From gesture to sign and from gesture to word. Pointing in deaf and hearing children.

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In this paper, we explore the issue of (dis)continuity between gestures and signs and gestures and words by comparing three longitudinal follow-ups of a hearing monolingual French speaking child, a deaf signing child (LSF), and a hearing bilingual (French-LSF) child. Our study indicates that the development of the same manual form (the index finger point) is influenced by the input children receive in the modalities they have at their disposal. Interestingly, the bilingual (French-LSF) child presents an intermediate profile as far as the number of points she uses is concerned. Our analyses do not enable us to differentiate pointing "gestures" from pointing used as a linguistic sign since we could observe no systematic formal distinction. But our study suggests that pointing facilitates the three children's entry into syntax: pointing gestures or/and signs are more and more combined to words and/or signs, facial expressions, gaze, in complex linguistic productions and with more and more deictic and anaphoric values.

Keywords: pointing, personal reference, sign language, language acquisition

Pointing gestures play an important role in the language acquisition process: they are grounded in joint attention, they trigger interaction, and they may also facilitate children's entry into word combination and syntax. Several studies have tackled this issue in the development of spoken language. Yet, this has not been thoroughly investigated in the development of sign language. This article aims at comparing the production of pointing gestures and their combination with words and/or signs in three children studied longitudinally between 8 and 24 months: one hearing child learning French, one deaf child learning French Sign Language (LSF) and one bilingual bimodal child learning both French and LSF. The main issue we address is that of (dis)continuity between early pointing gestures and the

Gesture 10:2-3 (2010), **172–201**. DOI 10.1075/gest.10.2-3.04mor
ISSN 1568–1475 / E-ISSN 1569–9773

development of spoken or sign language. We first compare how the same form (index finger pointing) evolves in the three children, and we then try to illustrate how pointing gestures are integrated in the children's linguistic systems under construction.

Literature review on the issues at stake

Pointing gestures in ontogeny

Just like language, pointing can be considered as a uniquely human gesture, if we consider the cognitive and symbolic operations involved rather than the gestural form alone, which can be produced by chimpanzees in certain trained conditions (Butterworth, 2003; Tomasello, 1999, 2003). Directing someone's attention to something is very likely to be a human universal (Kita, 2003).

Pointing has received distinctive attention in the field of language acquisition as it is seen as a bridge between gesture and language as well as between words and their referents. The "founding fathers" of the study of child development and language had great intuitions about the importance of gestures and their relation to language. In his notes on his son's development, Darwin (1877) stresses the importance of observing the transition from uncontrolled body movements to intentional gestures. Romanes (1889) compares human and animal gestures. He makes fine observations on qualitative differences and mentions the gestural language of deaf people as a sign of the universality of symbolic gestures. Stern (1924) considers pointing in particular as a precursor of intentional marking. For Werner and Kaplan (1963), pointing represents children's ability to discriminate between external objects and their own person. Communicational pointing then becomes the basis for referential behavior and reciprocity established in common activities between children and their parents (Bruner, 1975).

Children's neurological maturation enables them to control their bodily movements and transform them into gestures thanks to gradually finer motor skills. Some of these gestures are assigned meaning by their interlocutors. At the same time children develop cognitive prerequisites that allow them to take up symbolic gestures such as the "bye bye" gesture, or the "itsy bitsy spider" routine, from the environment. Pointing gestures in particular, thus combine motor and cognitive prerequisites with the capacity to symbolize and to take up forms used by adults in dialogue. As Tomasello and his colleagues underline, "pointing may thus represent a key transition, both phylogenetically and ontogenetically, from nonlinguistic to linguistic forms of human communication." (Tomasello, Carpenter & Liszkowski, 2007, p. 720).

The role of pointing gestures in interaction

Children use pointing gestures to designate an entity (object, person or location) as a focus for joint attention and exchange with adults, thus paving the way to early language acquisition. Through pointing and gazing, the designated object takes on a special status and stands out from its environment (Bruner, 1983). Pointing can therefore be one of children's first symbolizing devices in the "joint attentional frame" described by Tomasello (1999).

Using Speech Act theory, Bates et al. (1979) distinguished two types of communicative acts and attributed two main functions to pointing gestures viewed as a social tool. Infants use proto-imperative points to request an object from the adult. They use proto-declarative to get the adult to attend to an external entity. Bruner's classical account (1975) is more focused on the adult–child social interaction involved in pointing events grounded in meaningful social exchanges. Pointing is analyzed in the framework of joint attentional formats seen as a type of scaffolding thanks to which infants share information and affects with helpful adults, as observed by Werner and Kaplan who named them "primordial sharing situations" (1963).

Enfield, Kita and de Ruiter (2007) compare the role of pre-linguistic gestures to the role of large pointing gestures produced by Lao speakers they recorded in ethnographic interviews and free interaction. In both cases, what they identified as "big points" are essential for understanding what is being referred to. On the contrary, "small points" produced by adults only are not necessary but eliminate potential ambiguity or add information to what is said without over-telling. Therefore, as Calbris (1990) argued for all gestures produced by adult French speakers, pointing gestures may replace part or the whole utterance (for physical, psychological or informational reasons). They can complement the utterance and express attitudes of the speaker towards an event or the listener.

