in some other activity, for example free play around the room, she was allowed to do so, but her attention was repeatedly directed to the game by the experimenter by means of invitation in speech and gesture. When the child showed interest in the book, the experimenter started asking questions about the target items, as described in Section 6. The camera had been turned on at this point. The items, in the form of colourful pictures were presented in sets of 4 on each page.

Each child's task was to correctly match 12 consecutive items presented to them by the experimenter to 12 consecutive target pictures in each of the 3 rounds. Throughout the game, the target item was presented to each child 3 times, each time in a different condition. The entire game was played during one meeting. The meetings were from 45 to 90 minutes long. At the end of the meeting, the child was praised for their performance and given a small reward in the form of stickers, an educational puzzle game and a book of their choice. The protocol for the experimental procedure can be found in Appendix H, in English.

The data, coded as incorrect and correct matches (0–1), were acquired post-hoc on inspecting the video and notes taken by the experimenter during the session. Qualitative and quantitative analyses of the collected data are described in Chapter 4.

7. Data management

Working with children entails working with sensitive data. Therefore, I took precautions to assure parents that their children's data would be well protected. The documentation for their parents and data processing consents were prepared in collaboration with Nicolaus Copernicus University's Data Protection Officer Jakub Rutkowski and met all the EU demands for data processing (GDPR). The videos of the children, collected upon written consent, were anonymized during data analysis. If used in this dissertation or later for publication, also upon consent, the images presenting the children's faces were blurred. I obtained consent to conduct my research from the Scientific Research Ethics Committee of the University of Warmia and Mazury in Olsztyn. The consent is attached to the dissertation as Appendix D1 and D2 - obtained originally in Polish and English.

8. Covid-19 pandemic: research limitations

Since the pilot studies and the research were conducted during the COVID-19 pandemic, I took measures to assure epidemiological and psychological comfort of the families during the research meeting. The parents were asked to fill in a standardised medical COVID-19 survey on the day of the meeting. The guidelines for conducting research during the pandemic as well as laboratory maintenance were prepared by the Health and Safety Officer (BHP) of the Warsaw University's Baby Lab and kindly shared with me in personal communication by dr Agnieszka Pluta: the head of one of the projects with children, conducted at the Warsaw University's Baby Lab.

Initially, the research was supposed to be conducted at kindergarten facilities or Nicolaus Copernicus University's Baby Lab. Initially, I planned to recruit 90 children divided into 3 age groups: 24-, 30-,and 36-month-old. The lockdown and the national quarantine introduced in March 2020 and extending over the consecutive months disrupted this plan: many facilities, including kindergartens and universities, were closed or inaccessible during that time.

Additionally, parents were resigning from taking part in the research due to the health hazard and pandemic restrictions, and the University's facilities were closed for employees and guests for nearly two semesters. Therefore, in the dissertation, I present research on 3 age groups with 10 children in each group. 90 children would have provided much more robust results; however, it was nearly impossible to engage in face-to-face interactions children and parents in the year 2020.

When the lockdown restrictions were partially lifted in May 2020, kindergartens could not let in caregivers (they had to wait for their children outside of the facility), let alone strangers advertizing linguistic research. It was extremely difficult to recruit parents due to the fear of infection, lockdown directives, and medical guidelines regulating social life for almost two years (the epidemic state was lifted in Poland only in May 2022). Hence, the steps taken in the present PhD were to a large extent dictated by the lockdown and the COVID-19 pandemic.

Chapter 4
Analysis and results

Part 1: Quantitative analysis

1. Introduction

Chapter 4 discusses the methods and the process of data analysis. To facilitate reading, the chapter is divided into two parts. In Part 1, I present quantitative analysis of the data; in Part 2, I provide a description of behaviours observed in children throughout the interaction. The data gathered for the purposes of this research are investigated from two perspectives. Quantitative analyses were performed with the use of R Studio. The results of statistical tests are presented in the form of tables and figures and are discussed with reference to research hypotheses. Qualitative description is accompanied by stills from the video recordings of interaction with children. Each part is concluded with a brief summary of the findings.

2. Qualitative and Quantitative approaches to data

Child development can be measured. Using tools from pedagogy, psychology, and medical sciences, we can say that a child is taller, her vocabulary expanded, or her grades are getting better. The transition from the point when a child knows few words to the point when she knows numerous items of vocabulary can be quantified: one can count the number of lexical items a child knows at the two points in time. However, the two points in time can also be looked at beyond numbers, and the transition period between them can be described qualitatively. Therefore, in the present chapter, I used "mixed method research" (Croker, 2009: 4; Landrum & Garza, 2015): I both conducted statistical analysis of the collected data and qualitatively described selected cases of the children's performance during the experimental task. In doing so, I follow the tradition of cognitive semiotics and its methodology—phenomenological triangulation (Zlatev, 2015). I rely, in Esa Itkonen's words, on "pairing intuition with qualitative analysis and observation/experimentation with quantitative analysis" (1980: 338).

Qualitative and quantitative methods are both used in linguistic research (Johnson, 2008; Heigham & Croker, 2009). The qualitative approach is open for interpretation and concerned with "conscious noticing and detailed examination" (Cowie, 2009: 166). It is "valuable in providing rich descriptions of complex phenomena" and "tracking unique or unexpected events" (Sofaer, 1999: 1101). Hence, qualitative research tends to focus on selected cases of behaviours. The quantitative approach focuses on quantifiable data and presents research results in statistical terms. Statistical analyses serve to either corroborate or reject the research hypotheses (Itkonen, 1980; Schmied, 1993; Corbin & Strauss, 2008). The quantitative approach allows us to see relations between data obtained from a sample allows us to generalise them to a population (Aspers & Corte, 2019: 145). In contrast, the qualitative approach is limited to individual cases under study, and its results are not statistically generalisable (Aspers & Corte, 2019: 140–143).

Combining the two approaches for the purpose of this study enabled me to test research hypotheses and statistically generalize my findings but also to gain insight in the communicative development of the participants of this specific study.

3. Quantitative data analysis

As described in Chapter 3, I collected data from a forced-choice guessing-game task. To extract the children's answers, I annotated the video material with the use of ELAN (ver. 5.7 -FX): a tool for coding multimodal and polysemiotic data (Lausberg & Sloetjes, 2009), which allows the researcher to freely adjust video playback parameters, such as playback speed or sound (see Figure 12). The main window is equipped with tiers to help navigate between coded items.

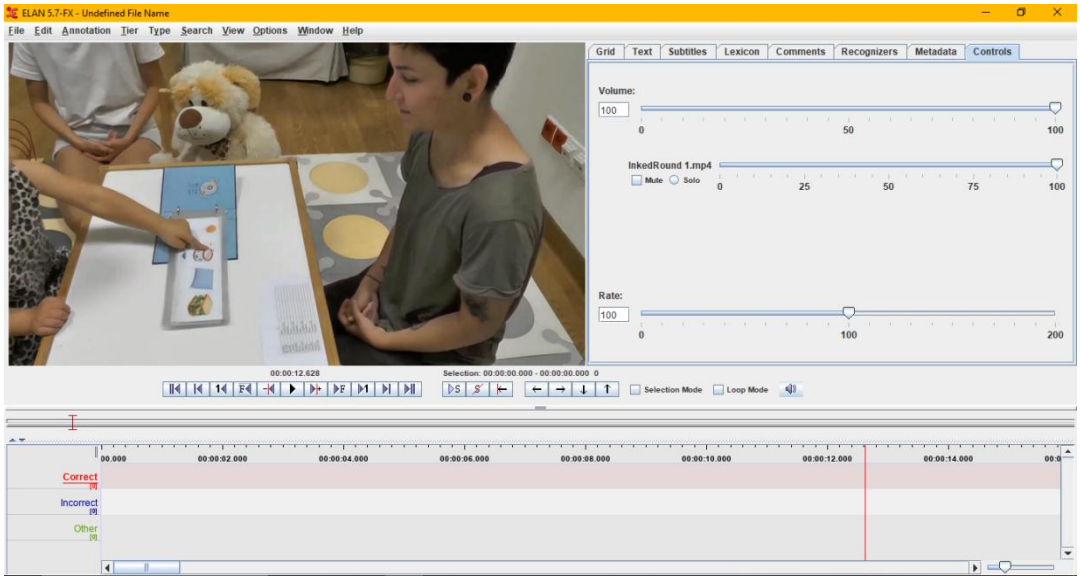


Figure 12. A video view window with the coding template in ELAN software.

I used a Microsoft Excel sheet to record the children's answers and research variables in the form of columns (see Table 18) that were later uploaded into statistical software. The task of each child (N = 30) from each age group was to match a gesture (given in 2 conditions interchangeably) or a spoken label (1 condition) to a correct item from 4 possibilities in 3 consecutive rounds of 12 pages, as described in detail in Chapter 3. The total number of answers from one child equalled 36. A correct answer was marked as 1 in the table; an incorrect answer or a lack of answer was marked as 0. The answers coded in this way gave me a total of 1,080 of datapoints from the three age groups of the children. The material was exported from Excel in the .csv format.

The distribution of the datapoints met the 3 criteria for binomial distribution: (1) fixed number of observations per variable, (2) two possible outcomes (0–1) per observation, and (3) the same probability of a correct and incorrect answer per observation (Kerns, 2018: 111). Hence, I was able to study the data by means of mixed effects models based on the binomial distribution.

To conduct quantitative data analysis, I fed the material into R Statistical Software (version 4.1.1; RStudio Team, 2019) equipped with the following packages: *lme4* (Bates et al., 2015), *tidyverse* (Wickham et al., 2019) *ggplot2* (Wickham, 2016), *MuMIn* (Barton, 2022), *emmeans* (Lenth et al., 2021), *anova* (Dobson, 2002), and *multcomp* (Hothorn, Bretz & Wesfall, 2008).

Table 18. Excerpt from the .csv datafile used to conduct statistical analysis.

child	object	difficulty	ageGroup	Condition	correctGuess	ConditionGroup
1	crayon	easy	young	speech	1	speech
1	crayon	easy	young	reen	1	other
1	crayon	easy	young	repr	0	other
1	pmill	difficult	young	speech	0	speech
1	pmill	difficult	young	reen	0	other
1	pmill	difficult	young	repr	0	other
1	rake	easy	young	speech	0	speech
1	rake	easy	young	reen	0	other
1	rake	easy	young	repr	0	other
1	laptop	difficult	young	speech	1	speech
1	laptop	difficult	young	reen	0	other
1	laptop	difficult	young	repr	0	other
1	ladder	difficult	young	speech	1	speech
1	ladder	difficult	young	reen	0	other
1	ladder	difficult	young	repr	1	other
1	ball	easy	young	speech	1	speech
1	ball	easy	young	reen	0	other
1	ball	easy	young	repr	0	other
1	glasses	easy	young	speech	1	speech
1	glasses	easy	young	reen	0	other
1	glasses	easy	young	repr	0	other

3.1. Variables

The dataset (Table 21 above) was organized into the following columns, which represent experimental variables that were used to perform statistical tests:

- **child**: a child's ID number; the numbers are divided according to the age **groups**: 24-monthers: 1-10; 30-monthers: 11-20; 36-monthers: 21-30;
- **object**: the name of an item; there are 12 items per child;
- **difficulty**: items categorized as "easy" and "difficult" (see Chapter 3);
- **ageGroup**: a child's age group: either young (24-monthers), mid (30-monthers), or old (36-monthers);
- **Condition**: the way an item was presented to a child: either by speech (speech), gesture1 (enacting gesture—reen) or gesture2 (representing gesture—repr);
- **correctGuess**: the column contains the answers of the children; "correctGuess" was the outcome variable (or the dependent variable);

- **ConditionGroup**: the column presents modified Conditions: :speech" and "other", where "other" stands for the two kinds of gestures used in the experiment (reen+repr combined).

3.2. Research hypotheses

I explored 3 research hypotheses:

- Hypothesis 1 (H1). As explained in Chapter 2, an increase in social experience and linguistic knowledge between the ages of 2 and 3 results in better speech and gesture comprehension. Hence, I hypothesise that **the number of correct answers will increase in the consecutive age groups irrespective of the condition** (i.e., whether the condition is speech, enacting or representing gesture);
- Hypothesis 2 focuses on iconic gestures' comprehension only, and comprises 3 sub-hypotheses. Hypothesis 2a (H2a) assumes that t**here will be a change in the guessing pattern resembling the social experience and linguistic knowledge children gain between the ages of 2 and 3, but only for items presented as gestures**. Hypothesis 2b (H2b) assumes that **the enacting gesture condition is easier for children than the representing gesture condition**. Hypothesis 2c (H2c) assumes that **the difference in the number of correct responses for the two types of iconic gestures will be decreasing with the age of the children.**
- Hypothesis 3 (H3) assumes that the children across the 3 age groups **will perform significantly better for items labelled as "difficult" in either of the gesture conditions than in the speech condition**, which would support the assumption that the sign function emerges first in gesture.

3.3. Testing the hypotheses: statistical procedure and tools

In all of the analyses below, I ran Mixed Effects Logistic Regression Models R package with "correctGuess" as a predictor variable and a variable (or variables) of interest as a fixed effect (or fixed effects; e.g., the variable "ageGroup" in H1). Further, in all of the analyses, the "child" and "object" variables were included as random intercepts: the former, because the children's cognitive abilities may vary, and the latter, because some items may be better guessable than others. To control

for the fact that some children may learn faster than others, it would be desirable to include the variable "child" as a random slope. Generally, random slopes are considered important to avoid inflated type I error rates (Barr et al., 2013; Schielzeth & Forstmeier, 2009). However, I was not able to include the random slope in the respective models because they did not converge, possibly due to an insufficient size of the sample.

3.3.1. Statistical procedure

The steps described in this section were applied to all hypotheses. Each hypothesis had separate fixed effects, which are described in the following sections accordingly. I follow the statistical protocol outlined in this section in all the analyses given below.

The overall significance of my full models in comparison with respective null models that comprised only the random effects, that is the random intercepts for the "child" and "object" variables, was tested with a likelihood ratio test *anova* (Dobson, 2002). In all cases, I checked whether the assumptions of normally distributed and homogeneous residuals were fulfilled by visual control done on the basis of a *qqplot* as well as the residuals plotted against the fitted values. No deviations from normality or homoscedasticity were detected. To assess the goodness-of-fit of my models, I calculated effect sizes using the function *r.squaredGLMM* of the *MuMIn* package (Barton, 2018). In this way, I obtained the marginal R2 (R2m value), which indicates the variance explained by the fixed effect, and the conditional R2, which indicates the variance explained by the sum of the fixed and random effects (Nakagawa & Schielzeth, 2013). I report the marginal and conditional R2 of the theoretical method, which is the method most appropriate for response variables with binomial distributions (Nakagawa & Schielzeth, 2013).

I was also interested in comparing all of the age groups with one another. Since pairwise comparison is prone to inflated type I error rates (false positive), and the confidence intervals comparison is prone to inflated type II error rates (false negative) (Barr et al., 2013; Schielzeth & Forstmeier, 2009), I decided to conduct these two types of comparisons. To conduct pairwise comparisons, I used the *multcomp* R-package (Hothorn, Bretz & Wesfall, 2008) and the package *emeans* (Lenth et al., 2021). In all pairwise comparisons, the p-values were

adjusted for multiple comparisons. For confidence intervals comparison, I calculated 95% confidence intervals for each level of predictor variables of interest. Non-overlapping confidence intervals indicate a significant difference between levels of predictor variables of interest (e.g., the difference between the mid and old group; Cummin & Finch, 2005).

3.4. Hypothesis 1

Hypothesis 1 focuses on the impact of age on the ability to provide a correct answer (guessability) for the experimental (target) items. Irrespective of the condition (i.e., speech, enacting gesture, or representing gesture), the children were expected to perform increasingly better—thus, their scores to get higher—as they grow older. In the model, guessability constitutes the outcome variable and ageGroup, the predictor variable, or a fixed effect.

3.4.1. Results

The first model tested the influence of ageGroup on correctGuess, using the statistical procedure described in Section 3.3.1. The comparison of the full model and the null model revealed that the age group influenced whether the answers were correct or incorrect (likelihood ratio test: $\chi2 = 26.356$, df = 2, $p < 0.001$; effect size for the full model: R2m = 0.06, R2c = 0.14; model results: Table19 below). In line with my prediction, I found that there was a significant difference between the young group and the mid group in favour of the latter, and the young and the old group, again, in favour of the latter (Table 19).

Additionally, the pairwise comparisons revealed an additional (marginally) significant difference between the mid and the old group, in favour of the latter (B = -0.44, SE = 0.178, z = -2.459, p = 0.04). All the results of the pairwise comparisons are given in Table 19. However, the confidence intervals for the middle and the old group overlap (Table 20, Figure 13), which would indicate that the difference between these two groups is not significant. Taken together the results of the pairwise comparisons and of the analysis of the confidence intervals, it can be concluded that the difference between the mid and old groups is noticeable—if not significant, it approaches significance.

Table 19. Results of the pairwise comparison, exploring the effects of age on correct answers. The table reports estimated model coefficients (Estimate), standard errors (SE), Z-score (z), and p-values (p).

ageGroup	Estimate (B)	SE	z	p
Intercept	-0.69	0.175	-3.95	
young-old	-1.13	0.179	-6.30	<.0001
mid-old	-0.44	0.178	-2.46	0.0418

The confidence intervals for the middle and the old group overlap, which confirms that the difference between these two groups is not significant (Table 20).