One difference between children and adults' pointing gestures is that pre-linguistic pointing gestures (used before the children produce their first words) develop within an emergent system, and their social-cognitive functions may obviously not be exactly the same as language evolves.

The role of pointing gestures in language acquisition

From pointing to words

Condillac (1756) assumes a developmental continuity between pointing and early linguistic productions such as demonstratives. Does linguistic representation emerge from non-linguistic representation (Werner & Kaplan, 1963)? For Clark

(1978), the early vocal demonstratives used by children follow pointing gestures as children shift rather fluidly from pre-linguistic to linguistic communication in a sequence of stages.

Pointing is also argued to facilitate the transition from gestures to non-deictic words. Children's pointing gestures are often taken up by adults, who label the entity at stake, which may in turn trigger children's labelling of the designated entity (Ninio & Bruner, 1978). Thus, in the development of spoken language in hearing children, pointing facilitates access to verbal naming and may predict lexical development (Bates et al., 1979).

"Assuming that gestures and speech are functioning as a unit" (Butcher & Goldin-Meadow, 2000, p. 86), pointing gestures may also facilitate access to combinations and early syntax (Bates et al., 1977). For Goldin-Meadow and Butcher (2003) pointing has a crucial role in the transition from one- to two-word speech: gesture-word combinations help trigger the onset of two-word speech. They facilitate children's entry into syntax (Greenfield & Smith, 1976), as cross-modal gesture-word combinations precede and announce utterances made of two or more vocal elements (Butcher & Goldin-Meadow, 2000; Goldin-Meadow & Butcher, 2003; Capirci et al., 1996; Volterra et al., 2005). Using a gesture combined with a word might be less demanding than conveying the same meaning in the verbal modality and puts less strain on memory. Pointing gestures are physically easy to produce once the motor control over the hand is fine enough, easy to remember (the cognitive load is therefore lighter), easy to be generated on the spot.

Pointing is part of the set of gestures that are considered to be "the cutting edge of early language development" (Ozçaliskan & Goldin-Meadow, 2005) thanks to supplementary gesture-speech combinations that precede by several months the same constructions performed in the oral modality. For example, before a child produces a two-word utterance, she will point at a cookie and say the word "cookie" or point at a bag and say the word "mommy". Children can produce a construction that could be interpreted as *predicate* + *argument* in a pointing gesture — speech combination. A child's ability to convey utterance-like meaning across modalities, and the types of supplementary gesture-speech combinations that children produce, change over time. They presage changes in their speech and predict the production of multi-word combinations.

Pointing gestures therefore play a crucial role in interaction and in cognition: they allow children to segment their environment, extract an element of the world that surrounds them and direct the adults' attention and speech to it. Inserted in a proto-syntactic structure formed of two elements combining gesture and word, they enable children's entry into syntax.

From pointing to signs

The issue of continuity between gesture and language is even more challenging in the case of sign language since pointing gestures are fully integrated in the linguistic system (see Hoiting & Slobin, 2007, for a study of the gesture-to-sign continuum).

When children first produce pointing gestures both in speaking or signing environments, they designate a place, an object, a person or sometimes an event. But for the child who is surrounded by sign language, those pointing gestures are progressively incorporated into her formal linguistic system and used for personal reference among other functions. According to Bellugi and Klima (1982) and Petitto (1986, 1987), children's pre-linguistic gestures are different from signs despite the same hand shape and may correspond to two distinct categories: "indexical" and "symbolic" pointing (Tomasello, 2003).

Petitto (1986) observed that the deaf signing child she studied longitudinally started pointing at 10 months. Up to 12 months, the child pointed freely at persons and objects. Between 12 and 18 months, points to persons disappeared. Petitto interprets this disappearance as indicating a discontinuity between non-linguistic pointing and linguistic pronouns. Another child studied by Petitto even made a reversal error, pointing towards her interlocutor to refer to herself. By 27 months, all the deictic pronouns were correct. The author's hypothesis is that the child interprets the pronoun YOU as a lexical sign equivalent to her name (see the "name hypothesis", Clark, 1978). The reversal would therefore reveal that the child treats pointing as having linguistic properties and does not use the transparency of the form-referent relation (pointing towards the interlocutor to refer to the interlocutor and not to the child).

While discontinuity between pointing gestures and points used as personal pronouns was illustrated in American Sign Language, the same phenomenon was not confirmed in Italian Sign Language with longitudinal data (Pizzutto & Capobianco, 2005), nor in the longitudinal recordings of two deaf children using LSF (Morgenstern, 1997) which showed no interruption of pointing toward persons and no pronominal reversal.

The relevance of the issue of (dis)continuity in the nature of pointing gestures has been questioned. According to Schick (2003), "for the child who produces spoken English, the point is considered a gesture. But for the child learning ASL, because points are considered linguistic in the adult system, it is tempting to consider the child's points as linguistic" (Schick, 2003, p. 221). How are we to decide whether the nature of pointing is linguistic or "non-linguistic"/"pre-linguistic"? Cheek et al. (2001, p. 298) in their analysis of the transition between gestures and signs do not consider that non linguistic and linguistic pointing can be distinguished: "Because pointing signs that are glossed as 'you', 'he', 'she', and 'it' could

not be reliably distinguished from pre-linguistic pointing gestures, such tokens were not included in the set of children's signs". Most sign language researchers assume that these pointing signs are pronouns, but that assumption is discussed by Evans and Levinson (2009) and Cormier (2010). Their reflection challenges the direct application of linguistic terminology from one language/modality to another. Pointing signs do not look different on the surface from pointing in non-signers (Kendon, 2004; Kita, 2003). In both cases, points belong to the deictic system, they index locations of objects, persons, events in the deictic space. Some studies, however, have focused on specific features of pointing in deaf-signing children and on their ability to use different forms and types of pointing for different functions (with the combinatorial dimensions of finger, wrist and arm configuration, movement, intensity and speed). Not only do deaf-signing children use an impressive amount of pointing gestures from very early on, but the functions of these points are "integrated into the process of conventionalization of gesture and control of the signing space" (Hoiting, 2009, p. 84).

In the current study, we do not aim at comparing the formal features of early and late points and classify them as being either "linguistic" or "gestural". Our interest mainly concerns the development of pointing *within* the communication systems that children develop, be they spoken, signed or both. As advised by McNeill (1992, p. 2), we might need to "broaden our concept of language" to fully understand the role of pointing.

Research questions and hypotheses

This study aims at comparing the development of a manual form, the index finger point, in the acquisition of two different languages, based on two different modalities: French, a spoken language, and French Sign Language (LSF), which mainly relies on the same visual-manual modality as early pointing gestures. We additionally aim at comparing the development of pointing in the language acquisition process of a bilingual bi-modal child, who learns both languages and relies on both modalities.

This paper addresses two main issues:

1. How pointing gestures and their development compare (quantitatively and qualitatively) in the three children, with a special focus on pointing to persons.
2. How pointing gestures evolve as children acquire LSF or/and French.

For each of these research questions, we made several hypotheses. Few studies have addressed the issue of the development of pointing gestures across languages and modalities (see Cormier 2010 for an overview of the problems involved).

Even fewer studies have addressed this issue from a bimodal bilingual perspective. Therefore, our aim here is essentially to describe the development of pointing gestures in the three datasets. In what follows, we look separately at overall pointing gestures, pointing gestures towards persons and pointing gestures towards self. We hypothesized that the child with the more input in sign language would produce the more points. The discrepancy was expected to be even larger for self-reference, since self-words are inherently non-ambiguous and pointing gestures would be semantically redundant.

Several studies have addressed the issue of the development of pointing gestures in each modality. The originality of this paper is that both hearing and signing modalities are investigated in parallel. Following Butcher and Goldin-Meadow (2000), our hypothesis is that pointing gestures play an important role in the transition from gestures to words in the hearing child. We investigate the length of the utterances produced with pointing gestures and the nature of the words in these utterances. We also hypothesized that in sign language acquisition, even though the role of pointing gestures in the transition from gestures to signs might not be easily observable, points might increase together with the increase of the signs with which they combine. On the contrary, pointing gestures might decrease in the French speaking child's data as her vocabulary expands and her verbal productions lengthen.

Methodology

Three studies conducted by three different teams were combined in this paper in order to make an attempt at establishing comparisons between the three longitudinal follow-ups. The authors worked together in order to extract comparable analyses from their data but some results could not be extended further than what the video data, the transcriptions, the coding systems, with their limitations, allowed us to do.[1]

Participants

Madeleine[2] is a hearing little girl with two hearing monolingual parents and an older sister, who speak to her in French. She lives in Paris in an upper-middle class family. She was taken care of by a nanny until she entered kinder garden. Martine Sekali filmed her for one hour once a month from the age of ten months to the age of five.

Charlotte is a deaf little girl raised by deaf middle-class parents who both use French Sign Language. She is their first child. She was filmed for one hour once a

month from the age of seven months to three. Charlotte lives in Paris and attended a day-care center at the time with one deaf educator. She was filmed exclusively by Fanny Limousin who is a deaf junior researcher.

Illana was filmed between the ages of six months and 2;8 by Marion Blondel, Laurie Tuller and Isis Lecourt. They collected 22 samples of spontaneous productions of Illana, who is from a middle-class family living in Tours and was acquiring French and LSF in a natural setting. Her father is a deaf native signer and is a child of deaf parents; her mother is hearing and a fluent signer. Illana was about three months old when she first attended a day-care center, an environment which is exclusively French-speaking, but she was also in frequent contact with her deaf grandfather and with other signers in the local deaf community. The team recorded Illana's interactions with her mother, her father, or both in this spontaneous bilingual and bimodal environment (with a majority of hearing people and French-speaking input).

The three little girls were quite precocious in their linguistic development (they produced their first words and first combinations early) and could be considered as quite comparable in the two modalities used. Their data has been analyzed for various studies focusing on prosody and morpho-syntax which give us more insight on their linguistic development[3] (Blondel & Tuller, 2008; Limousin & Blondel, 2010; Morgenstern & Sekali, 2009; Morgenstern, 2009).

Differences between modalities

There are important distinctions between the visual and oral modalities, which we can observe in the interaction between the parents and daughters that we have been studying. The deaf dyad relies solely on the visual modality, whereas the hearing dyad can use both the oral and visual modality.