Table 20. Mean score, standard deviation (SD), sample size (n), standard error (SE), and lower and upper 95% confidence intervals (CI) for each experimental group.

ageGroup	Mean	SD	n	SE	Lower CI	Upper CI
young	0.426	0.1	10	0.032	0.354	0.498
mid	0.583	0.08	10	0.025	0.525	0.641
old	0.677	0.09	10	0.028	0.615	0.739

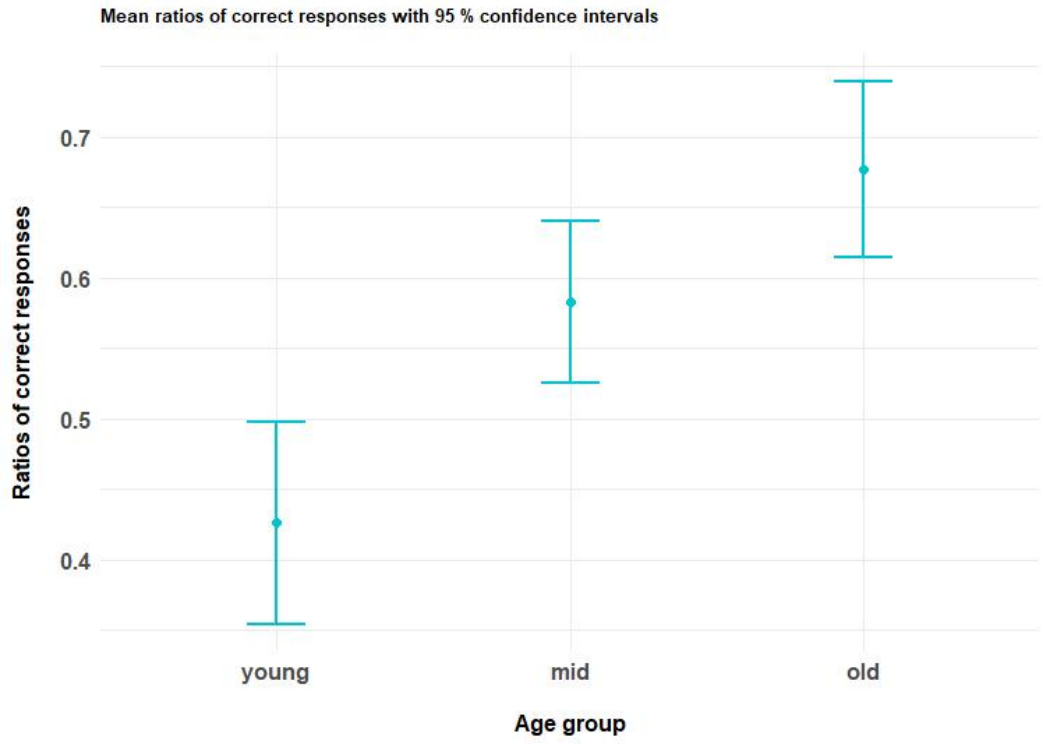


Figure 13. Mean ratios of correct responses. Points indicate mean values, and whiskers indicate 95% confidence intervals of the correct answers. Non-overlapping confidence intervals indicate significant differences between the groups.

3.5. Hypothesis 2

Hypothesis 2 focuses on two gesture conditions (only): enacting and representing, and is broken down into 3 sub-hypotheses. Hypothesis 2a (H2a) states that the understanding of iconic gestures increases with age (outcome variable: correctGuess without the condition "speech"; predictor variable: ageGroup). Hypothesis 2b (H2b) states all three age groups of children perform significantly better in the enacting gesture condition than in the representing gesture condition (outcome variable: correctGuess without the condition "speech"; predictor variable: condition "enacting gesture" vs. "representing gesture"). Hypothesis 2c (H2c) states that there is an interaction between the comprehension of enacting gestures vs. representing gestures and the age of the children (outcome variable: correctGuess without the condition "speech"; predictor variable 1: condition "enacting gesture" vs. "representing gesture", predictor variable 2: ageGroup).

For the purpose of testing Hypothesis 2, I removed the condition "speech" from the "Condition" variable, which resulted in the dataset of 720 datapoints coded as either enacting ("reen") or representing ("repr") gesture. All the steps of the statistical procedure were the same as in the analysis of Hypothesis 1.

3.5.1. Hypothesis 2a: results

The comparison of the full model and the null model revealed that the guessability of items in gesture condition increased in the consecutive age groups (likelihood ratio test: $\chi2 = 22.513$, df = 2, $p < 0.001$; effect size for the full model: R2m = 0.08, R2c = 0.18). In line with Hypothesis 2a, I found that there was a significant difference between the understanding of the two types of gestures by the young and the mid group in favour of the latter, and the young and the old group, again in favour of the latter (Table 21).

Table 21. Fixed effects table: Standard deviation (SD), Z-scores (z), and p-values (p).

ageGroup	SD	SE	z	p
Intercept	-1.05	0.239	-4.404	

mid	0.84	0.252	3.310	<.0001
old	1.42	0.254	5.578	<.0001

Further, the pairwise comparisons indicate the difference between the middle and the old age group is marginally significant (B = -0.58, SE = 0.244, z = -2.396, p = 0.0499). All results of the pairwise comparisons are given in Table 22, below.

Table 22. Results of the pairwise comparison, exploring the effects of ageGroup on the correct answers. The table reports estimated model coefficients (Estimate), standard errors (SE), Z-score (z), and p-values (p).

ageGroup	Estimate (B)	SE	z	p
young-mid	-0.84	0.252	-3.310	0.0028
young-old	-1.42	0.255	-5.578	<.0001
mid-old	-0.58	0.244	-2.396	0.0499

The overlap in the confidence intervals, even though a very slight overlap, confirms the lack of a significant difference between the middle and the old age group. However, similarly to the pairwise comparisons, the analysis of the confidence intervals gives further evidence of the significant difference between the young and middle, and the young and old age group results (Table 23, Figure 14).

Table 23. Mean score, standard deviation (SD), sample size (n), standard error (SE), and lower and upper 95% confidence intervals (CI) for each gesture condition.

ageGroup	Mean	SD	n	SE	Lower CI	Upper CI
young	0.143	0.07	19	0.017	0.108	0.178
mid	0.225	0.08	20	0.018	0.188	0.262
old	0.292	0.07	20	0.015	0.261	0.322

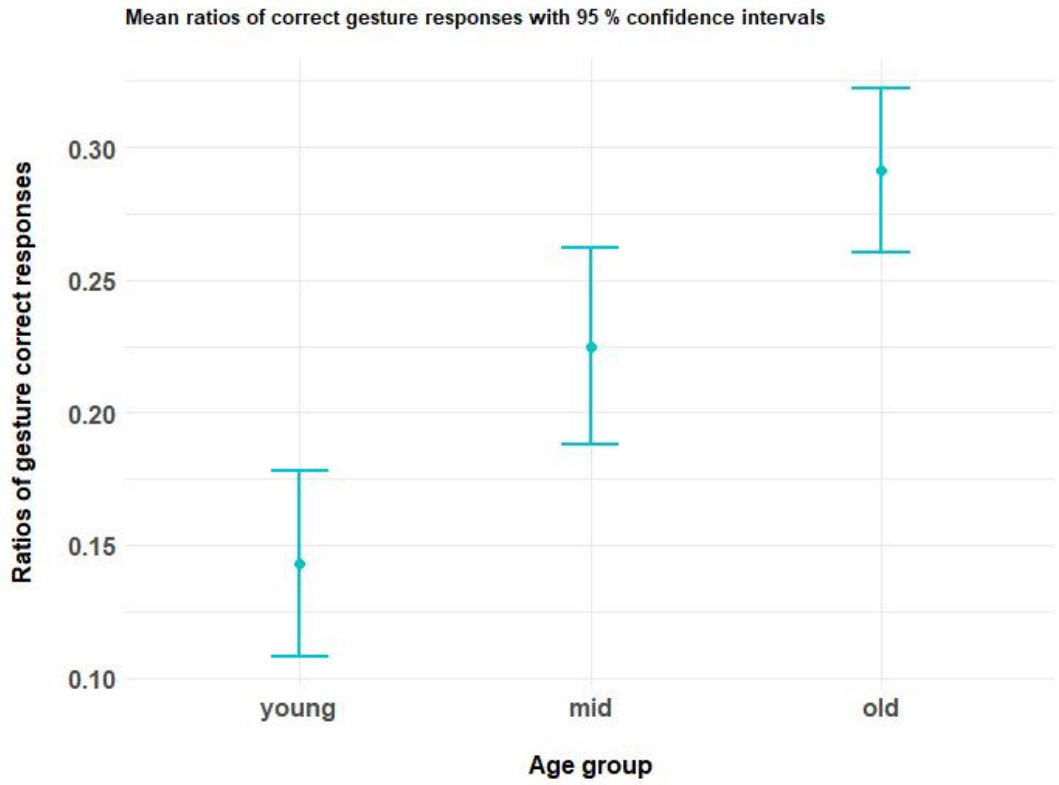


Figure 14. Mean ratios of correct responses for the two types of iconic gesture together. Points indicate mean values, and whiskers indicate 95% confidence intervals of the correct answers. Overlapping confidence intervals indicate insignificant differences between the groups.

3.5.2. Hypothesis 2b: results

The comparison of the full model and the null model revealed that the gesture condition did not influence whether the answers were correct or incorrect (likelihood ratio test: $\chi2 = 0.9446$, df = 1, p = 0.3311; effect size for the full model: R2m = 0.002, R2c = 0.19). Inconsistent with my prediction, there was no difference in guessability between the two gesture conditions: enacting and representing gestures (model results: Table 24 below).

Table 24. Fixed effects table: Standard deviation (SD), Z-scores (z), and p-values (p).

Condition	SD	SE	z	p
Intercept	-0.38	0.229	-1.659	
repr	0.16	0.161	0.975	0.329

Further, the pairwise comparison confirmed that the difference between the two gesture conditions not to be statistically significant (B = -0.16, SE = 0.162, z = -0.975, p = 0.3298), even though it was the expected direction, with

higher rates for enacting than the representing iconic gestures. The results of the pairwise comparison are given in Table 25 below.

Table 25. Results of the pairwise comparison, exploring the effects of gesture condition on the correct answers. The table reports estimated model coefficients (Estimate), standard errors (SE), Z-score (z), and p-values (p).

Condition	Estimate (B)	SE	z	p
reen-repr	-0.16	0.162	-0.975	0.3298

The results of the regression model are also confirmed by the overlap in the confidence intervals for the two gesture conditions (Table 26, Figure 15).

Table 26. Mean score, standard deviation (SD), sample size (n), standard error (SE), and lower and upper 95% confidence intervals (CI) for each gesture condition.

Condition	Mean	SD	n	SE	Lower CI	Upper CI
reen	0.209	0.1	30	0.019	0.170	0.248
repr	0.234	0.08	29	0.015	0.203	0.265

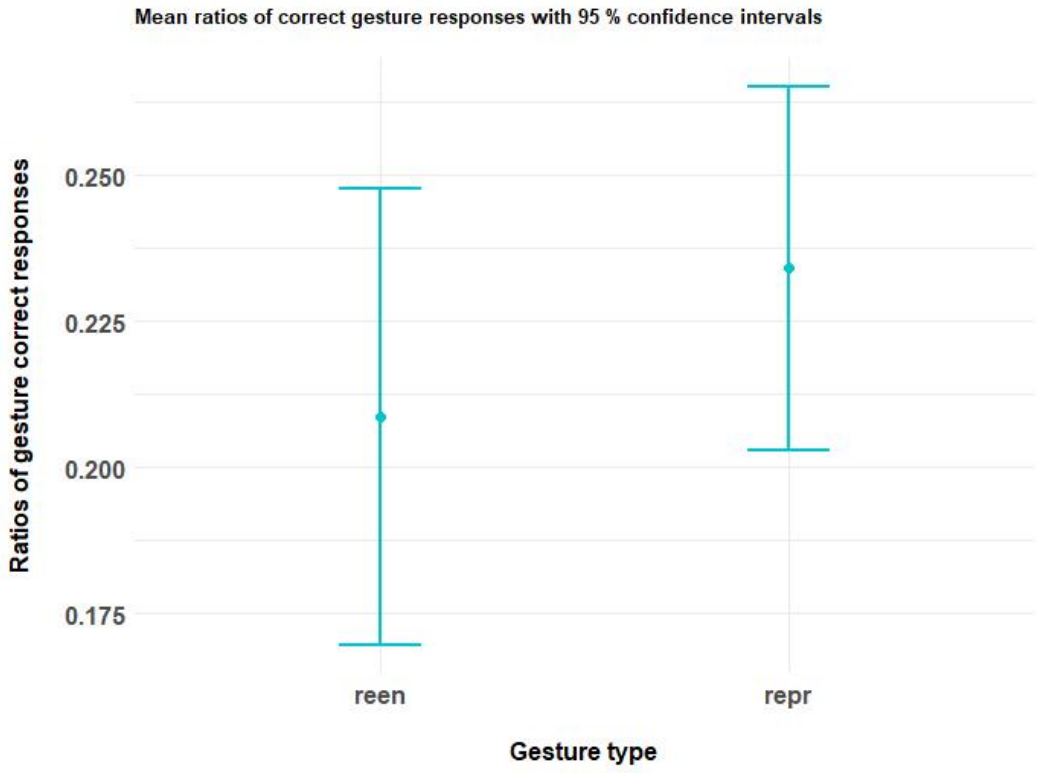


Figure 15. Mean ratios of correct responses in “reen” and “repr” condition. Points indicate mean values, and whiskers indicate 95% confidence intervals of the correct answers. Overlapping confidence intervals indicate insignificant differences between the conditions.

3.5.3. Hypothesis 2c: results

To test H2c, I built two models:

- one with the interaction between the 2 predictors: the 2 gesture conditions and age;
- the other, without the interaction term between the 2 predictors.

The second model did not reveal significant interactions between the variables. Hence, the model without interaction was adopted for the purpose of further analysis and confirmed the results obtained for H2a and H2b

The comparison of this model and the null model revealed that enacting gestures are guessed better by the mid and old group than by the young group, and that there was no significant difference in the way the young group guessed the meaning of enacting and representing gestures (likelihood ratio test: $\chi 2$ = 23.457, df = 3, $p < .0001$; effect size for the full model: R2m = 0.09, R2c = 0.18; model results: Table 27).

Table 27. Fixed effects table: Standard deviation (SD), Z-scores (z), and p-values (p).

	SD	**SE**	**z**	**p**
Intercept Cond-reen-ageGroup -young	-1.13	0.254	-4.465	
Condition-repr	0.15	0.162	0.972	0.3308
ageGroup-mid	0.83	0.253	3.310	<.0001
ageGroup-old	1.42	0.255	5.577	<.0001

Since the confidence intervals for the 2 variables are the same as in H2a and H2b, respectively, I do not report them here. However, to gain a fuller picture of how the two variables influence guessability, I report of all results of the pairwise comparisons in Table 28. I also use boxplot to jointly visualise the impact of the conditions “enacting gesture” vs. “representing gesture” and ageGroup on guessability (Figure 16).

Table 28. Results of the pairwise comparison, exploring the effects of "Condition" and "ageGroup" on the correct answers. The table reports estimated model coefficients (Estimate), standard errors (SE), Z-score (z), and p-values (p). Significant results are marked with an asterisk (*).

	Estimate (B)	**SE**	**z**	**p**
reen/young- repr/young	-0.16	0.162	-0.972	1.0000
reen/young-reen/mid	-0.84	0.253	-3.310	0.0140*
reen/young-repr/mid	-0.99	0.301	-3.298	0.0146*
reen/young-reen/old	-1.42	0.255	-5.577	<.0001*
reen/young-repr/old	-1.58	0.304	-5.192	<.0001*
repr/young-reen/mid	-0.68	0.299	-2.274	0.3441
repr/young-repr/mid	-0.84	0.253	-3.310	0.0140*
repr/young-reen/old	-1.26	0.300	-4.221	0.0004*
repr/young-repr/old	-1.42	0.255	-5.577	<.0001*
reen/mid-repr/mid	-0.16	0.162	-0.972	1.0000
reen/mid-reen/old	-0.59	0.244	-2.394	0.2498
reen/mid-repr/old	-0.74	0.294	-2.525	0.1737
repr/mid-reen/old	-0.43	0.292	-1.465	1.0000
repr/mid-repr/old	-0.59	0.244	-2.394	0.2498
reen/old-repr/old	-0.16	0.162	-0.972	1.000

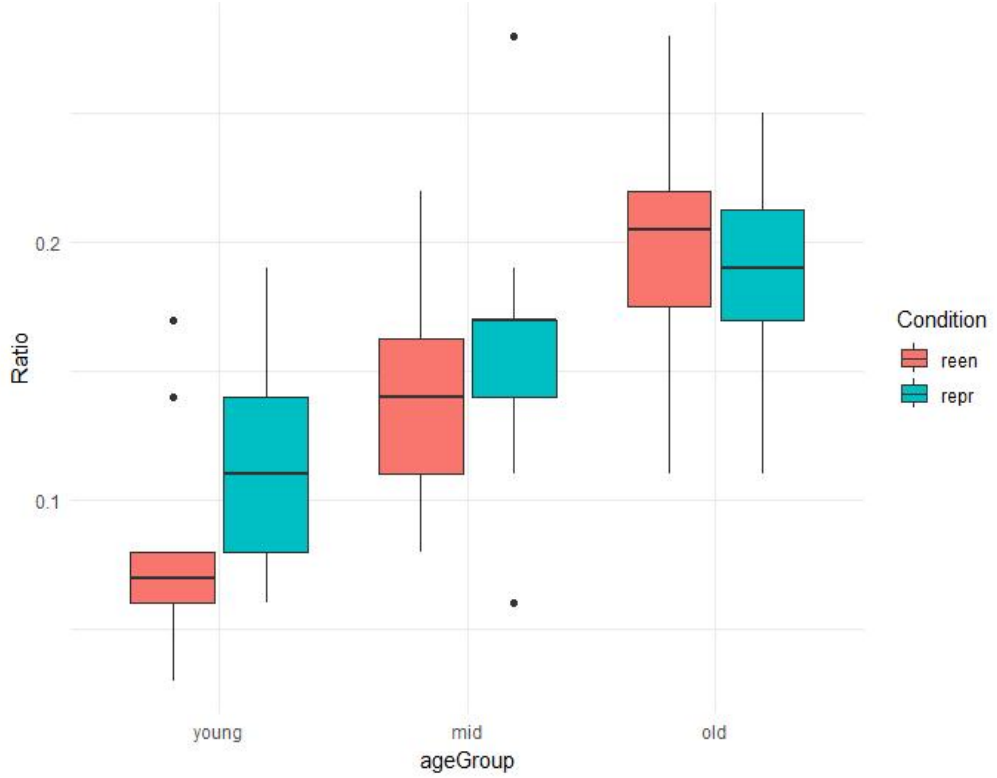


Figure 16. Mean ratios of correct responses for the two types of iconic gestures for each of the age groups in the two gesture conditions. Points indicate mean values, and whiskers indicate 95% confidence intervals of the correct answers. Overlapping confidence intervals indicate insignificant differences between the groups.