A first difference is that the articulation between daily activities and language is totally different in the dyads. In the hearing dyads, the parent is often busy doing various activities such as cooking, cleaning, setting the table while he/she talks to the child. In the deaf dyad, it is practically impossible to communicate in sign language while doing a manual activity: the mother does not simultaneously sign and cook, change a diaper or clean. Language moments are intense; both participants are concentrated on each other. Language is mostly a mono-activity, especially when the child is very young.

This difference is important for our study. In fact, we would like to argue that in part for these reasons, the number of turns for each of the participants of the signing dyads in an hour is much lower than in the speaking dyad. To illustrate this point, we counted the number of turns produced by mothers and daughters when Madeleine and Charlotte were 1;7 and 2;0. At 1;7, Madeleine produced 285

Table 1. Adult–child position in Madeleine and Charlotte's data (from Mathiot et al., 2009)

Adult–child position	Charlotte	Madeleine
Face to face	88%	44%
Side by Side	8%	46%
Behind	3%	10%

turns in an hour (her mother: 338) and Charlotte produced 134 turns an hour (her mother: 111). At 2;0, Madeleine produced 395 turns in an hour (her mother: 378) and Charlotte produced 152 turns (her mother: 160). Madeleine and her mother therefore exchange roughly two times more turns in an hour of recording than Charlotte and her mother.

A second important difference is that it is easier for parents of children learning sign language to modify their manual mode by acting on their hands, shaping, modelling them, than it is to rectify the oral mode (one cannot act on a child's vocal tract). We have several videos in which deaf parents actually modify the configuration of their children's hands in order to help them correct the "phonology" of the item they are producing.

A third difference is that in oral language acquisition, sound, gesture and gaze are all extremely important in early communication, whereas in sign language, gesture and gaze are predominant. A child exposed to sign language might therefore be even more sensitive to gesture, and deaf adults are going to interpret their children's first gestures much earlier, just like hearing adults do with babbling. One of the major differences between the mother–child dyads we have studied also lies in the use of GAZE. The eyes of Charlotte's mother are her essential link with her child and enable her to check how safe and well she is at all times. The interactional mode is therefore quite specific since the mother is constantly "visually listening" to her child. Her visual field is wider than that of the hearing mother because of a lot of practice. In Mathiot et al. (2009), we have shown that contrarily to Madeleine, Charlotte accompanies her pointing gestures with gaze, either on the adult or alternating between the object she is pointing at and the adult. Her use of gaze is quite precise at a very early age. The importance of gaze on the adult in Charlotte's data is to be related to the position of the interlocutors during pointing events. Indeed, 82% of Charlotte's pointing gestures are produced when she is face to face with the adult, against only 44% for Madeleine (see Table 1). The face to face situation is a privileged one in the deaf dyad and probably conditions the orientation of their gaze.

Transcriptions

The three children were recorded in different research contexts and different tools are necessary according to the nature of the data (sign language and/or spoken language). Therefore, each dataset presents specific characteristics that need to be explained.

All of Madeleine's videos were transcribed in the CHAT format using the CLAN[4] programme (MacWhinney, 2000). This programme, used to link the transcription and the video, allows us to keep track of the context in which words and gestures are produced. Since we consider coding and transcription as "theory" (Ochs, 1979) or at least as a representation of our theoretical approach, we pay special attention to the features we distinguish. For this study, we made intensive use of important secondary tiers such as %gaze, %point (followed by the function we assigned to pointing gestures according to context, either "show", "comment" or "request") and of course %pho (vocal or verbal production transcribed in IPA).

All of Charlotte's videos were entirely coded with the software ELAN.[5] Specific tiers were also created for gaze, glosses of the gestures and signs, functions of pointing, object referred to and features concerning the addressee.

Illana's recordings are currently being transferred into CLAN and ELAN after being transcribed in Word tables. For this reason, Illana's data cannot be included in each of the following analyses yet. Nevertheless, we extracted and analysed all pointing gestures from the videos. The results of these ongoing analyses will be introduced as often as possible.

Coding system and analytical methods

Coding pointing gestures

We first counted all pointing gestures produced by the three children per hour. For Madeleine, we could also count her mother's pointing gestures per hour. Pointing gestures were defined as hand gestures with the index finger extended.

For the three children, we then coded whether these pointing gestures were directed towards persons. When they were directed towards persons, we coded whether they were directed towards the interlocutor, another person or the self. As a follow up of self-point coding, we also counted all explicit other means of self-reference used by Madeleine, Illana and Charlotte: the use of their first names and for Madeleine, the use of personal pronouns ("moi", "je" including proto-pronouns or filler syllables).

Coding linguistic utterances

For Madeleine, we were interested in knowing when her verbal utterances were used together with a finger point. We therefore counted all utterances that were simultaneously produced with a pointing gesture. We then analysed these utterances, in order to know whether they contained one, two and three words, and what the nature of these words were.

The study of linguistic productions of signing children is at its very beginning, and there is hardly any literature available yet. In her study of Charlotte's signs and gestures, Limousin (2010) identified four categories in Charlotte's data: (1) gestures; (2) pointing;[6] (3) non intelligible signs (NIS) which present all the characteristics of signs but which the deaf adults cannot understand; (4) signs.