3.6. Hypothesis 3

Hypothesis 3 predicts children to perform better in the either of the gesture conditions than in the speech condition, when guessing the meaning of "difficult" items. Hypothesis 3a (H3a) states this is the case irrespective of the age group (outcome variable: correctGuess without the level "easy"; predictor variable: Condition). This hypothesis directly informs the research question about the semiotic system in which the sign function emerges first. However, to get a better understanding how children guess "difficult" items, I also explored two ancillary hypotheses:

- age influences guessability of "difficult" items irrespective of the condition (outcome variable: correctGuess without the level "easy"; predictor variable: ageGroup)—Hypothesis 3b (H3b);

- there is an interaction between the comprehension of "difficult" items in the conditions "speech" vs. the two types of gestures and age group (outcome variable: correctGuess without the level "easy"; predictor variable 1: Condition, predictor variable 2: age Group)—Hypothesis 3 (H3c).

To test this hypothesis, I removed items labelled as "easy" from the "difficulty" variable, which resulted in a dataset comprised of 540 data-points. All the steps of the statistical procedure were the same as in the analysis of Hypotheses 1 and 2.

3.6.1. Hypothesis 3a: results

Contrary to my prediction, the comparison of the full model and the null model revealed that "difficult" items were guessed significantly better in the speech condition than in the two gesture conditions (likelihood ratio test: $\chi 2 = 67.093$, df = 2, p = <.0001; effect size for the full model: R2m = 0.14, R2c = 0.24; model results: Table 29 below).

Table 29. Fixed effects table: Standard deviation (SD), Z-scores (z), and p-values (p).

Condition	SD	SE	z	p
Intercept	0.88	0.275	3.184	
reen	-1.12	0.232	-4.806	<.0001
repr	-1.90	0.248	-7.637	<.0001

Additionally, the pairwise comparisons indicate that the difference between enacting and representing gestures when guessing "difficult" items is significant, in favour of the former (B = 0.77, SE = 0.235, z = 3.299, p = 0.0029). The results of the pairwise comparisons are given in Table 30.

Table 30. Results of the pairwise comparison, exploring the effects of gesture condition on the correct answers. The table reports estimated model coefficients (Estimate), standard errors (SE), Z-score (z), and p-values (p).

Condition	Estimate (B)	SE	z	p
speech-reen	1.12	0.233	4.806	<.0001
speech-repr	1.89	0.248	7.637	<.0001

reen-repr	0.77	0.235	3.299	0.0029

There are no overlapping confidence intervals between all three conditions, which indicates that when guessing "difficult" items the children performed significantly better in "speech" than in the 2 gesture conditions, but also that they performed significantly better in the enacting condition than the representing condition (Table 31, Figure 17).

Table 31. Mean score, standard deviation (SD), sample size (n), standard error (SE), and lower and upper 95% confidence intervals (CI) for each gesture condition.

Condition	Mean	SD	n	SE	Lower CI	Upper CI
speech	0.23	0.641	30	0.012	0.207	0.255
reen	0.16	0.763	28	0.014	0.130	0.190
repr	0.11	0.534	27	0.010	0.086	0.128

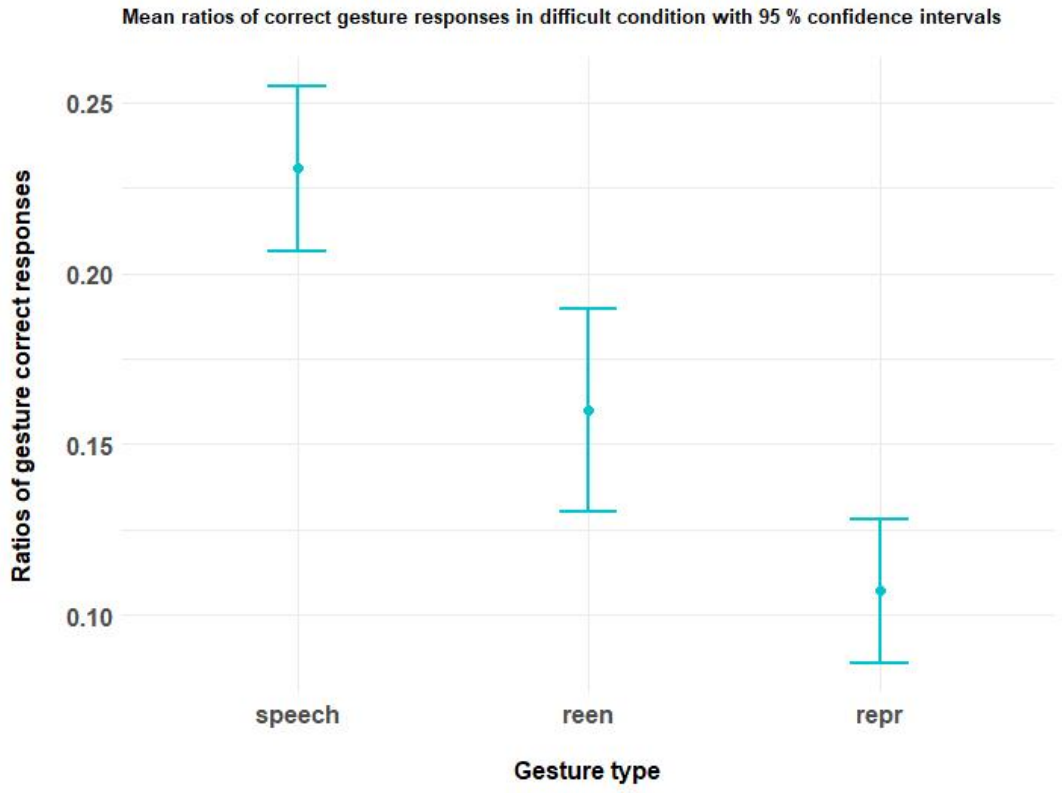


Figure 17. Mean ratios of correct responses in the three conditions for items labelled as "difficult". Points indicate mean values, and whiskers indicate 95% confidence intervals of the correct answers. Non-overlapping confidence intervals indicate significant differences between the groups.

3.6.2. Hypothesis 3b: results

The comparison of the full model and the null model revealed that the variable "ageGroup" significantly influenced the guessability of "difficult" items (likelihood ratio test: $\chi 2 = 23.3$, df = 2, $p < .0001$; effect size for the full model: R2m = 0.06, R2c = 0.11). The young group was significantly worse at guessing "difficult" items than the mid and old groups (model results: Table 32 below).

Table 32. Fixed effects table: Standard deviation (SD), Z-scores (z), and p-values (p).

	SD	SE	z	p
Intercept	-0.77	0.237	-3.252	
ageGroup/mid	0.80	0.223	3.577	<.0001
ageGroup/old	1.15	0.225	5.103	<.0001

Further, the pairwise comparisons did not reveal a significant difference between the mid group and the old group (B = -0.35, SE = 0.217, z = -1.619, p = 0.3163). The results of the pairwise comparisons are given in Table 33 below.

Table 33. Results of the pairwise comparisons, exploring the effects of "Condition" and "ageGroup" on the correct answers. The table reports estimated model coefficients (Estimate), standard errors (SE), Z-score (z), and p-values (p).

	Estimate (B)	SE	z	p
young-mid	-0.78	0.223	-3.577	0.0010
young-old	-1.15	0.225	-5.103	<.0001
mid-old	-0.35	0.217	-1.619	0.3163

The results of the pairwise comparisons are further corroborated by the analysis of the confidence intervals, where an overlap between the confidence intervals for the mid and the old group indicates lack of significant difference between them. The data are presented in Table 34 and Figure 18.

Table 34. Mean score, standard deviation (SD), sample size (n), standard error (SE), and lower and upper 95% confidence intervals (CI) for each gesture condition.

ageGroup	Mean	SD	n	SE	Lower CI	Upper CI
young	0.322	0.10	10	0.038	0.236	0.408
mid	0.504	0.08	10	0.027	0.446	0.562

old	0.289	0.07	10	0.021	0.542	0.636

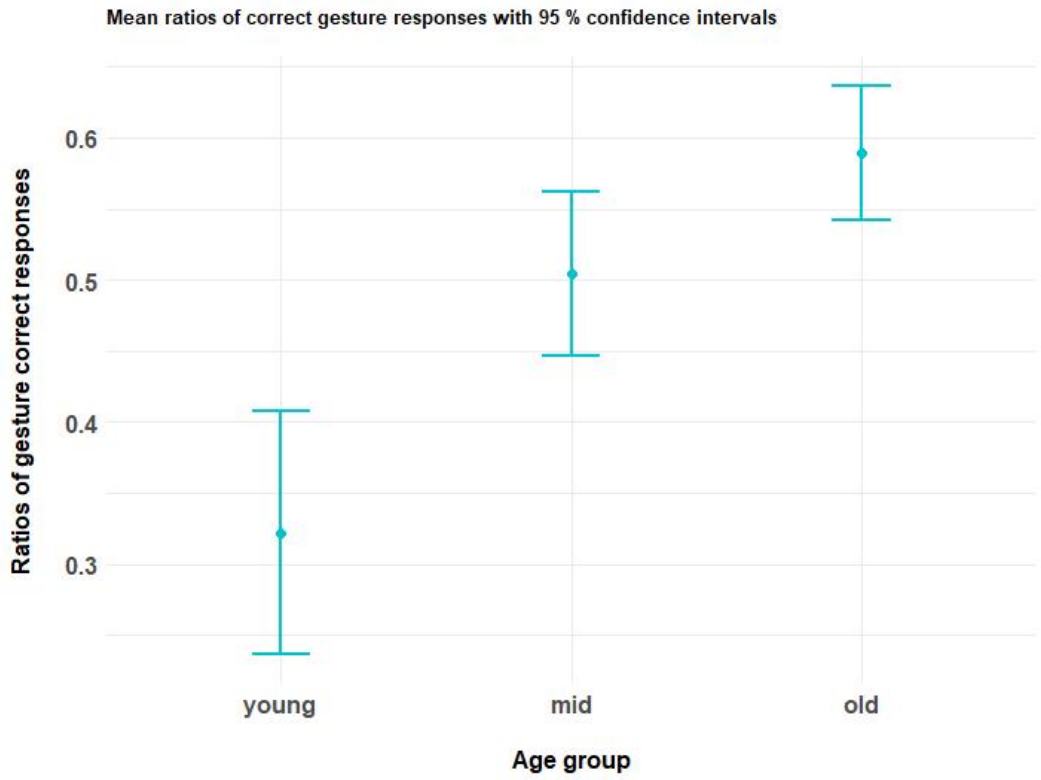


Figure 18. Mean ratios of correct responses in the three age groups for items labelled as „difficult". Points indicate mean values, and whiskers indicate 95% confidence intervals of the correct answers. Non-overlapping confidence intervals indicate significant differences between the groups.

3.6.3. Hypothesis 3c: results

To test H3c, I built two models:

- one with the interaction between the two predictors: the three experimental conditions (speech, enacting gesture, and representing gesture) and age;
- the other, without the interaction term between the two predictors.

The second model did not reveal significant interaction between the variables. Hence, the model without interaction was adopted for the purpose of further analysis and confirmed the results obtained for H3a and H3b.

The comparison of this model and the null model revealed that the young group was significantly better at guessing "difficult" items with speech than with enacting gestures and representing gestures, and that there was a significant difference in guessing "difficult" items with speech between the young group and the 2 other groups, in favour of the latter (likelihood ratio test: $\chi 2 = 93.804$, df = 4, $p < .0001$; effect size for the full model: R2m = 0.21, R2c = 0.26; model results: Table 35 below).

Table 35. Fixed effects table: Standard deviation (SD), Z-scores (z), and p-values (p).

	SD	**SE**	**z**	**p**
Intercept	0.15	0.291	0.500	
Condition-reen	-1.14	0.235	-4.860	<.0001
Condition-repr	-1.93	0.250	-7.735	<.0001
ageGroup-mid	0.92	0.240	3.809	0.0001
ageGroup-old	1.31	0.244	5.401	<.0001

Since the confidence intervals for the 2 variables are the same as in H3a and H3b, I do not report them here. However, to gain a fuller picture of how the 2 variables influence the guessability of "difficult" items, I report all of the results of the pairwise comparisons in Table 36, where I indicate the comparisons of interest by the bold font. I also use boxplot (Figure 19) to jointly visualise the impact of the variable Condition and ageGroup on the guessability of difficult items.

Table 36. Results of the pairwise comparison, exploring the effects of "Condition" and "ageGroup" on the correct answers for items labelled as "difficult". The table reports estimated model coefficients (Estimate), standard errors (SE), Z-score (z), and p-values (p). The table presents only the significant results.

	Estimate (B)	**SE**	**z**	**p**
speech/young-reen/young	1.14	0.235	4.860	<.0001
speech/young-repr/young	1.93	0.249	7.735	<.0001
speech/young-speech/mid	-0.92	0.241	-3.809	0.0044
speech/young-speech/old	-1.32	0.244	-5.401	<.0001
reen/young-speech/mid	-2.06	0.351	-5.870	<.0001
reen/young-reen/mid	-0.92	0.241	-3.809	0.0044
reen/young-speech/old	-2.46	0.358	-6.875	<.0001
reen/young-reed/old	-1.32	0.244	-5.410	<.0001

repr/young-speech/mid	-2.85	0.367	-7.749	<.0001
repr/young-reen/mid	-1.70	0.345	-4.943	<.0001
repr/young-repr/mid	-0.92	0.241	-3.809	0.0044
repr/young-speech/old	-3.25	0.378	-8.588	<.0001
repr/young-reen/old	-2.11	0.352	-5.991	<.0001
repr/young-repr/old	-1.32	0.244	-5.401	<.0001
speech/mid-reen/mid	1.14	0.235	4.860	<.0001
speech//mid-repr/mid	1.93	0.249	7.735	<.0001
speech/mid-repr/old	1.53	0.332	4.605	0.0001
reen/mid-speech/old	-1.55	0.336	-4.602	0.0001
repr/mid-speech/old	-2.33	0.350	-6.655	<.0001
speech/old-reen/old	1.14	0.235	4.860	<.0001
speech/old-repr/old	1.93	0.249	7.735	<.0001

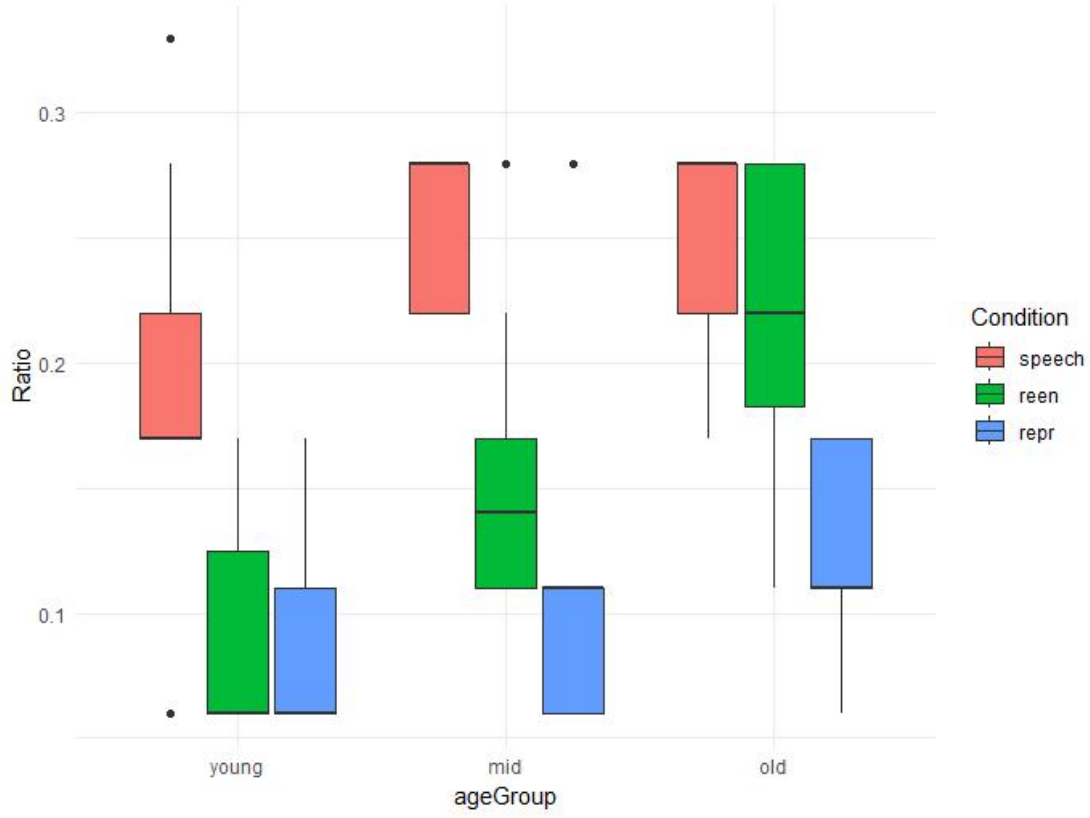


Figure 19. Mean ratios of correct responses for the items labelled as “difficult” for each of the age groups. Points indicate mean values, and whiskers indicate 95% confidence intervals of the correct answers. Overlapping confidence intervals indicate insignificant differences between the groups.

3.6.3.1. Commentary to Hypothesis 3 based on qualitative observations

Even though the effect connected with Hypothesis 3 turned out to be statistically insignificant, there were isolated cases where children did not know the word label for the item, but they did know the gestural label for this item. The phenomenon was observed mainly for items labelled as "difficult". Table 37 presents the number of children in each of the age groups who made a mistake in favour of iconic gestures. "Cleaver", "pepper mill", and "laptop" were the most frequently mistaken in favour of gesture.

Table 37. A summary of the mistakes made by the children in the 3 groups.