The discrimination between signs and non intelligible signs is quite difficult to code but the researcher used both the fact that those productions resembled signs in all features (configuration, location, movement, facial expressions, gaze …), but that the parents and herself did not understand the child in context.[7] It was also quite complex to distinguish signs and gestures. All the ambiguous occurrences were discussed with two other hearing researchers familiar with hearing children's gestures.

Because Illana's data is still under construction, her productions were mostly analysed from a qualitative perspective. The analyses were based on French and LSF analyses combined.

Evaluating talkativeness in the three girls

Theoretical and practical analysis of sign language is an ongoing process, and systematic analysis of sign language data is a rather new field of research. Because our study is anchored in this ongoing research and because we still need to establish clear bases for comparing modalities,[8] our analyses mainly draw from raw numbers of occurrences. Yet, as mentioned earlier, our tentative analysis of turn-taking in signing dyads and speaking dyads showed that the number of turns exchanged in the hearing dyad is twice as high as the number of turns exchanged in the signing dyad. Madeleine also produces more turns than Illana and she produces more turns than Charlotte, as summarized in Table 2. Thus, all numbers introduced in the result section should be considered in the light of this discrepancy.

Table 2. Number of turns produced by the children in an hour at 1;7 and 2;0 years.

	1;7	**2;0**
Charlotte	134	152
Illana	187	166
Madeleine	285	395

Quantitative results

We first compare the production of overall pointing gestures, pointing gestures towards persons, and pointing gestures towards self. We then consider the development of pointing gestures in parallel to the development of language in Madeleine, Charlotte, and Illana's data.

Development of pointing gestures in the three girls' data

In this section, we describe the development of pointing gestures for the three children, from 0;7 to 2;0.

Overall proportions of pointing gestures

One of our hypotheses was that Charlotte would produce more pointing gestures than Illana, who would produce more than Madeleine. In order to draw a comparison between the three girls, we extracted the total number of pointing gestures per one hour session in our data (Figure 1).

For each child, the number of pointing gestures is very variable from one session to another according to the various situations. Nevertheless, Charlotte produces more pointing gestures in the 18 recordings (1187 in total) than both hearing girls (609 for Illana; 465 for Madeleine). The frequencies of pointing gestures Charlotte produces increase irregularly but gradually between 7 months and 2 years. Madeleine produces her first pointing gestures three months later and she globally produces fewer pointing gestures than both signing girls, although the

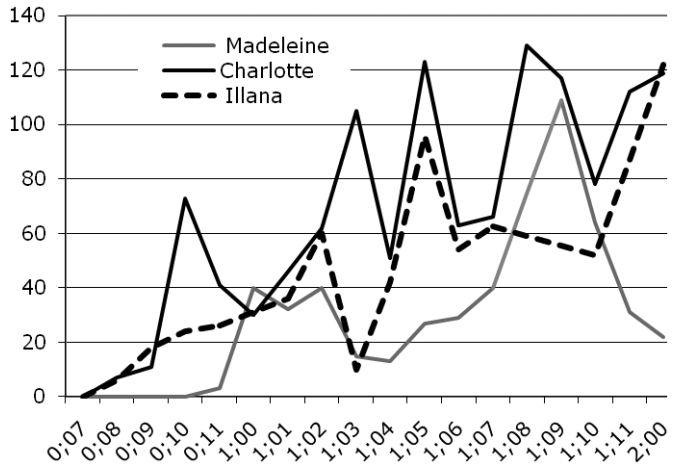

Figure 1. Number of pointing gestures produced in an hour for the three children according to age.

number of pointing gestures also increases between 11 months and 2 years. Illana has an intermediate profile. She starts pointing at the same time as Charlotte (at 8 months old) and she also produces more pointing gestures than Madeleine, but fewer than Charlotte.

Pointing gestures towards persons

Since the studies on the discontinuity between pointing and pointing signs have focused on points towards persons (Petitto, 1986, 1987), we compared the number of pointing gestures/signs towards persons[9] in the three little girls' data (Figure 2). Our hypothesis was that the difference observed for all pointing gestures would be even more accentuated because in sign language, pointing gestures are one of the main resources to refer to people (names are not often used in our data) whereas in spoken language, the child can use both verbal and non-verbal resources.

Similarly to results concerning overall pointing gestures (amounts are still very much linked to context), Charlotte globally produces more pointing gestures towards persons (357) than both hearing girls (93 for Illana; 16 for Madeleine). The number of pointing gestures increases from 7 months up to 2 years. Pointing gestures towards persons represent around 30% of all pointing gestures in Charlotte's data, and this proportion is higher than in Illana and Madeleine's data. Madeleine produces her first pointing gestures towards persons four months