	24-monthers	**30-monthers**	**36-monthers**
Number of children who made a mistake	8/10	8/10	9/10
Sum of mistakes in the group	14	11	18
The list of mistaken items	- cleaver -pepper mill -laptop -boat -ladder -scissors	-cleaver -rake -pepper mill -laptop	-cleaver -pepper mill -laptop -fishing rod -glasses

Such a trend shows that there are instances where sign function in the case of particular objects (referent) is first realized in gesture, and only later in speech, even though it is not reflected in the quantifiable data. This suggests strongly that an iconic gesture can be understood before the word corresponding to it is. The number of mistakes differed for enacting and representing gestures (Table 38).

Table 38. Sum total of mistakes in favour of gesture across the 3 groups of children. The table presents enacting and representing separately.

Sum total of mistakes	43
Enacting gestures	26
Representing gestures	17

The results presented in Tables 40 and 41 are not significant in any way. However, they do indicate that enacting gestures, related to action can be easier to comprehend for children and, hence can help children map the form of the gesture

to its referent, especially when children observe gestures for items they do not know words for.

4. Summary of findings

The first of my research questions concerned the understanding of signs produced in speech and gesture. I asked whether this ability to perceive uttered names and gestures as signs changed in the transition period between the ages of 24- and 36-months. The hypothesis stated that the children will be getting better in guessing items presented to them (their scores will be getting significantly higher, their comprehension abilities increase) with age (H1). The hypothesis was confirmed. Statistical analysis of the collected data showed that there is an overall increase in children's ability to recognise the meaning behind spoken words and iconic gestures. As for 30-month-olds: they were significantly better in guessing all of the items presented to them (regardless of the condition) than 24-month-olds; and 36-month-olds were significantly better in guessing all if the items presented to them than the 24-month-olds and the 30-month-olds.

In my second research question I was interested only in scores for the two types of iconic gestures. The hypothesis stated that the children will be getting better in guessing iconic gestures presented to them (their scores will be getting significantly higher, their comprehension abilities increase) with age (H2a). The hypothesis was confirmed. Statistical analysis of the collected data for gestures only revealed a developmental pattern similar to that seen in the first hypothesis: age of the children positively influenced their ability to perceive iconic gestures as signs. However, the group of 30-month-olds was, better than the group of 24-month-olds, the group of 36-month-olds was better than the 24-month-olds, but there was not statistically significant difference between the groups of 30-month-olds and 36-month-olds. This suggests that even thought the two latter groups are better than the 24-monthers, the difference in the ability to perceive iconic gestures as signs is not that great between them.

The second part of the second hypothesis assumed that the children will be getting higher scores for enacting gestures than for representing gestures (H2b), regardless of their age. This hypothesis was not confirmed. There was no statistically significant difference between the quessability of the two types of iconic gestures. Yet, the third part of the second hypothesis (H2c) revealed that

enacting is easier to comprehend, when we take into consideration the age of the children. There was no difference in comprehension of enacting and representing gestures for the group of 24-month-olds, but there was already a statistically significant difference in guessing the two types of iconic gestures in the groups of 30- and 36-month-olds in favour of enacting gestures.

In my third research question I was interested in the emergence of sign function in speech and gesture. The hypothesis stated that, the sign function emerges in gesture earlier than it does in speech, for the selected age group of children (their scores will be getting significantly higher, their comprehension abilities increase, in favour of gestures; H3a) especially for the items they are unlikely to know at that age. The hypothesis was not confirmed. Statistical analysis revealed that children do significantly better in speech compared to either gesture condition, for the items labelled as "difficult". Interestingly, the analysis also showed that, for "difficult" items, enacting condition was significantly easier to guess in spite of the age of the children.

Further, age-related test showed a statistically significant result for age differences in guessing the "difficult" items: 30-month-olds and 36-month-olds scored better at comprehending these items than 24-month-olds, but there was no observable difference between the scores of the two older groups (H3b).

The last model, looking at the age and condition separately, revealed an interesting trajectory for the development of comprehension for speech and iconic gestures. While the scores for speech and representing gestures did not change much across the three age groups, enacting gestures deserve particular attention, as they changed drastically: comprehension of these items increases throughout the selected time period and reaches almost the same level in the 36-month of life as the result for speech. The results are not significant, but there is an observable trend in the increase of correct answers in enacting condition for "difficult" items.

As a result of the analysis, we can observe that the sign function: the ability to perceive and comprehend signs as meaningful (in speech or gestures, in the case of the present dissertation), changes in the transition period from the second to the third year of a child's life, but, in fact, accelerates between month 30 and 36. We cannot say, by statistical significance, that sign function emerges in gestures earlier than it does in speech.

Part 2: Qualitative analysis

1. Qualitative analysis of the video-material

The video-material and notes allowed me to supplement the quantitative analysis with a qualitative description of the behaviours children presented during the game. The qualitative description also helps to understand the results of the quantitative analysis: it sheds light on the source of behaviours children present and the mistakes children make in the game. In the description, I focus on three observations: children's behavioural strategies across the age groups, children's recurring mistakes, and the change in the comprehension of gestures that happens in the selected age period. All of the still images presented in the qualitative analysis are taken from the research material. The stills are anonymized and cannot be reproduced.

2. Self-regulatory behaviours in young children

Not all of the children were sure of their answers and not all of them were interested in the task throughout the game. In their uncertainty and disinterest, they seemed to employ various coping strategies and self-regulatory behaviours. While coping strategies are most often described in the context of medical practice in adults (Meggiolaro et al., 2016; Algorani & Gupta, 2022), we speak of self-regulatory activities already in infancy (cf. "coping" in: Lazarus & Folkman, 1984; Rothbart et al., 1992; Rueda et al., 2004). Coping mechanisms are comprised of thoughts and behaviours used to manage stress. That is, they are used to tolerate or reduce stress levels, which can either arise from internal or external sources (Venner, 1988; Folkman & Moskowitz, 2004), regardless of the type of stress. Similarly, gaining regulatory competence is a mechanism of adaptation: a child learns how to inform others about her state, notices that others react to her signals, and learns how to regulate emotional arousal or attention levels on her own. Self-regulation is "a process that subsumes the internalization of social norms and the development of skills to conform to standards" or expectations of others (Elias & Berke, 2002: 216; Vygotsky & Cole, 1978). As an

effect of the development of self-regulation, a child becomes more independent in personal and social situations (Shonkoff et al., 2000).

Everyday observation of children shows that they employ various strategies to adapt to new environments: they may cry, become very active, shy, or talkative—all these behaviours modulate their stress levels. By the age of 18 months, children possess the ability to control their attention: plan and perform certain behaviours or avoid certain behaviours (Posner & Rothbart, 1997). Between 18 and 30 months of age, children's ability to monitor their own behaviour and modulate it changes rapidly and becomes stable across situations (Kopp, 1982; Vaugh et al.. 1984). At that time, they also stay close to their parents, with whom they feel safe (Bridges & Grolnick, 1995). Under such conditions, their exploratory behaviours are more spontaneous (Bowlby, 1969; Feldman et al., 2006). By the age of 36 months, children have basic control over their emotions (Braungart & Stifter, 1991; Buss & Goldsmith, 1998; Shonkoff et al., 2000). They can also inhibit certain reactions and focus their attention on various tasks for increasingly longer periods of time (Lyon & Krasnegor, 1996; Lieberman, 2017). More advanced examples of the development of effortful control (Rueda, 2012) can include the understanding of delayed gratification, attention inhibition or patience, task-oriented concentration (Shonkoff et al., 2000), as well as problem-solving or planning (Stuss, 1992). Self-regulation development testifies to brain maturation and conscious control of attention mechanisms (Diamond & Taylor, 1996; Perlman & Pelphrey, 2010).

During the interaction with the experimenter, the children redirected their attention to toys present in the room. Pretend play, "a form of playful behaviour that involves nonliteral action" (Weisberg, 2015: 249; see Chapter 2), is a phenomenon observed already in infancy that allows young children to practice a range of linguistic, cognitive, and social skills (for an overview, see: Pleyer, 2020: 54–90). Using play, children exercise joint attention mechanisms, intersubjectivity, and communicative skills of both verbal and nonverbal origin (Göncü, 1993; Lewis et al., 2000; Didow & Eckerman, 2001; Branco, 2005; Quinn & Kidd, 2019). It is one of the first and important ways that infants and young children communicate. Children use pointing in play to establish contact with others and to inform them about particular objects or events (Liebal et al., 2009; Liszkowski et al., 2012). Importantly to this research, children use play

behaviours to rehearse self-regulatory skills, such as stress release or emotion control (Kwon & Yawkey, 2000; Whitebread & O'Sullivan, 2012; Cabrera et al., 2017). Play observed in the video-data can serve as an explanation of the children's behaviour throughout the interaction with the experimenter—a situation that could be seen as a potentially stressful one due to an unfamiliar setting and an unfamiliar person who wants to interact with the child. Observing the change in the behavioural patterns of children from the 3 age groups in the same environment can be very informative for future experimental research and naturalistic observation studies.

2.1. Behavioural strategies - observations

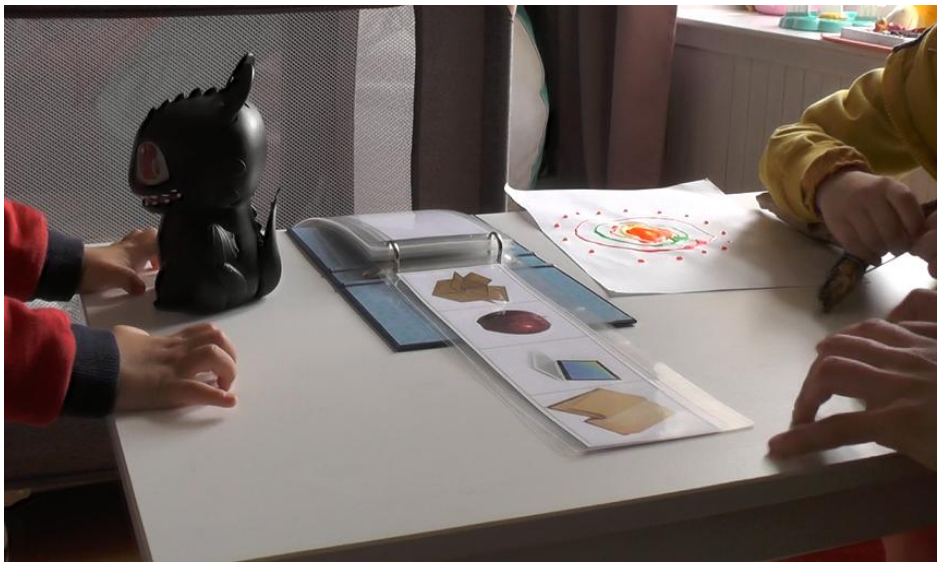
All of the children who took part in the research were able to focus their attention and perform the task, with a different result, as presented in sections 1–3 of Chapter 4. Not all of the children were able to perform the task in a single attempt: children in the young and middle groups took breaks more often than the children in the old group. 6 out of 10 children in the old group were able to perform the entire task in a single attempt. For some children, especially those from the youngest group, the task was too long and, at times, too repetitive to be fun. These children would often get engaged in the exploration of toys found in the room instead. To counter their frustration, the researcher would play with them for a while and invite their parents to play, too (Still 1, Still 5, Still 6 below). The children from the middle and the old group were able to keep their focus on the task for longer. Still, some of the children from these two groups demanded a few breaks throughout the interaction.

The behaviours of the youngest children were the richest in terms of different strategies used throughout the game. They presented several ways of managing the questions from the experimenter. Most often, they would engage in imitation, a form of bodily mimesis (see Chapter 2): 7 out of 10 24-month-olds copied the gestures of the experimenter (Pictures 10-13 below). The children repeated the gesture presented to them and only after this short play provided their answer. The imitation did not seem to influence the children's answers: there was no assumption about how, if present, copying the gestures would increase the children's score in the game. Such a behaviour, however, shows that the children were able to simulate and perform the movement on their own, which

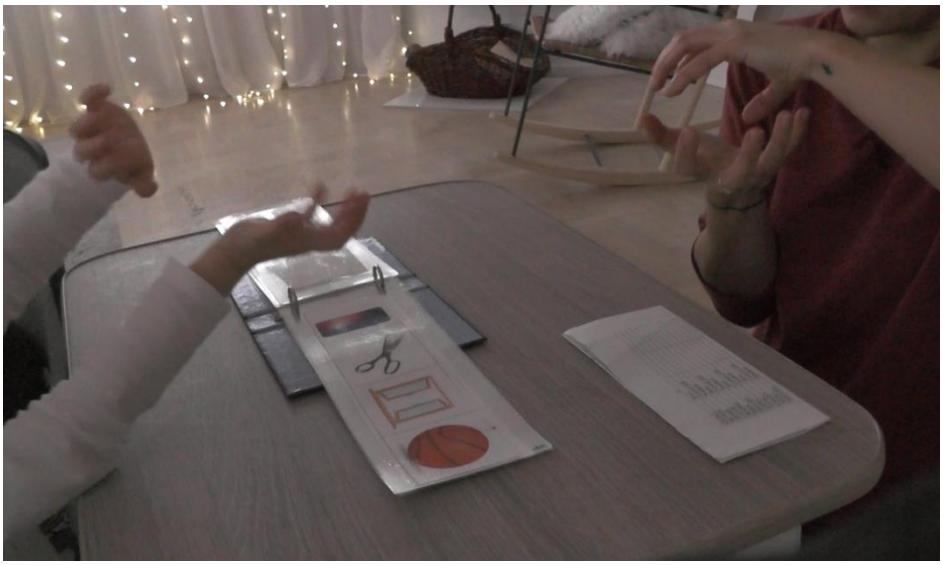
also testifies to the development of their self-awareness and effortful control (Reddy, 2008). There were much fewer attempts at imitation in the group of 30-month-olds, as compared to 24-month-olds, and there was only 1 child who was imitating the gestures used in the game in the group of 36-month-olds. I did not observe any manual gestures related to affect displays in any of the groups.

Picture 10. A 24-month-old imitating “crayon”—the shape of the gesture. A toy can be seen on the table.

Picture 11. A 24-month-old imitating “rake”—the shape of the gesture. Toys can be seen on the table.



Picture 12. A 24-month-old imitating “computer”—the shape and movement of the gesture (on the left). A toy can be seen on the table.



Picture 13. A 30-month-old imitating “ball”—the shape of the gesture.

Another strategy employed most often by the youngest children was shifting their attention from the task to the toys present in the room (Pictures 10-12 above; Pictures 14-15 below), regardless of the place of the meeting. This behaviour was emerging most often after a few trials in the experimental part of the task. Such circumstances invite the interpretation that changing the object of interest from the task to the toys was done as a result of exhaustion, tiredness, or boredom. Another possibility is that the children were not feeling comfortable in

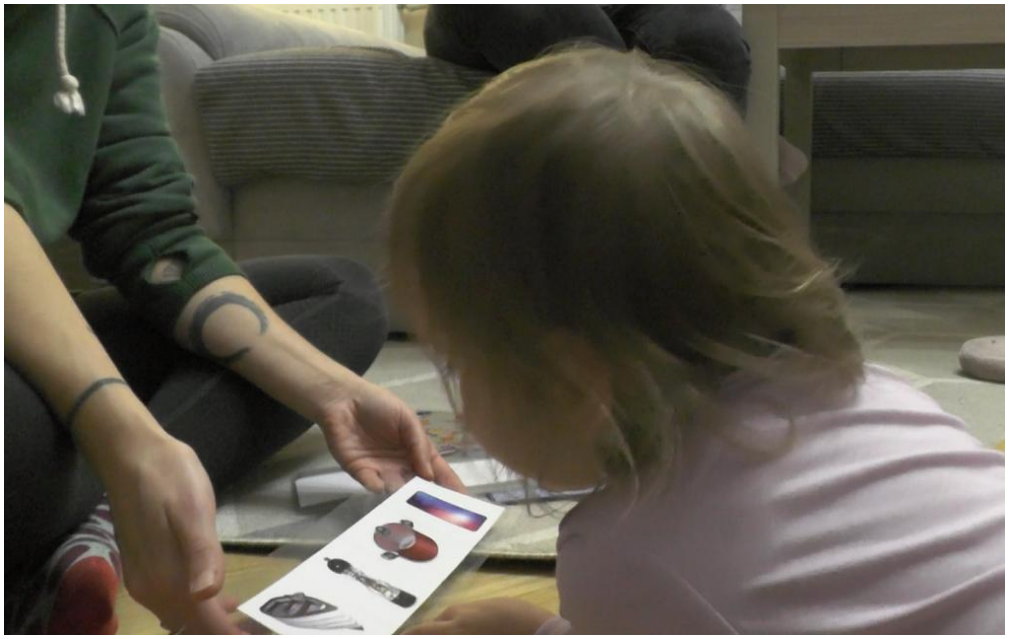
the game, as the behaviour would become more vivid after a few failed attempts to match the gesture/speech with the correct item from the page. Yet another explanation is that the children in the selected age groups enjoy engaging in pretend play with others, and such an interaction is more important to them than the task itself, which is in line with the purpose of pretend play described in Section 4.1. of Chapter 4. Children in the young and middle groups would readily engage in play with the experimenter. The difference between the groups, however, was that the middle group would shift to play a bit later in the game. Another difference between the 24-month-olds' group and the 30-month-olds' group was that the older children were more likely to come back to the task soon after a short break, or provide answers using toys, compared to the youngest children, for whom playing with toys and providing answers at the same time seemed too cognitively demanding. The group of 36-month-olds seemed to be more focused on the task than on the possibility of playing with the experimenter. Observation of the gathered video-material shows that 36-month-olds would also visually inspect the material for longer before selecting their answer, compared to the two remaining groups. It can be suggested that the oldest group gave their answers more thought, compared to the two remaining groups. Such a strategy could translate into more correct answers that were seen in the quantitative analysis for the oldest group of children.

Picture 14. A 24-month-old engaged in play with the researcher during a short break. The proximity between the child and the researcher testifies to the comfort of the child.

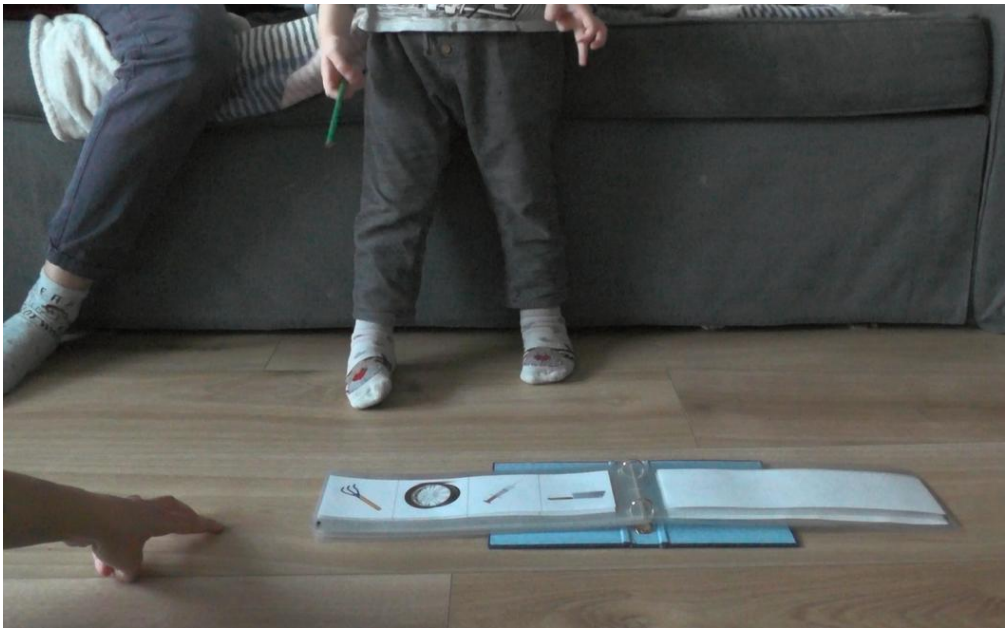
Pictrue 15. A 30-month-old engaged in play with the researcher during a short break. The proximity between the child and the researcher testifies to the comfort of the child.

Picture 16. A 36-month-old focused on the game.

The last behaviour was linked to the proximity the child wanted to stay in with her parents (Picture 17-18). There was no observable rule for the proximity, but it was more common for 24-month-olds to stay close to their parent, rather than engage with the experimenter. The two older groups, 30- and 36-month-olds, were more likely to leave their parent's side and engage in the task, as well as in additional activities: some children would show and describe toys to the researcher or ask the researcher to, for example, read a book to them or answer their questions. The proximity-related behaviour was also visible on the side of the parents: the caregivers of the youngest group left their side less often than those of the two remaining groups. It is likely that those children who felt more relaxed provided better answers throughout the task. On the other hand, more outgoing and relaxed children could be less focused on the game and more prone to distraction.



Picture 17. A relaxed 24-month-old: the child was laying on the floor, rolling, and getting into very close proximity to the experimenter throughout the game.



Picture 18. A 30-month-old who did not engage in play and stayed close to the mother throughout the game. Such a behaviour may indicate higher stress levels in the child.

Since the research was partially conducted during the COVID-19 pandemic, it was for some time impossible to invite the participants to University facilities, as they were closed for everyone. During that time, the meetings with participants took place at their homes. Later, when lockdown was partially lifted in Poland, I started to invite parents and children back to the University's Baby

Lab. I observed that children across the three age groups behaved differently in the lab and at home. Toddlers who came to the lab were more distracted, more active motorically, and less obedient towards their parents' instructions. Those tested at homes were more focused on the game, less active motorically, and more obedient towards their parents' instructions. The difference might stem from the environment children found themselves in, as unknown environment promotes exploration and curiosity. It is also possible that the children were more focused on the game at their homes, as the only new element was the experimenter and the very game. Such an observation yields questions whether it is just to conduct research with toddlers in the lab as it seems the children's attention mechanism can be highly influenced by their surroundings, especially when they enter a new place.

3. Errors in language acquisition

Children exhibit rapid vocabulary growth between the ages of 2 and 3 years (see Chapter 2), which is made possible by the acquisition of the sign function that allows them to first understand the notion of simple signs, and the sign combinations (see Chapter 2). Language acquisition in that period can to some degree be characterised by a "trial-and-error" approach children adopt towards lexical items and grammatical rules they rehearse in everyday communication. They use their general knowledge, new words and structures in novel situations and contexts freely, regardless of the mistakes they make (Gentner & Namy, 2006; Benson, 2020). They also make use of gestures that help them in communication with others (see Chapter 2). However, the more vocabulary items children gather, the easier it is for them to make a mistake (Gershkoff-Stowe & Smith, 1997). The three most common kinds of "errors" in language acquisition are overgeneralisation, overextension, and underextension.

Overgeneralization (or: overregularization) is related to the use of improper syntactic structures, which results from the knowledge of the rules for regular verbs: in English, the need to add the "-ed" suffix to regular verbs is transferred to irregular ones. As a result, a child might say "goed" instead of "went"; or might add the "-s" suffix of the third person singular where it is not necessary (Baker, 1979; Onnis et al., 2002; Parke & Gauvain, 2009).

Overextension is related to the use of a single word as a label for various objects (Rescorla, 1980; Clark, 2015; Barrett, 2017). It contains three subcategories of errors: (1) categorical overinclusion, in which one word is used as a label for all of the referents that match the same category: for example, the word "cat" used to refer to all quadrupeds, "dad" used to refer to all men, or "apple" used to refer to all round food items; (2) analogical overextensions, in which one word is used as a labelled referent based on the perceptual similarity to the standard referent: for example, a "centipede" would be called a "comb", any round object would become a "ball", or a "box" would become a "hat" if placed on the head; the last subcategory contains (3) predicate statements, in which a child would use a word to convey information about the referent's relation to an absent entity or state: for example, a child would say "doll" as a referent to the usual location of the doll, without the doll being present in the location, or the use of the word "grandfather" to indicate a building where the said person lived (Rescorla, 1980: 325–327; Fremgen & Fay, 1980; Kay & Anglin, 1982; Kuczaj, 1982; Barrett, 2017). Extended information on children's behaviour during Rescorla's (1980) study is not provided, but it seems likely that the last subcategory would often be accompanied by a pointing gesture.

The last kind of error, the error of underextension is the opposite of overextension. We speak of underextension when a child uses a word for a single item and does not see that the item belongs to a broader category. For example, a child fails to retrieve a vocabulary label for an object they know: a "rose" is a flower, yet in the child's understanding only the rose is a flower, or "ketchup" is not a food item to a child's mind (Kay & Anglin, 1982; White, 1982; López-Couso et al., 2017; Barrett, 2017). Research focuses on underextension of nouns, but it is also possible to see underextension of verbs. For example, the word "clock" would refer only to objects hung on a wall, or the use of the word "cut" would be reserved for the action done with a knife, but not with another tool (Harris et al., 1995; Naigles et al., 2009).

In the research, I was looking at vocabulary items, not sentences or expressions. Therefore, the overgeneralization error did not occur in any of the interactions. However, the mistakes observed in the research, presented in the following paragraphs, bear resemblance to those of overextension. The only difference between my observations and the observations of the other researchers

is the semiotic system in which the mistakes occur: in my research, they are present in a gesture comprehension task.

3.1. Recurring mistakes of the children

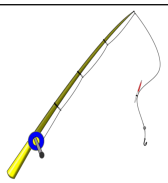
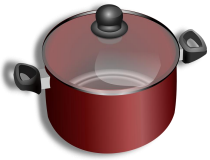
The children across the 3 age groups made similar mistakes when asked to match a gesture with the correct picture out of 4 possibilities. The mistakes were more common for the "difficult" items. The number of mistakes was similar between the groups. Moreover, the mistaken items tended to be similar between the groups of children, too. Table 39 and 40, below, presents the mistakes children made for selected items presented to them in the form of more dynamic—enacting ("reen") gestures, and more static—representing ("repr") gestures. The mistakes are provided for each of the age groups separately. I selected those items for which at least 3 children within the group made the same mistake.

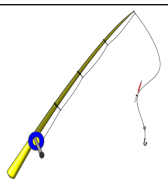
Table 39. The mistakes in gesture comprehension made by the children in different age groups, and the number of children that made the same mistake.

ageGroup	№ mistakes	Condition	Target item	Mistaken for
young	3	repr	rake	cleaver
young	3	reen	fishing rod	tyre
young	3	reen	book	key
young	4	repr	pepper mill	banana
young	4	repr	ladder	fishing rod
mid	4	reen	pepper mill	key
mid	4	reen	boat	pepper mill
mid	5	repr	boat	pot
mid	6	reen	fishing rod	tyre
mid	6	repr	laptop	cardboard box
mid	3	repr	fishing rod	ladder
old	5	reen	pepper mill	key
old	3	reen	boat	pot
old	4	repr	boat	pepper mill
old	3	reen	book	key
old	3/3	repr	laptop	cardboard box / book

Table 40. 6 sample mistakes illustrated with the pictures of the target item and the incorrect choice. The description of gesture for the target item made by the experimenter is provided in the rightmost column (but see also Chapter 3). The mistakes are paired for condition. RH stands for "right hand", LH stand for "left hand".

ageGroup	Condition	Terget item	Mistaken for	Gesture
young	reen	fishing rod	tyre	LH fist, knuckles facing left, RH fist, knuckles facing righ, RH placed over LH,

				but with a distance of 20cm, both fists tilted right by 45 degrees, RH performs a movement backwards, and then forwards, LH follows in the distance given, at the end of the forwards motion RH opens, goes to the level of LH, closes into a fist again, knuckles facing upwards, and performs a spinning motion clockwise; “casting the fishing rod”;
young	repr	pepper mill 	banana 	LH fist, knuckles to the left, RH fist, knuckles to the right, fists placed on one another, RH on top;
mid	reen	pepper mill 	key 	LH fist, RH fingers stretched out, slightly curved towards the palm of the hand, placed above the RH fist, LH performs a twisting motion to the right; “grinding pepper”;
mid	repr	boat 	pot 	RH fingest erected, placed together, LH finders erected, RH and LH thumbs touching the palms of respective hands, RH fingertips touching LH fingertips, wrists touching one another;
old	reen	boat 	pot 	RH fist, LH fist, knuckles facing up in front of chest, hands, arms and torso set in motion - RH and LH held in position, push forward, body leans accordingly, RH and LH held in position, body, pull backwards, body leans accordingly; “rowing”;
old	repr	fishing rod	ladder	RH erected pointing finger, pointing right and up, arm stretched following the hand position, LH fist,

				thumb touching the elbow;

First, let us look at “fishing rod”. The mistake made for the enacting gesture was picking “tyre” instead of the target item. The error could result from the spinning motion that the children associate with a tyre or a wheel rather than the fishing rod. The mistake made for the representing gesture was picking the “ladder”. The error could stem from the shape of the two objects and the fact that they are both long or tall.

The next error was related to “pepper mill”. The mistake made for the enacting gesture was picking “key” instead of the target item. The error could result from the twisting motion that the children may associate with the key sooner than the said difficult item: “pepper mill”. The mistake made for the representing gesture was picking “banana”. The error could stem from the relatively straight and simple shape of the representing gesture that the children could associate with the object that seemed easier than the pepper mill.

The last mistake was made for “boat”. The children mismatched the enacting gesture for “boat” and selected “pot”. The error could result from what looked like a stirring motion associated with the action done to pots, too. The mistake for the same item given in the form of a representing gesture could be made because of the shape of the boat and the shape of the pot: one could put something into these two container-like objects.

The mistakes children made repeatedly across the age groups may have their source in the perception of gestural labels, their referents, their semantic content, and the conceptualization of these objects in a child’s mind at the ages of 2- and 3-years old (Nuyts & Pederson, 1999; Langacker, 1999; Sweetser, 1999; cf. a change in 4-year-olds in: Gopnik, 1993). A meaning of a word is understood based on its salient features: a “cat” is not a “dog” even though both of them are mammals, have four legs, and, most often, have a tail, too, but only one of them has pronounced whiskers that are often used to distinguish the looks of a cat from the looks of a dog. In the same way, the meaning of the gesture of twisting one’s hand in the air with fingers spread apart resembles the action of grinding pepper

to an adult, who knows pepper mills, uses them, and is able to perceive the salient element of the gesture, but, perhaps, to a child's mind, it is more similar to turning a key in a lock—a concept that is closer to a child's experience. Semantic features of an object can be linked to one object more than another in spite of shared characteristics of these objects. It depends on the user's experience. A diagrammatic representation of the properties of an item a child knows and tries to make a decision on the meaning of a gesture could be represented as in Figure 20:

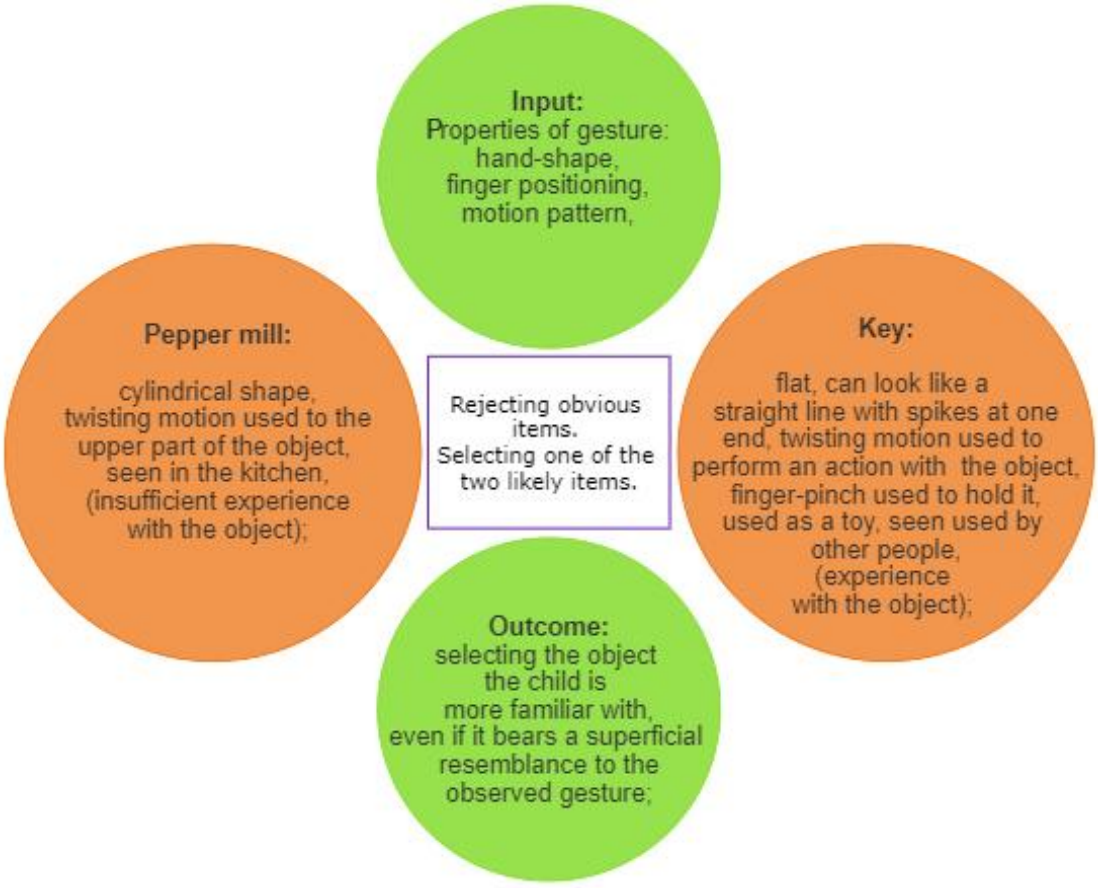


Figure 20. "Pepper mill" and "key" interpreted as meaning an object that you can twist the upper part of.

This explanation is in line with the prototype theory approach for concepts, proposed by Rosch and Lloyd (1978), which we can extend to signs. The formation of a category is a complex cognitive and lexical process that requires a number of examples of sign use (with expression being a word, a gesture, or a picture) before an individual is able to distinguish it from other, similar signs. In

her early life, a child operates on prototypical exemplars—the best, most frequently observed, and most well-known examples of the use of various concepts (Anglin, 1977; Kuczaj, 1982; Croft, 1991) and it is easy for her to make a mistake. Kuczaj (1982: 102) writes that:

> ... the prototypes are most likely to be appropriate exemplars (assuming that such exemplars are most frequent in the context in which the child hears the terms, this increasing the likelihood that some appropriate exemplars will be viewed as prototypic by the child). The result is that children will view at least some appropriate exemplars as prototypic or more prototypic than exemplars to which they overextend particular *terms* and so choose such appropriate exemplars rather than the overextended exemplars. The important point is that such a pattern does not mean that children will invariably fail to overextend *terms* in comprehension but instead reflects the more prototypic status of the appropriate exemplars, the less prototypic exemplars (including at least some to which the *term* is overextended) being chosen after the more prototypic exemplars if children are given the opportunity to make subsequent choices. (my emphasis, in italics)

Perhaps this recognition and categorization pattern that is here discussed for speech items is also true for gesture comprehension in children and changes with age. It can be the schema for the particular object (Piaget, 1962; Langacker, 1993 [2013]; Zlatev, 2014) that children have in mind when making their choices. The elements known to children can be organized into frames (Fillmore, 1976). The frames store the knowledge of properties of linguistic items, but also referents presented as gestures, and expand gradually into, for example, the knowledge of contexts in which particular words or phrases are used (Cienki, 2007; Fillmore & Baker, 2009) or into the knowledge of salient elements that enable an individual to discriminate between two similar objects presented to them by means of gestures. For that to occur, a child needs time and communicative experience.

Another, but a less likely, explanation of the errors made by the children can be the "semantically crowded" material. Semantic properties of a word establish its individual meaning distinct from other words and help us discriminate between similar linguistic items (Nida, 1979; Palmer & Frank, 1981; Lipka, 2002), like the "cat" and "dog" example above. The properties of the referents of "cardboard box" and "laptop" are alike when we think of the way we open the two objects; similarly, the referents of "ball" and "apple" bear resemblance to one another in shape. If that was the case, the "semantically crowded" material would make the children repeat the mistakes for particular sets of items, such as ones containing "cardboard box" and "laptop", much more often

than for the sets of other items. Such a pattern, however, was not present in the gathered material.