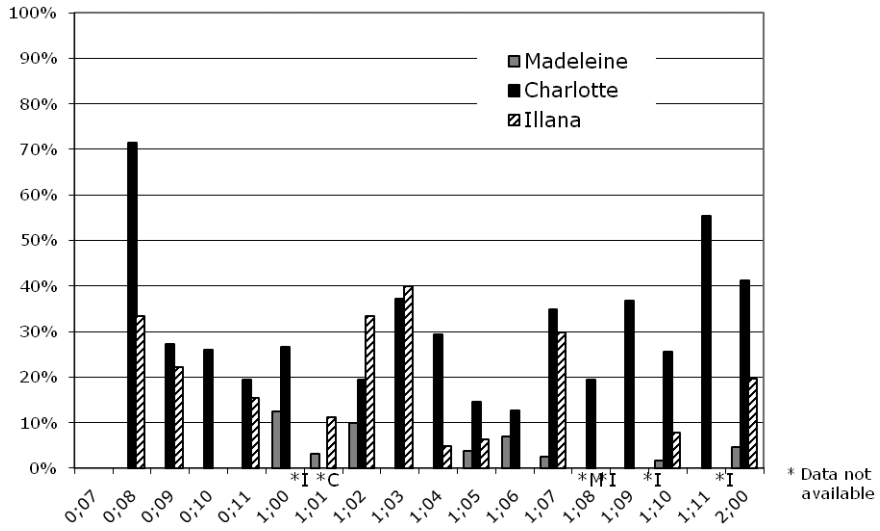

Figure 2. Percentage of pointing gestures towards persons out of all pointing gestures produced according to age in Madeleine (M), Charlotte (C) and Illana (I)'s data (asterisks mean data was not available for this particular child at that particular age, although it is available for the other children).

later (at 1;0) and she globally produces fewer pointing gestures than both signing girls, although the number of pointing gestures also increases between 12 and 24 months. The proportion of her pointing gestures towards persons often represents less than 10% of all her pointing gestures. Illana still has an intermediate profile. She starts pointing to persons at the same time as Charlotte and she also produces more pointing gestures towards persons than Madeleine, but fewer than Charlotte. Generally, pointing towards persons seems to increase in the second half of the data (around 1;2) for the two little girls surrounded by sign language.

Pointing towards self and self-reference

Since the studies on the discontinuity between pointing and signs have focused on points towards self and pronominal reversals (Petitto, 1986, 1987), we investigated the development of pointing towards self in the three little girls' data (Figure 3). Our hypothesis was that pointing gestures towards self would be rare in Madeleine's data because the first person pronoun (with the form "je"/"I" and the use of "moi je"/stressed "I" to create contrast) inherently refers to the speaker. In Charlotte's data, pointing towards self would be more frequent because it is her only means to clarify the reference to self. We made the hypothesis that Illana would point towards herself less than Charlotte, and more than Madeleine. Figure 3 illustrates the proportion of pointing towards self in the three datasets.

Compared with both hearing girls, Charlotte produces pointing gestures towards herself very frequently (123 occurrences of self-point in total). The number of pointing gestures towards herself increases from 1;1 until 1;9, up to 35 self-

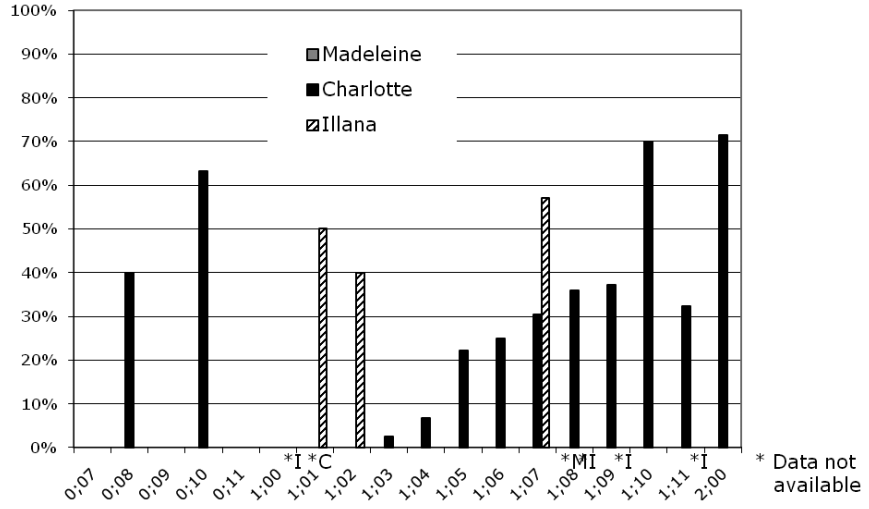

Figure 3. Percentage of self-pointing gestures out of all pointing gestures towards persons in three girls' data.

points (more than 70% of all pointing towards persons). Illana has an intermediate profile for self-pointing as well: she uses self-pointing later and less frequently (20 occurrences in total) than Charlotte. But when produced, pointing towards self represents 40 to 60% of all pointing towards persons. After careful analysis of the interactional contexts and coding of the referents for each point to persons, we observed no inversions (pointing to the interlocutor to refer to self or conversely) in the signing children's data.

Madeleine does not use self-pointing at all. This does not mean that all hearing non-signing children do not use self-pointing. We have several examples of self-pointing gestures in our other longitudinal data of hearing children exclusively surrounded by French-speaking interlocutors. But they remain quite infrequent; we never have more than one or two per hour session outside specific play situations.

Since Madeleine did not produce any self-point whereas Charlotte regularly and increasingly produced them, we further investigated the development of all explicit (marked) forms (verbal and non-verbal) of self-reference in Charlotte (Figure 4) and Madeleine (Figure 5) and Illana's data (Figure 6).