Comprehension of iconic gestures requires experience and ability to look for subtleties in hand movements and finger positioning (Table 40 above). The groups of adults that took part in the corroboration of the material (see Chapter 3) did not have problems with iconic gesture comprehension when presented with the material. The process of salient features perception in gesture seems to be still ongoing at the ages between 2 and 3 years old. To the best of my knowledge, there has been hardly any research analysis that has examined overextension or other types of "errors" in the comprehension of different types of iconic gestures in children at the ages of 24-, 30- and 36 months. The topic definitely deserves more attention.

4. When pointing doesn't point any more

Human beings use pointing for communication throughout their lives. Pointing gestures can be done with a finger, a hand, an object held in a hand, a gaze pattern, a head tilt, or a tongue movement (Carpenter, 2009; Debras & Cienki, 2012; in sign languages: Stokoe, 1978; Liddell & Metzger, 1998). These gestures do not have a representational meaning of their own (Goldin-Meadow, 2007; Cooperrider & Núñez, 2009) and are used to indicate people, objects, or events in both immediate proximity and in metaphorical distance such as time (de Vega et al., 1996; Núñez & Sweetser, 2006). In semiotic terms, their meaning is (predominantly) indexical rather than iconic or symbolic.

As described in Chapter 2, children recognize and follow pointing when they are as young as 6 months old (Butterworth et al., 2013; Melinder et al., 2015; Schmitow et al., 2016) and start to actively use it when they are around 9 months old (Carpenter et al., 1998; Liszkowski et al., 2012). Initially, they exercise it in social interactions with another individual (dyadic communication: Legerstee, 2009), and later are able to use it in interactions with other individual(s) and object(s) (triadic interaction: Moreno-Núñez & Alessandroni, 2021). Such a "form of social interaction whereby two or more individuals coordinate their actions in space and time to bring about a change in the environment" (Sebanz et al., 2006: 70) is a form of "joint attention" (Tomasello, 1995; Striano & Rochat, 1999; Franco & Gagliano, 2001; Franco et al., 2009; Fiebich & Gallagher, 2013;

see Chapter 2). Pointing is a key behaviour that orchestrates attention of others and enables a child to achieve her communicative goals as early as in the pre-linguistic stage (Call, 1980; Liszkowski et al., 2004; Liszkowski, 2011; cf. different cultures: Choi et al., 2018; Cameron-Faulkner, 2021). It is, therefore, a very strong communicative tool, rooted deeply in human communication.

I did not come across any unexpected reaction to pointing gestures while piloting the research material. Nor did it occur to me that children may react to the "pointing element" present in an iconic gesture that had a meaning of its own. Therefore, it was interesting to see how the iconic representation of the "fishing rod" item led to confusion in some children. One of the elements of the said gesture was an erect pointing finger, directed upwards diagonally, while the rest of the fingers was folded into a fist (Picture 19).

Picture 19. Iconic gesture representing the "fishing rod" item.

It was surprising to observe a recurring reaction of children to this particular element of the gesture. It was also interesting to see how the reaction to the pointing element got weaker with age. The youngest group manifested the strongest reaction to pointing: the children would not only look for the item that was as-if pointed at, but also automatically imitated the shape of the hand and performed the gesture together with the researcher. They would also ask

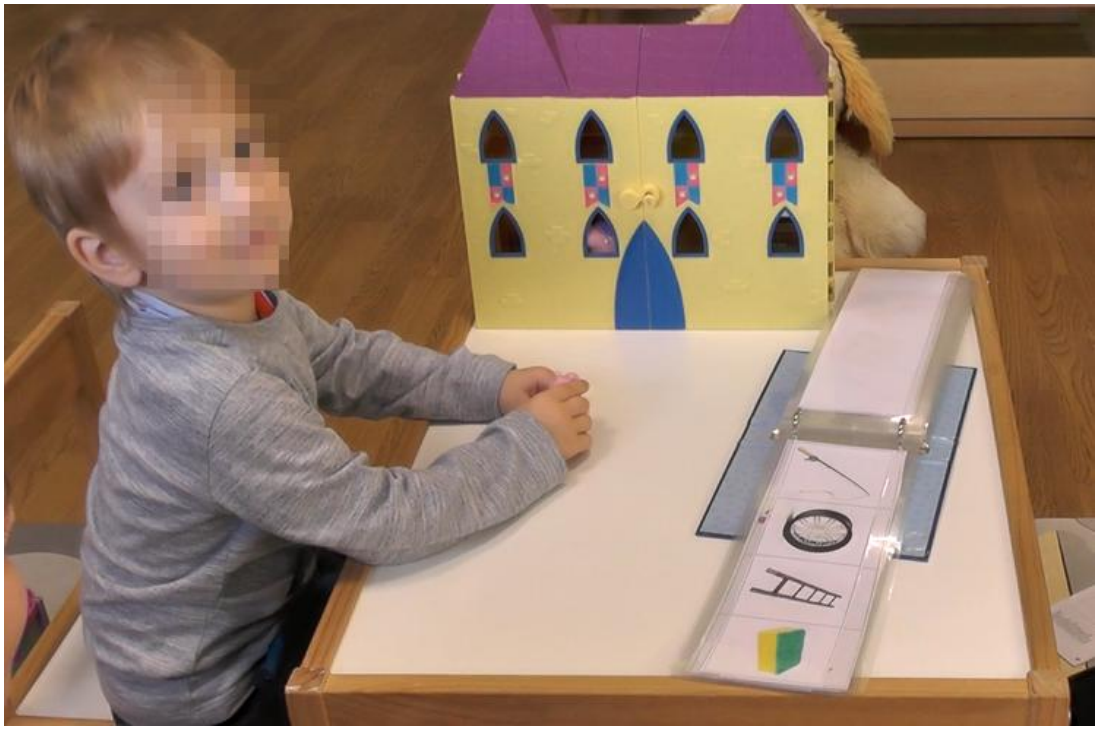
clarification questions, such as “There?”, accompanied by the pointing gesture. The middle group would also look into the direction of pointing and perform the gesture, but they would not ask questions. The two children who reacted to pointing in the old group would provide the name of the object that, it seemed to them, was pointed towards. Table 41, below, presents a brief description of the behaviours presented by the children. What follows the table are stills from the video-material presenting the children’s reactions (Pictures 20-24A).

Table 41. The number of reactions to the “fishing rod” gesture as a pointing gesture in the three age groups. The number is provided “x” out of 10.

ageGroup	№ reactions	Types of behaviour
young	7/10	Looking for what the gesture is pointing at, looking in the direction set by the pointing gesture, turning the head and the body to look in the direction of pointing, copying the posture of the hand for the pointing gesture, asking clarification questions e.g. “Where?”, “There?”, or “The hole?” (referring to the door frame);
mid	5/10	Looking for what the gesture is pointing at, looking in the direction set by the pointing gesture, turning the head to look in the direction of pointing, sometimes copying the action of pointing;
old	2/10	Looking in the direction set by the pointing gesture, turning the head to look in the direction of pointing, copying the action of pointing, giving the name of the object that was as-if pointed at e.g. “The TV?”;

Picture 20. A 24-month-old confused by the “fishing rod” gesture. The child tries to look for the referent of the pointing. The child was asked “Which item looks like this?” and responded “The huge hole? Door?”.

Picture 21. A 30-month-old confused by the “fishing rod” gesture. The child turns to the side and tries to look for the referent of the pointing gesture. The child imitates the pointing gesture.



Picture 22. A 30-month-old confused by the “fishing rod” gesture. The child turns to the side and tries to look for the referent of the pointing gesture. The child was asked “Which item looks like this?” and responded “A small finger!”.

Picture 23. A 30-month-old confused by the “fishing rod” gesture. The child turns to the side and tries to look for the referent of the pointing gesture.

Picture 24-24A. A 36-month-old confused by the “fishing rod” gesture. The child turns to the side, mimics the entire gesture, and looks for its referent. The child was asked “Which item looks like this?” and responded “The TV!”, which was as-if pointed at.

The decreasing reaction to the pointing element of the iconic gesture, observed as children grow older, can be explained with how much the pointing gesture is rooted in human communicative ability and how early in life human children start to pay attention to that particular sign. As mentioned above, but also discussed in Chapter 2, pointing comprehension emerges at a very early age. It is used for orchestrating the attention of others and making requests—a very important ability for language and communication rehearsal. It is also a precursor to the use of names of objects and its flexible use is observed prior to the two-word stage in language development. The discussed observation suggests that between 30 and 36 months of age, children start to realize that signs presented as gestures can be complex: one gesture can become a component of another, more complex gesture. It seems that the children “let go” of the importance of the pointing gesture.

5. Summary of findings: qualitative analysis

Qualitative analysis can provide an extension to quantitative results of a research, especially when there is a recorded form of interaction between individuals. The

analyses of quantitative research, presented in Sections 1–3 of Chapter 4 Part 1 provide answers to the research questions and hypotheses of the thesis. They shed light on the development of sign function in the selected age group and expand our knowledge on the development of iconic gesture perception in toddlers. They also fill in the gap regarding the underrepresentation of typically developing toddlers between the ages of 2 and 3 in experimental research and show the potential of time- and resource-intensive research focused on nonverbal communication in the selected age group. Part 2 of Chapter 4 discusses the range of behaviours children presented in the recorded interactions and explains, to an extent, the potential sources of mistakes the children made in the game. It also reports a very interesting observation of the change in the understanding of the pointing gesture, which broadens our understanding of the time of formation of polysemiotic signs and the shift in perception of deictic and iconic gestures. To the best of my knowledge, no research up to this point observed the transition phase from pointing to iconic gesture. Overall, the findings lend perspectives on the linguistic and cognitive development of children at the period between the 2 and 3 years of age. The video-material collected in the project has great potential for being developed into separate lines of research.

Conclusions

1. Introduction

The present part aims to summarize the results of my research in view of what has been established by previous research. In Section 1, I present the main findings of my thesis and discuss how they expand our understanding of the emergence of sign function in gesture for children at the transition between the second and the third year of life. In Section 2, I criticize those aspects of my design that require cautious interpretation and how they will be amended in my upcoming experimental work with children. In Section 3, I lay out future lines of experimental semiotic research within the domain of gesture studies.

2. Research summary

The aim of the present thesis was to contribute to our understanding of the role of iconic gestures in the emergence of sign function in toddlers in 3 age groups: 24-month-old, 30-month-old, and 36-month-old. My work aimed to bridge two gaps: one in experimental research on gesture comprehension and another in research on gesture development within the ages of 24 months, 30 months, and 36 months (see Chapters 1–2). In my study, I raised questions about the comprehension of iconic gestures in the selected period. I asked how the understanding of signs in speech and iconic gesture of two kinds (enacting and representing) changes with the age of the child. I looked at the dynamics of the change in children's comprehension of these two kinds of gestures and checked whether it is possible that the sign function emerges in gesture earlier than it does in speech. My research integrated the perspectives from experimental linguistics, cognitive semiotics, and psychology. I created 12 sets of 4 pictures, presented them to children in the 3 age groups, and asked them questions in two semiotic systems: speech and gesture. Labels for items in the speech condition were uttered, while labels for items in the gesture condition were presented by means of hand movements and hand-shapes. I used both quantitative and qualitative methods for analyzing the data that were collected for the purpose of my research, which is the first study on this range of problems conducted with Polish toddlers.

The developmental trajectories of speech and gesture in children are similar with regard to comprehension and production: not only do toddlers understand more words than they are able to say, but they also understand more gestures than they produce. In the study on speech comprehension in children between 14 and 26 months, Goldin-Meadow and colleagues write that "[l]anguage in the two-year old must possess some permanent representation of objects and actions in order to understand words" (1976: 200–201). The prediction turned out to be true also for gestures in children's transition from the age of 2 to the age of 3, at which time the child must gain permanent representation of objects and actions that enables her to see the similarities between a hand-shape or movement and its referent. I observed that as children grow older and acquire linguistic and social experience, they realize that certain gestures can be used as signs, which is congruent with Hodges and colleagues' (2018), as well as Tolar and colleagues' (2008) findings (see Chapter 2; Chapter 4, Part 1). The scores of my subjects correlated with their age, which in my view reflects an increasing understanding of iconic gestures as children develop. This finding is important to research on language acquisition, as it suggests that children start to perceive gestures as semiotic vehicles in the transition from the age of 30 to the age of 36 months.

My results also suggest that, overall, enacting gestures that are related to action are easier to comprehend for children than representing gestures that focus on salient elements of an image, or its shape, which is congruent with the results of former research, e.g. by Tolar and colleagues (2008) or Hodges and colleagues (2018) (see Chapter 2; Chapter 4 Part 1). However, the change for comprehension of these gestures happens between month 30 and 36, as 24-month-olds scored higher for representing gestures while there was a change between 30- and 36-months, as it was the time when the children started to score increasingly higher at guessing enacting gestures compared to representing gestures.

The comparison between speech and iconic gesture shows that sign function emerges primarily in speech, which is in line with Sekine and colleagues' findings (2015), as well as Özçalişkan and colleagues' findings on word-gesture interplay (2014) (see Chapter 2; Chapter 4, Part 1). However, there were isolated cases where item comprehension in gesture preceded item comprehension in speech (see Chapter 4, Hypothesis 3). This was observed

mainly in the group of 3-year-olds, and concerned only those items that were assessed as potentially unknown to children at the selected age.

Taken together, the results of the present study extend previous findings on the ability to comprehend iconic gestures in toddlerhood, but do not provide a definite answer as to whether representing gestures or enacting gestures are easier for toddlers. They do, however, inform us that Polish toddlers are better in seeing the similarity between a gesture and its referential action, and thus comprehending enacting gestures at the transition from 30 to 36 months of age. More research in the field is in order.

The most surprising result of the study was related to the changing perception of iconic gestures. No research up to this point observed the transition phase from pointing to iconic gesture. Qualitative description (see Chapter 4, Part 2) of children's behaviour indicates that there is a transition in the ability to perceive a deictic-like handshape as a component of another gesture between 30 and 36 months of age. The effect of the use of a pointing-like handshape within another gesture is very strong and primes children to pay attention to what they use more often—the pointing gesture—rather than to the newly acquired ability to recognise meaning behind gestures that resemble shapes and actions.

3. Semiotic development: an update of the model

In Chapter 1, I outlined the gap found in child development hierarchies. I focused on the model proposed by Jordan Zlatev and Lorraine McCune (2014), which defines skills children gain as they grow older. The model is composed of 6 stages and extends from birth to the third year of life. Aa a result of my research, I propose to subdivide Stage 6 "Discourse and narrative" into two shorter, 6-month-long, stages: "Sign insight" and "Discourse and narrative". I was able to update the model and bridge the age gap with my observations about the development of gestures in toddlers (Table 42).

Table 42. Semiotic hierarchy updated with my findings: Adapted from Zlatev and McCune (2014: 66).

	Stage	Cognitive-semiotic skills	Approx. age
1	Primary audalism	- neonatal mirroring - bodily molding	0-4 m

		- affect attunement - proto-conversations	
2	Dyadic interactions (self-other, self-object)	- social routines - social referencing - stranger anxiety - locomotion and object exploration - perception of deictic gestures - pre-symbolic play (Level 1)	5-9 m
3	Triadic interactions (self, object, other)	- imitation (of novel acts) - production of deictic gestures - context-limited words - self/other pretend play (Level 2/3)	10-14 m
4	Intentional communication	- communicative intent - communicative grunts - referential words - production of deictic gestures of different kinds - combinatorial representational play (Level 4)	15-20 m
5	Onset of symbolic communication	- integrating representation and intent - hierarchical representational play (Level 5) - sign combinations: word+ gesture - onset of grammar	21-24 m
6	Sign insight	- simple sentences - sign combinations: two words+ gesture - perception of iconic gestures in others - comprehension of complex instructions from others	25-30 m
7	Discourse and narrative	- complex sentences - discourse - onset of narrative - comprehension of iconic gestures as manual signs	31-36 m

Although the present model has more empirical backing, there are many more problems still to be addressed in research on semiotic development in children. These, however, lie beyond the scope of my present project.

4. Limitations

In personal communication, Molly Flaherty, a prominent scholar of sign language and language development in children, told me that we learn how to do research

with children by making mistakes. The design may seem perfect, all the pilots are promising, and we begin collecting experimental data. During the experiment, more often than not, we notice that things do not go as planned, but it is already too late to change the design. In this section I discuss what we can do to improve our research with toddlers in general and what should have been given more attention while preparing this study.

4.1. Number of items presented to children

In the game, each child was presented with 12 items that recurred in 3 different conditions. In sum, a participant saw 24 iconic gestures for everyday objects and heard 12 word labels for these objects. As described in Chapter 2, toddlers get to know their environment by their newly acquired skills of walking, running, and climbing. It was very difficult for them to sit through 36 questions while they wanted to move around. Additionally, the complexity of the elements and their recurrence in the 3 rounds, even though the material was balanced for these aspects, may well have led to the children's decreasing focus on the game and interest in the task, irrespective of their age. Fatigue was reflected in their behaviour: while children were fairly focused on the task in round 1, it was increasingly difficult for them to keep that focus in round 3 (see Chapter 4, Part 2).

The number of items entailed another problem: length of the meeting. It was advised to make the meetings short which would be beneficial due to a 2-year-old's daily routine, such as feeding or naptime, as well as due to the epidemiological restrictions. The number of questions children were supposed to answer in the experiment did not translate into short meetings. In the future, the length of the meetings with toddlers should be evaluated more thoroughly, depending on the task.

4.2. Lab vs. home environment

Experimental research with children is generally done in the lab. Defining setting that can be reconstructed by other scholars is of crucial importance for its replicability. This research was partly conducted at the children's homes. The problem I saw later, while working back in the lab, was the difference in how the children behaved at home compared to the laboratory. Toddlers were much less

disciplined in the lab because they wanted to explore the room, play with the lab equipment, and with toys present there. They also wanted to see the offices and meet other people working in the laboratory space. In contrast, children whose recordings were done at their homes conformed to their parent's instructions more willingly and they tended to stay focused throughout the experiment. It also found it easier for them to sit calmly during the game (see Chapter 4, Part 2). These observations lead to the conclusion that an environment (home vs. lab) can influence children's performance in experimental research, which may have particularly serious consequences in research on comprehension. This is because comprehension tasks often demand a fixed position and increased focus on the stimulus material for a certain amount of time.

While it should be acknowledged that the lab setting has a great replicatory potential, it seems to adversely affect children's attention mechanisms. New environments, such as a lab space, makes them more excited and distracted, which translates into their ability to focus on experimental tasks. In my opinion, it is better to work with children in their natural environment—home, but it is important to control confounding factors by adjusting the time of the study to their routine and making sure all participants are not hungry, sleepy, or tired.

4.3. Developmental measures

While working with children, we need to know whether the group we are looking at is uniform. Group uniformity enables us to compare the results of our experiment between the groups we observe in our study. The developmental measures selected for the present research deserve critical reflection.

To assess group uniformity, I relied on a combined communicative and temperament measure specifically created for the purpose of the research. Although the measure was not standardized, even though it was based on standardised tools (see Chapter 3). I am aware that using fully standardized MacArthur-Bates CDI and Rothbart's ECBQ would have produced a much more conclusive assessment of the children's developmental trajectories. For that, however, I would have to work with or under the supervision of a psychologist, which I intend to do in the future. After consideration, I also think that Mean Length of Utterance, a reliable measure of language development widely used in

research with toddlers, that can be used without any assistance from a psychologist can be used in my future research.

Another factor responsible for my selection of the developmental measures social outreach of experimental research with children in Toruń and parents' attitudes towards of such research. As I mentioned at the beginning of Chapter 3, parents would rather resign from taking part in the study than provide extensive documentation of their children's development. It is a responsibility of the scientific community to demystify research with children and inform parents about its importance.

5. Future directions

The results, presented and summarized in Chapter 4, can provide inspiration for projects on the role of gestural iconicity in language development. I would like to specify three lines of enquiry that can follow up from my research.

5.1. When pointing doesn't point any more

Capirci and colleagues write that "[d]eictic gestures, which appear very early in children's communicative repertoires, are more directly linked to reality than deictic words: they can be used in the same manner to point to objects, people or locations, without differentiating demonstrative and locative meanings, and the object or event to which they refer can be identified in the physical context of the child's utterance" (1996: 669). Pointing can therefore be considered as the first sign in the child's semiotic repertoire.

One of the observation made in the present research regards the change in children's perception of pointing. As outlined in Chapter 2, pointing is the earliest gesture humans use for communication. Children are skilful observers, and they know early on that certain sounds and gestures cause others to react in predictable ways. They follow pointing already in the first months after birth. They start to use pointing around the nineth month of their life with word-like syllable sounds. As they develop, toddlers use pointing gestures to refer to everyday objects in combination with nouns, such as names of animals or foodstuffs, or frequently used adjectives, such as "big" or "small". Then, they use pointing in two-word combinations, such as a noun+verb+point, as in "mama+give+[object pointed at]".

There has been no research to this date showing the change in children's perception of a pointing-like handshape as a part of another, more complex, gesture, such as an iconic gesture. In my research, I noticed the transition period from perceiving pointing gesture as a deictic sign to perceiving it as a part of another gesture, for example an element of an iconic gesture. Even though the results show the change clearly, the phenomenon calls for a research of its own. In the future research, the design for which has already been outlined in private communication with my collaborators—Marta Sibierska and Šárka Kadavá—we propose a selection of gestures that all include a pointing-like hand-shape. The gestures will be presented interchangeably with iconic gestures without the component of pointing-like hand-shapes. The reactions of children will be recorded and analyzed. Overall, the game-like design will be similar to the one used in the present thesis. We expect to see a different reaction to iconic gestures with and without the pointing component. To put this future research into a large developmental perspective, we would like to add a group of 4-year-olds. Data collection for this research project is scheduled for 2024.

5.2. Research with deaf children

In personal communication with Ana Mineiro, a prominent scholar who has documented the emergence of São Tomé and Príincipe Sign Language (Mineiro et al., 2017), I was told that, in her opinion, the research with Deaf children would produce different results for pointing gestures that those observed in my study (Conclusions, Section 3.1.; Coppola & Senghas, 2010). The time of the emergence of pointing in hearing and Deaf children is estimated at 10 months (Stokoe, 1978; Mayberry & Squires, 2006). Yet, due to the visual-manual modality of sign languages, the pronounced iconicity of sign languages and children's exposition to iconic signs from early months (Thompson et al., 2012; Hou, 2018; Mineiro et al., 2021), Deaf children are likely to understand the sign function of manual gestures earlier than hearing children understand the sign function of (co-speech) gestures. The case may be that they also understand pointing gestures earlier than the hearing population, and would not make a mistake seen with the hearing toddlers (see Chapter 4, Part 2).

Such a prediction could be checked in an experimental setting with Deaf children. The design described in the present thesis, yet improved by adjustments

to the design described in Sections 1–1.3, could be used for this purpose. The hypothesis would assume that Deaf toddlers between the ages of 2 and 3 are better at comprehending of iconic manual gestures than hearing toddlers of the same age (Fuks, 2023; cf. Orlansky & Bonvillian, 1984).

5.3. The changing role of iconicity in the elderly

Another line of research on iconic gesture comprehension and production is directed at seniors and concerns the role of iconicity in their communication. As we grow older, our cognitive and perceptual abilities decrease. We can now use such tools as glasses, to enhance our vision, and hearing aid, to enhance our auditory abilities, but it is difficult to enhance our attention-related skills in a significant way. When processing speech and gesture, the human brain processes multimodal and polysemiotic information at the same time, which can decrease cognitive load (Skipper et al., 2009; Xu et al., 2009; Ping & Goldin-Meadow, 2010; cf. Overoye & Wilson, 2020), and, hence help maintain focus and facilitate understanding and memorisation (Hostetter, 2011; Kang & Tversky, 2016; Dargue et al., 2019; Dargue & Sweller, 2020). I am wondering if such an effect can be seen in the elderly, and whether iconic gestures can promote their understanding of messages or instructions at the stage when their hearing starts to fail them.

The conceptual-empirical loop is thus closed.

But the loop is never closed.

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Appendix A

Informacje o badaniu

Osoba prowadząca badanie: mgr Monika Boruta-Żywiczyńska, doktorantka programu *Academia Copernicana*, UMK w Toruniu; kontakt: mboruta@doktorant.umk.pl lub telefon 570764317.

Temat badania: Rozwój znaku językowego u dzieci w wieku od 24 do 38 miesięcy.

Cel badania: Sprawdzenie, czy dzieci w różnym wieku radzą sobie z rozpoznawaniem znaku w formie gestu tak dobrze jak z jego rozpoznawaniem w formie werbalnej - wypowiadanego słowa.

Czas trwania badania: Około 20 minut, czas przeznaczony na spotkanie: około 45 minut.

Przebieg spotkania: Rodzic zostaje poinformowany o temacie, celu i przebiegu badania; następnie otrzyma on do wypełnienia niniejszy kwestionariusz, który pozostawi badaczowi do analizy. Następnie, badacz poinformuje rodzica o przebiegu badania: badacz uruchomi kamerę i pokaże dziecku karty na których znajdować się będą obrazki przedstawiające przedmioty codziennego użytku, badacz poprosi - za pomocą słowa lub gestu - aby dziecko wskazało na wybrany przedmiot. Jeżeli dziecko odgadnie przedmiot o który chodzi dwa razy z trzech, badacz przejdzie do gry-zgadywanki opartej na książeczce. Gra-zgadywanka składa się z trzech rund. W każdej rundzie dziecko odgaduje dwanaście słówek. Na koniec, badacz odpowie na dodatkowe pytania rodzica dziecka. Za udział w badaniu, dziecko otrzymuje upominek.

Informacje dotyczące dziecka zbierane na potrzeby badania:

1. Imię dziecka, data urodzenia dziecka oraz wiek w miesiącach: .....
2. Czy dziecko ma rodzeństwo? TAK / NIE (Jeśli TAK to ile? W jakim wieku?): .....
3. Czy dziecko chodzi do żłobka/przedszkola? TAK / NIE. Jeśli NIE, to kto zajmuje się dzieckiem? .....
4. Czy dziecko korzysta z poradni lub bierze udział w warsztatach terapeutycznych (słuch, wzrok, motoryka, SI)? TAK / NIE.

Jeśli TAK, to z jakiej poradni/warsztatów korzysta dziecko: .....

5. Czy dziecko korzysta z dodatkowych aktywności np. taniec, pływanie, jazda konno, zajęcia muzyczne, plastyczne, język obcy ?

Proszę podkreślić właściwe i/lub wymień inne: .....

Proszę zaznaczyć właściwe, częściej występujące zachowania dziecka a) lub b):

Czy dziecko: **a)** swobodnie chodzi i podejmuje bieg czy **b)** chodzi niepewnie, woli trzymać się dłoni/przedmiotów?

Czy dziecko: **a)** precyzyjnie łapie różne przedmioty i ma pewny chwyt czy **b)** przedmioty wyślizgują się dziecku z rąk?

Czy dziecko: **a)** gestylukuje, podaje przedmioty, używa rąk do komunikacji czy **b)** nie gestykuluje, nie używa rąk do komunikacji?

Czy dziecko: **a)** używa palca wskazującego, żeby coś pokazać czy **b)** nie używa palca wskazującego, żeby coś pokazać?

Czy dziecko: **a)** kręci głową przecząco/potakuje, posyła całusy, robi *pa pa* lub *hej hej* czy **b)** nie wykazuje zachowań z **a)**?

Czy dziecko: **a)** tańczy do muzyki, kopie piłkę, bawi się w ruchu czy **b)** spędza czas siedząc i bawiąc się w jednej pozycji?
Czy dziecko: **a)** chętnie podejmuje nowe aktywności czy **b)** woli aktywności, które już zna?
Czy dziecko: **a)** jest śmiałe i chętnie nawiązkuje kontakty czy **b)** boi się nowo poznanych osób ?
Czy dziecko: **a)** często jest pogodne, trudno je zdenerwować czy **b)** często jest rozgniewane, łatwo je zdenerwować?
Czy dziecko: **a)** bawi się i prowadzi narrację w czasie zabawy czy **b)** bawi się w ciszy nie udaje „głosów zabawek"?
Czy dziecko: **a)** reaguje na swoje imię, np. odwraca głowę, gdy jest wołane czy **b)** nie reaguje na swoje imię?
Czy dziecko: **a)** rozumie wypowiedzi innych i reaguje na nie **b)** nie rozumie wypowiedzi innych i nie reaguje na nie?
Czy dziecko: **a)** reaguje na prośby np. *Podaj mi* i patrzy na rozmówcę czy **b)** nie reaguje na prośby, nie podnosi wzroku?
Czy dziecko: **a)** reaguje na uwagi np. *Zostaw, Nie wolno* czy **b)** nie reaguje na uwagi, nie przerywa czynności?
Czy dziecko: **a)** raguje na pytania np. *Gdzie jest miś?* i szuka przedmiotu wzrokiem czy **b)** nie reaguje i nie szuka przedmiotu?
Czy dziecko: **a)** powtarza czynności np. Udaje, że myje zęby, odkurza, gotuje, pije, je czy **a)** nie wykazuje zachowań z **a)**?
Czy dziecko: **a)** samo powtarza usłyszane słowa i zwroty czy **b)** trzeba prosić dziecko zanim powtórzy usłyszane słowo lub zwrot?
Czy dziecko: **a)** próbuje samo wykonywać czynności np. Ubiera czapkę, buty, czesze się czy **b)** nie wykazuje zachowań z **a)**?
Czy dziecko: **a)** chętnie mówi, sylabizuje, śpiewa, nuci czy **b)** jest ciche, nie spiewa, niechętnie się odzywa?
Czy dziecko: **a)** wymyśla własne nazwy na nieznane przedmioty czy **b)** nie wymyśla własnych nazw na nowe przedmioty?
Czy dziecko: **a)** nadaje imiona zabawkom i zwierzętom czy **b)** nie nadaje imion zabawkom i zwierzętom?
Czy dziecko: **a)** używa onomatopei np. pies to *hau-hau*, samochód to *brum-brum*, itd. czy **b)** nie używa onomatopei?
Czy dziecko: **a)** zadaje proste pytania np. Co to? Kto to? Gdzie? To? Tam? Czy **b)** nie zadaje prostych pytań?
Czy dziecko: **a)** używa zdań np. *Mama pić*; *Tata am*; *Dzidzi bam* czy **b)** jeszcze nie łączy wyrazów, ale używa pojedynczych słów?

Pytania z zakresu statusu socjoekonomicznego rodziny (właściwe podkreślić):

- Wykształcenie matki dziecka:- podstawowe - gimnazjalne - zasadnicze zawodowe - średnie - wyższe -

Inne: .....

- Wykształcenie ojca dziecka:- podstawowe - gimnazjalne - zasadnicze zawodowe - średnie - wyższe -

Inne: .....

- Ilość osób w gospodarstwie domowym: - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 -

- Miesięczny dochód na jednego członka gospodarstwa domowego: <1000 <2000 <3000 <4000 <5000, 5000 i więcej

Ja niżej podpisana/y oświadczam, że zostałam/em poinformowana/y przez mgr Monikę Boruta-Żywiczyńską o celach i formie przeprowadzania badania. Przeczytałam/em i zrozumiałam treść Informacji o badaniu. Poinformowano mnie, że dodatkowe pytania mogę kierować bezpośrednio do osoby prowadzącej badania i że uzyskam na nie odpowiedź. Wiem, że badanie uzyskało zgodę komisji etycznej. Arkusz kwestionariusza został wypełniony przeze mnie zgodnie z moją najlepszą wiedzą.

Jestem świadoma/y, że mogę zrezygnować z badania na każdym jego etapie, bez podania przyczyny.

Niniejszym wyrażam pełną, świadomą i dobrowolną zgodę na udział mojego dziecka w badaniu oraz na anonimowe przetwarzanie, udostępnianie i na publikację danych związanych z moim dzieckiem.

....

Data i podpis osoby wyrażającej zgodę *Data i podpis osoby prowadzącej badanie*

Appendix B

Imię i nazwisko osoby badanej:	
Numer kontaktowy:	
Data wywiadu:	
Osoba przeprowadzająca wywyiad:	

Czy w przeciągu ostatniego tygodnia wystąpiły u Pana(i) następujące objawy:		
gorączka	TAK	NIE
kaszel	TAK	NIE
duszność	TAK	NIE
katar (inny niż alergiczny)	TAK	NIE
utrata smaku	TAK	NIE
utrata węchu	TAK	NIE
bóle mięśni i/lub stawów	TAK	NIE

1) W ostatnich 14 dniach ani ja ani moje dziecko nie mieliśmy kontaktu z osobą przejawiającą powyższe objawy lub objawy infekcji dróg oddechowych.

2) Ani ja ani moje dziecko nie mieliśmy kontaktu z osobą, u której rozpoznano COVID-19 lub z osobą przebywającą na kwarantannie ze względu na kontakt osobą chorą na COVID-19.

3) Zapoznałem/am się z informacją dotyczącą stosowanych podczas badania środków ostrożności oraz zdaję sobie sprawę z istniejącego ryzyka epidemiologicznego.

Pomiar temperatury przed badaniem: Opiekun/ka prawny/a _____ Dziecko: _____

Badacze mają prawo odmówić przeprowadzenia badania, jeśli Opiekun/ka prawny/a dziecka nie zgadza się z minimum jednym ze stwierdzeń 1) 2) 3) oraz zaznaczył/a TAK w conajmniej jednym okienku w tabeli powyżej.

Podane przez Państwa dane osobowe i wrażliwe dotyczące stanu zdrowia Państwa i Państwa dziecka są odpowiednio chronione zgodnie z polityką RODO obowiązującą na Uniwersytecie Mikołaja Kopernika w Toruniu i wykorzystywane jedynie w celu przeprowadzenia badania.

Toruń, ……(data)

Podpis Rodzica lub Opiekuna …….....……...