When we compare self-designations in the three children, we can observe that:

– Charlotte (Figure 4) mainly uses pointing gestures towards herself (as early as 8 months old). She also occasionally uses the sign for her name to refer to herself (13 occurrences at 1;09 in a photo sequence and 2 occurrences at

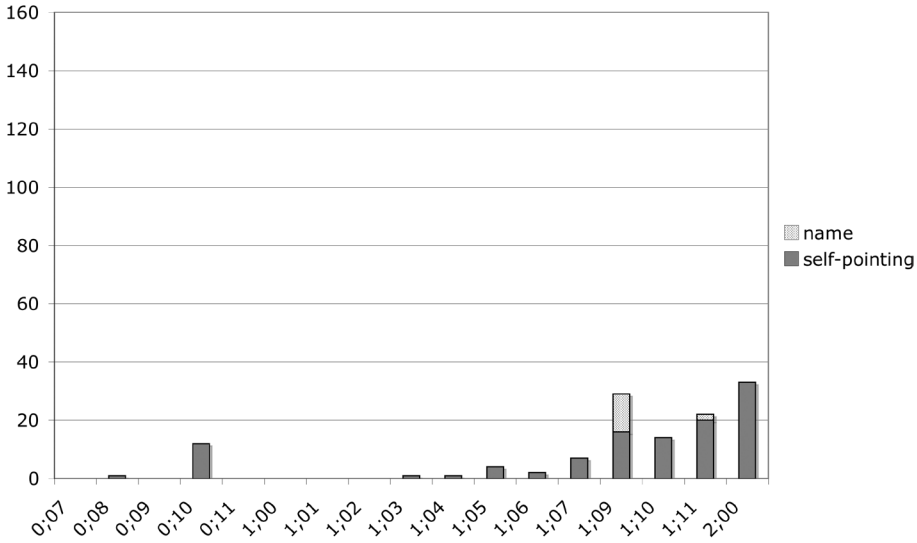

Figure 4. Number of all forms of self-reference (name and self-pointing) in Charlotte's data according to age.

1;11). However, marked self designation is not always used. In our study on the comparison of Madeleine and Charlotte's forms of self-reference (Morgenstern et al., 2010), we noted that marked forms (as opposed to bare predications) are used in 65% of Charlotte's productions at 2;0 (her mother uses 80%) whereas Madeleine uses marked forms in 90% of her utterances (her mother uses 100%). LSF is usually not considered as a "pro-drop language", but reference to the speaker can be left unmarked in some cases (either for pragmatic reasons or because the reference is marked in the shape, the movement, the directionality of the sign used for the predicate) contrarily to French.

– Madeleine (Figure 5) uses no pointing towards herself at all, but a very large number of verbal elements (including fillers as in "eu veux gâteau"/"a want cake"), which vary over time. She starts using clear self-designations several months later than the deaf child, even though her linguistic competence is quite high. This seems to be related to the language modality: when signing, pointing towards one's body is a transparent gesture whereas the use of the first person pronoun is more complex.
– The data is quite scarce for Illana (Figure 6) but she uses both manual and vocal forms of self-reference. She might be less precocious than Madeleine and Charlotte in each of her languages at that early stage. She does not produce filler syllables in her vocal productions before 2;0, but it is hard to tell if that absence is influenced by the use of sign language. There seems to be a shift from self-points to verbal productions (constrative "moi"/"me" and her name), but we don't know if that trend continues after 2;0. It will be interesting to code

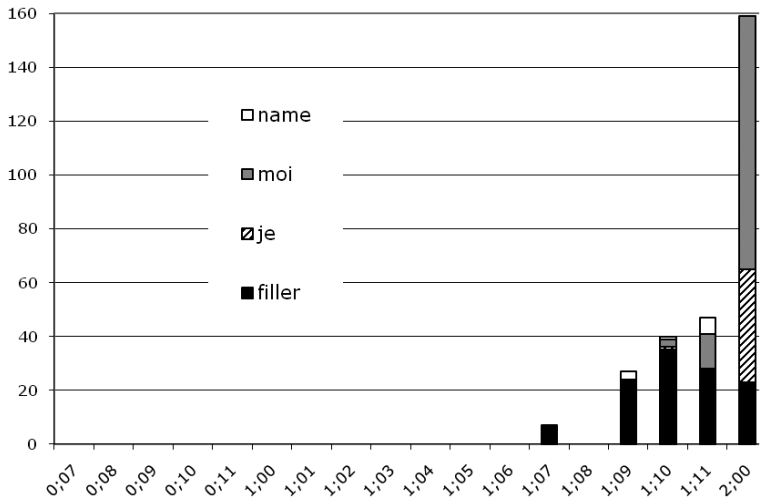

Figure 5. Number of verbal forms of self-reference in Madeleine's data ("Je"/"I" filler syllables; name; "moi"/"me") according to age