Zgodnie z art. 13 ust. 1 i 2 Rozporządzenia Parlamentu Europejskiego i Rady (UE) 2016/679 z dnia27 kwietnia 2016 r. w sprawie ochrony osób fizycznych w związku z przetwarzaniem danych osobowych i w sprawie swobodnego przepływu takich danych oraz uchylenia dyrektywy 95/46/WE(ogólne rozporządzenie o ochronie danych) informuję, że:
1) administratorem Pani/Pana danych osobowych jest Uniwersytet Mikołaja Kopernika w Toruniu, ul. Gagarina 11, 87-100.
2) kontakt do Inspektora Ochrony Danych: iod@umk.pl
3) Pani/Pana dane osobowe przetwarzane będą na podstawie art. 6 ust. 1 lit d) RODO oraz art. 9 ust. 2 lit i) RODO w celu ułatwienia służbom sanitarnym dochodzenia epidemiologicznego na wypadek wykrycia, że osoba zakażona brała udział w wydarzeniu, w którym Pani/Pan uczestniczyła/uczestniczył.
4) odbiorcami Pani/Pana danych osobowych będą wyłącznie podmioty uprawnione do uzyskania danych osobowych na podstawie przepisów prawa w tym Państwowy Inspektor Sanitarny
5) Pani/Pana dane osobowe przechowywane będą przez okres 2-ch tygodni
6) posiada Pani/Pan prawo do żądania od administratora dostępu do danych osobowych, prawo do ich sprostowania, usunięcia lub ograniczenia przetwarzania.
7) ma Pani/Pan prawo wniesienia skargi do organu nadzorczego zajmującego się ochroną danych osobowych
8) podanie danych osobowych jest dobrowolne, jednakże odmowa podania danych może skutkować odmową uczestnictwa w badaniu

Appendix C

Informacja o przetwarzaniu danych osobowych
Na podstawie Rozporządzenia Parlamentu Europejskiego i Rady UE 2016/679 z dnia 27 kwietnia 2016 r. w sprawie ochrony osób fizycznych w związku z przetwarzaniem danych osobowych i w sprawie swobodnego przepływu takich danych oraz uchylenia dyrektywy 95/46/WE, zwanego dalej „RODO", informujemy, że:

1. Administratorem Pana/Pani danych osobowych będzie Uniwersytet Mikołaja Kopernika w Toruniu z siedzibą przy ul. Gagarina 11, 87-100 Toruń (dalej: Uczelnia, ADO).
2. Pana/Pani dane osobowe, uzyskane w związku z uczestnictwem w badaniu prowadzonym przez mgr Monikę Boruta-Żywiczyńską, UMK w Toruniu, na potrzeby jej pracy doktorskiej związanej z rozwojem znaku językowego u dzieci w wieku od 24 do 38 miesięcy, będą przetwarzane na podstawie:
    a. art. 6 ust. 1 lit. a) i art. 9 RODO – Pana/Pani zgody, w celu prawidłowej realizacji badania,
    b. art. 6 ust. 1 lit. f) RODO – w naszym usprawiedliwionym interesie jakim jest:
        - pozyskanie danych umożliwiających kontakt, oraz przechowywanie zgód opiekunów prawnych dzieci;
        - ustalenie, dochodzenie lub obrona roszczeń,
3. Zebrane dane osobowe będą przechowywane przez 6 miesięcy i w takim czasie może Pan/Pani żądać od nas wydania wyników badania; po tym czasie dane zostaną bezpowrotnie zanonimizowane.
4. Przysługują Panu/Pani prawa, które zrealizujemy na wniosek o:
    a. Żądanie dostępu do danych osobowych oraz z zastrzeżeniem przepisów prawa: prawo ich sprostowania,
    b. Żądanie usunięcia lub ograniczenia przetwarzania,
    c. Sprzeciw wobec przetwarzania,
    d. Przeniesienie danych osobowych przetwarzanych w systemach informatycznych do innego administratora.
5. Podanie danych osobowych jest dobrowolne, ale niezbędne do realizacji celu, w którym zostały zebrane.
6. Przysługuje Panu/Pani prawo do cofnięcia zgody w każdym czasie, ale cofnięcie to nie wywołuje skutków prawnych w stosunku do przetwarzania, które odbywało się na podstawie zgody przed jej wycofaniem.
7. Przysługuje Panu/Pani prawo wniesienia skargi do Prezesa Urzędu Ochrony Danych Osobowych.
8. Pana/Pani dane osobowe mogą być udostępnione podmiotom administracji publicznej, podmiotom, z którymi UMK współpracuje przy organizacji konferencji.
9. Na dzień zbierania Pana/Pani danych osobowych nie planujemy przekazywać ich poza EOG (obejmujący Unię Europejską, Norwegię, Lichtenstein i Islandię), nie wykluczając tego w przyszłości, o czym zostanie Pan/Pani poinformowania ze stosownym wyprzedzeniem.
10. W stosunku do Pana/Pani nie będą prowadzone działania polegające na podejmowaniu decyzji w sposób zautomatyzowany, nie będą one również podlegały zautomatyzowanemu profilowaniu.
11. Jeżeli chce Pan/Pani skontaktować się z Uczelnią w sprawach związanych z przetwarzaniem danych osobowych, w szczególności w związku z wniesieniem wniosku o realizację przysługujących praw prosimy o kontakt pod adresem e-mail: iod@umk.pl lub adresem korespondencyjnym: UMK w Toruniu, ul. Gagarina 11, 87-100 Toruń, z dopiskiem „IOD", dostępny jest również kontakt telefoniczny: 56 611 27 42.

Wyrażam zgodę na przetwarzanie moich danych osobowych, w celu niezbędnym do uczestnictwa w badaniach prowadzonych przez mgr Monikę Boruta-Żywiczyńską, UMK w Toruniu, na potrzeby jej pracy doktorskiej związanej z rozwojem znaku językowego u dzieci w wieku od 24 do 38 miesięcy.

_____
podpis osoby badanej

Imię i nazwisko badacza; kontakt: Monika Boruta-Żywiczyńska; mboruta@doktorant.umk.pl ;

Imię i nazwisko osoby badanej; wiek; płeć.....

Kontakt (e-mail lub telefon):.....

Ja niżej podpisana/y oświadczam, że zostałam/em poinformowana/y przez mgr Monikę Boruta-Żywiczyńską o celach i formie przeprowadzania badania. Przeczytałam/em i zrozumiałam treść Informacji o badaniu.

Poinformowano mnie, że dodatkowe pytania mogę kierować bezpośrednio do osoby prowadzącej badania i że uzyskam na nie odpowiedź. Wiem, że badanie uzyskało zgodę komisji etycznej.

Jestem świadoma/y, że mogę zrezygnować z badania na każdym jego etapie, bez podania przyczyny.
Oświadczam, że otrzymałam/em kopię niniejeszego dokumentu, a informacje podane w nim przeze mnie są zgodne z prawdą.

Niniejszym wyrażam pełną, świadomą i dobrowolną zgodę na udział w badaniu oraz na anonimowe przetwarzanie, udostępnianie i publikację zebranych danych.

.....	.....
Data i podpis osoby wyrażającej zgodę	*Data i podpis osoby prowadzącej badanie*

Appendix D1

UNIWERSYTET
WARMIŃSKO-MAZURSKI W OLSZTYNIE
Komisja ds. Etyki Badań Naukowych
The Scientific Research Ethics Committee

DECYZJA nr 14/2021 KOMISJI ds. ETYKI BADAŃ NAUKOWYCH

A. Pozytywna

Komisja ds. Etyki Badań Naukowych Uniwersytetu Warmińsko-Mazurskiego w Olsztynie, po rozpatrzeniu wniosku projektu badawczego złożonego przez mgr Monikę Boruta-Żywiczyńską, z Uniwersytetu Mikołaja Kopernika w Toruniu, zatytułowanego: ***Mind the gap! Sign function emergence in the second year of life and beyond. Semiotic development of toddlers aged 22-36 mos,*** wydała pozytywną opinię dla realizacji projektu o w/w tytule.

Olsztyn, dnia 14 maja 2021 roku

Przewodnicząca Komisji
Dr hab. Beata Krzywosz-Rynkiewicz, prof. UWM

~~B. Negatywna~~

Uzasadnienie: nie dotyczy

UNIWERSYTET WARMIŃSKO-MAZURSKI W OLSZTYNIE
ul. Michała Oczapowskiego 2, 10-719 Olsztyn
tel. (89) 523 00 12
fax (89) 523 00 00 www.uwm.edu.pl

Appendix D2

UNIWERSYTET
WARMIŃSKO-MAZURSKI W OLSZTYNIE

Komisja ds. Etyki Badań Naukowych
The Scientific Research Ethics Committee

DECISION No. 14/2021 of the SCIENTIFIC RESEARCH ETHICS COMMITTEE

A. Positive

The Scientific Research Ethics Committee of the University of Warmia and Mazury in Olsztyn, having considered an application of a research project submitted by Monika Boruta-Żywiczyńska, M.A, from Nicolaus Copernicus University in Toruń, entitled: ***Mind the gap! Sign function emergence in the second year of life and beyond. Semiotic development of toddlers aged 22-36 mos***, has granted **an approval** for realisation of the above-mentioned project.

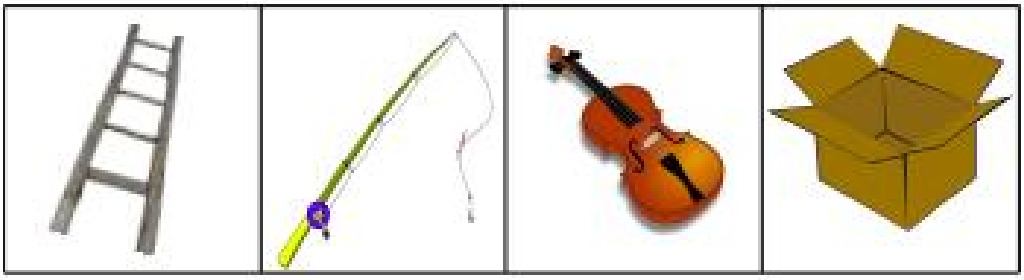
Olsztyn, 14th May 2021

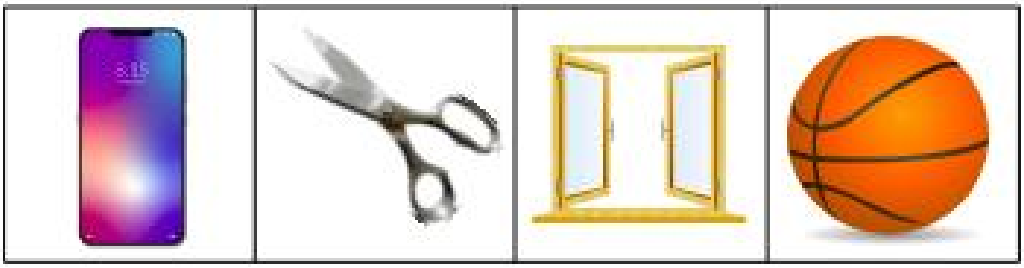
Chairperson of the Committee
Dr hab. Beata Krzywosz-Rynkiewicz, prof. UWM

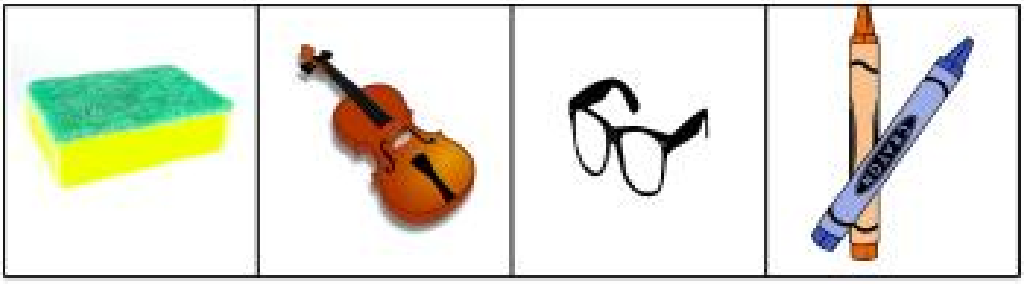
B. Negative n/a
Justifications: n/a

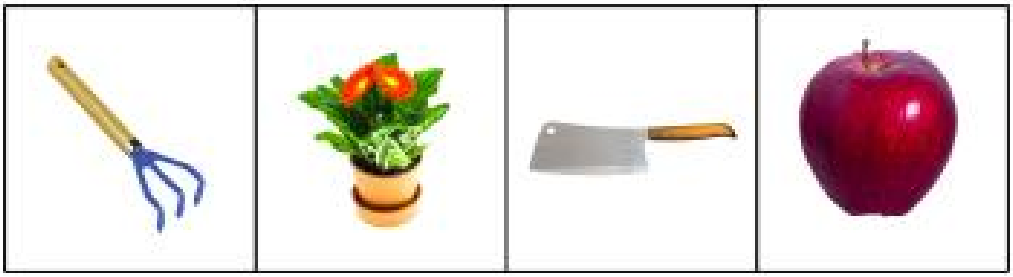
UNIWERSYTET WARMIŃSKO-MAZURSKI W OLSZTYNIE
ul. Michała Oczapowskiego 2, 10-719 Olsztyn
tel. (89) 523 00 12 [illegible]
fax (89) 523 00 60 www.uwm.edu.pl

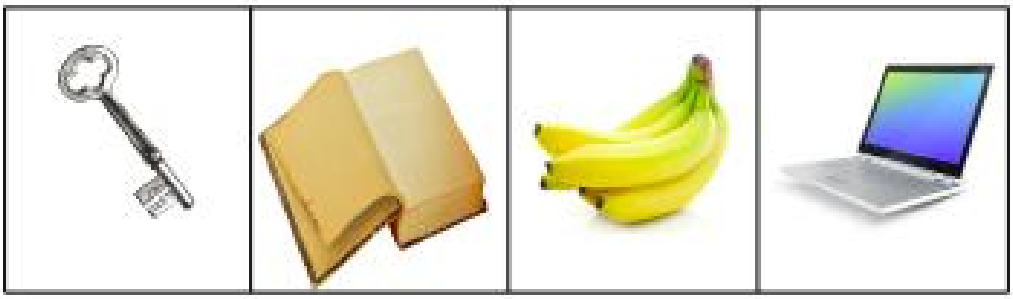
Appendix E











Appendix F

A) **Familiar words**: 6 words present in the IRMiK SiG (8-18 mos of age) & SiZ (18-36 mos of age) - the speech and communication development inventory for children. Based on the information given in the inventory, children should be familiar with the following words: Scissors, Ball, Book, Crayon, Glasses, Rake.

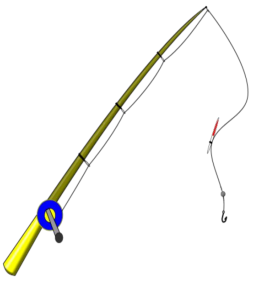
B) **Unfamiliar words**:6 words chosen outside of the IRMiK SiG (8-18 mos of age) & SiZ (18-36 mos of age) - the speech and communication development inventory for children. Based on the information given in the inventory, children are unlikely to be familiar with the following words: Pepper mill, Boat, **Ladder**, Laptop, Cleaver, Fishing rod.
Ladder was not listed in SiG but was listed in SiZ questionnaire, but, based on a discussion, was accepted for the research.

ENG:

Pepper mill	Boat	Ladder	Laptop	Cleaver
Scissors	**Ball**	**Book**	**Crayon**	**Glasses**
Fishing rod	**Rake**			

PL:

Młynek	Łódź	Drabina	Laptop	Tasak
Nożyczki	**Piłka**	**Książka**	**Kredka**	**Okulary**
Wędka	**Grabie**			

Fiishing rod 


Cleaver

Ladder 

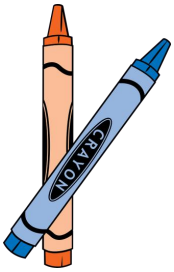

Pepper mill


Rowboat


Glasses

Ball 

Scissors 

Crayon 

Book 

Rake 

Laptop 

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https://pixabay.com/vectors/crayons-blue-orange-coloring-new-40324/ by Clker-Free-Vector-Images

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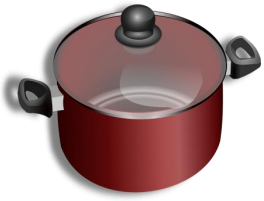
DOA 20.02.2020

Appendix G

Pot 

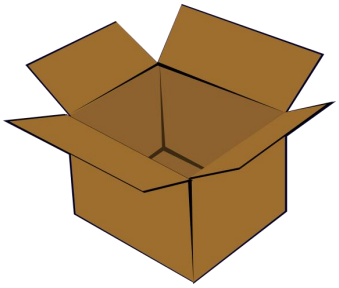
Sponge 

Apple 

Tyre 

Flower 

Banana 

Box 

Syringe 

Violin 

Window 

Key  Phone 

Sources:
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20.02.2022

Appendix H

The Sign Function Game Protocol

The parents are asked to come only if they feel well. At the beginning of the meeting, I take their body temperature and ask them to fill in a COVID-19 self-assesment survey.

1. Setting the camera - one camera set in a way which enables to record my gestures and the book which the child uses to answer my questions (by means of pointing gesture). The camera is set so that it doesn't record the child's face at all times, but focuses on hands and arms.

2. Before the warm-up and game I tell the parents about the experiment, even thought they were given instructions via email invitation. I explain the procedure to the parents, I make sure they understand it is safe and can be fun for their child. Then I provide them with documentation they have to sign and questionnaires they have to fill in. I ask them if they have questions/need explanation concerning the documents, the experiment, and data collection and processing. The parents have time to read the documentation. I ask them to sigh GDPR and other consent forms. Whe the documentation is ready, I invite the parent to join in the game, but I also tell them not to interrupt or help the child. The parent is asked not to face the child, so that the child does not feel the need to look at their face for approval.

The recording starts here.

3. Warm-up - the same for all children - I present children with 3 sets of 4 images. I conduct the procedure, and:

a) present the page to the child, tell them to look at me, say "Show me X" (X = word uttered once); I give feedback if the answer is correct, such as: „Bravo!", if the answer is incorrect, such as: „I am not sure that is the right image";
b) present the second page to the child, tell them to look at me, say "Show me X" and present the object as an enacting gesture (X = gesture performed); I give feedback: if the answer is correct, such as: „Bravo!", if the answer is incorrect, such as: „I am not sure that is the right image";
c) present the third page to the child, tell them to look at me, say "Show me X" present the object as a representing gesture (X = gesture performed);I give feedback if the answer is correct, such as: „Bravo!", if the answer is incorrect, such as: „I am not sure that is the right image";

+ In case the child **does not** understand the game (does not respond by pointing to one of the pictures in each case, correctly or not), I repeat the whole procedure.

+ If the child **does not** understand the game after 2 rounds of warm-up (a,b,c above, repeated twice), I stop the experiment.
+If the child **is not interested in the game at all/protests**, I stop the experiment. I invite the child again after a few minutes. If the child does not want to cooperate, I do not force the child to play the game.

If the child understands the procedure, I move to the game proper:

4. I tell the child: "Good. Now, let us play the game with the book. It will be very similar to the game we have just played. I will be showing different pictures to you, just like before, and you will have to show me with your finger which picture I'm asking about." There are 3 rounds (12 trials each). When we finish the game you will get a small present, OK?

5. The procedure begins and is repeated throughout the game. I say: Now, *name* look at me... Show me „X" and utter/enact/represent the target item. Be it a boat: **Speech:** Show me the boat. **Gesture:** 1) Show me *hand movement as if rowing the boat*; **Gesture:** 2) Show me *hands folded together in a boat-like shape**.

If the child is **correct**, I say, e.g. Bravo! Well done! That is right! If the child's answer is **incorrect**, I say: Hmm... I am not sure this is the right answer. Let us try another one.

If needs be, I introduce a short break between the games of rounds.

After 3 rounds the game is over.

Here, I stop the camera. I copy the data to an external drive.

I thank the parents and children for cooperation. The parents are invited to ask any further questions and take part in the research in the future.
I give the child a reward, if the parent agrees.

The room is aired and the booklet, the toys, and the furniture are disinfected. There is an hour break.