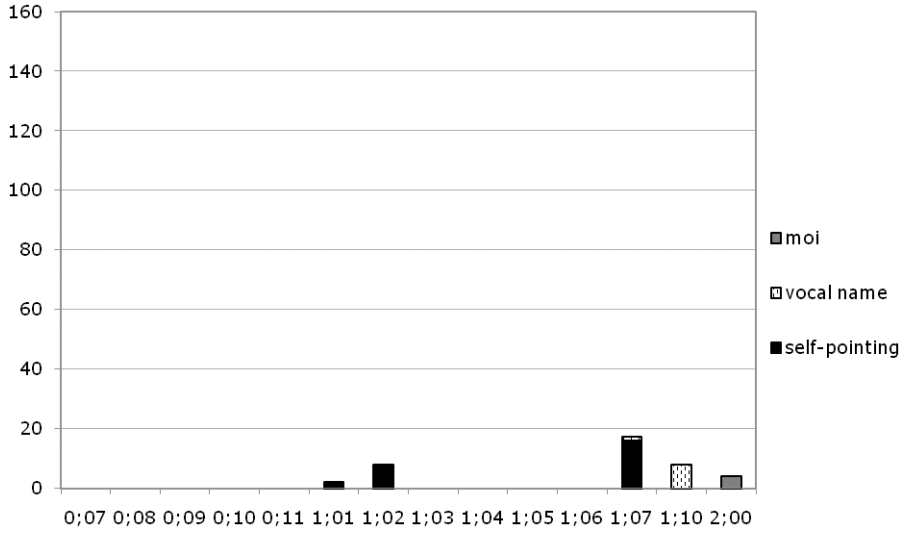

Figure 6. Number of verbal and manual forms of self-reference in Illana's data (name; "moi"/"me", self-pointing) according to age.

her productions at a later age to analyze the distribution of manual and vocal forms and the possible mutual influence of one language over the other.[10]

Development of pointing gestures and words/signs

After focusing on the development of pointing gestures in the three children, this section aims at investigating the combination of pointing gestures with words and/or signs. We conducted extensive analyses of Madeleine's combinations of pointing gestures and words. As far as Charlotte and Illana's data are concerned, our analyses focus mainly on qualitative combinations of pointing gestures and signs/words. Our hypothesis was that pointing gestures would first combine with single words and then decrease as Madeleine started producing more and more words and entered syntax, whereas Charlotte would produce more and more points as signs appeared and syntax developed.

Madeleine

Leroy et al. (2009) have shown that virtually all the pointing gestures Madeleine produces in her longitudinal data are co-vocal and co-verbal gestures. One question we had concerning co-verbal pointing gestures was how many pointing gestures are still present when a spoken language is acquired. Thanks to the CLAN software and our coding of pointing gestures, we were able to compare Madeleine's use of pointing gestures to her mother's (Figure 7).

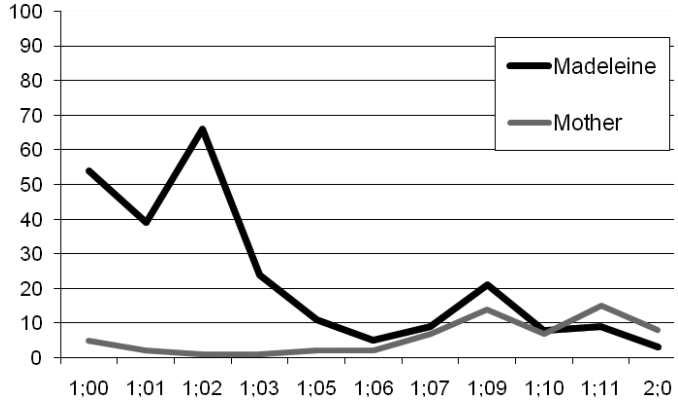

Figure 7. Percentage of vocal and verbal productions with pointing gestures in Madeleine and her mother's data.

Between 1;0 and 1;4, Madeleine uses many more co-verbal pointing gestures than her mother out of approximately the same number of turns. But from the age of 1;5, she and her mother use approximately the same rate of co-verbal pointing gestures (around 5%).

As illustrated in Figure 8, these two periods also correspond to two clear stages in the child's use of co-verbal pointing gestures: up to 1;5, Madeleine mainly produces co-verbal pointing gestures with one-word utterances. After 1;5, the number of pointing gestures accompanying one-word utterances decreases and she starts using co-verbal pointing gestures with two-word utterances. At 1;7 and more clearly at 1;11, she then starts using co-verbal pointing gestures with three word utterances (from 2 to 6%).

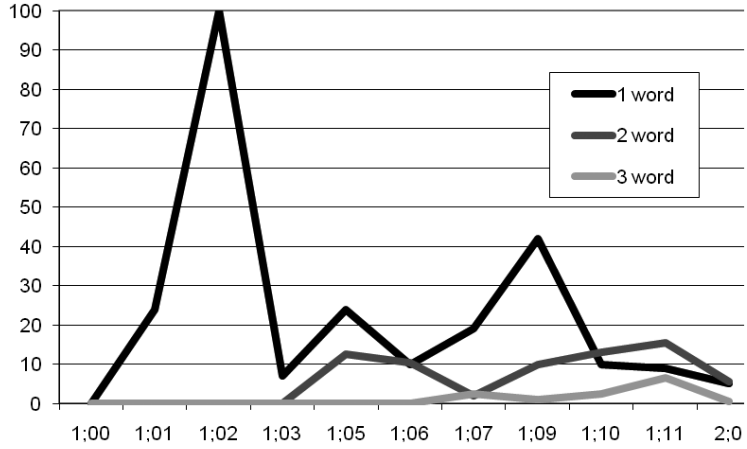

Figure 8. Percentage of 1 word, two word and three word + pointing gesture productions in Madeleine's data.

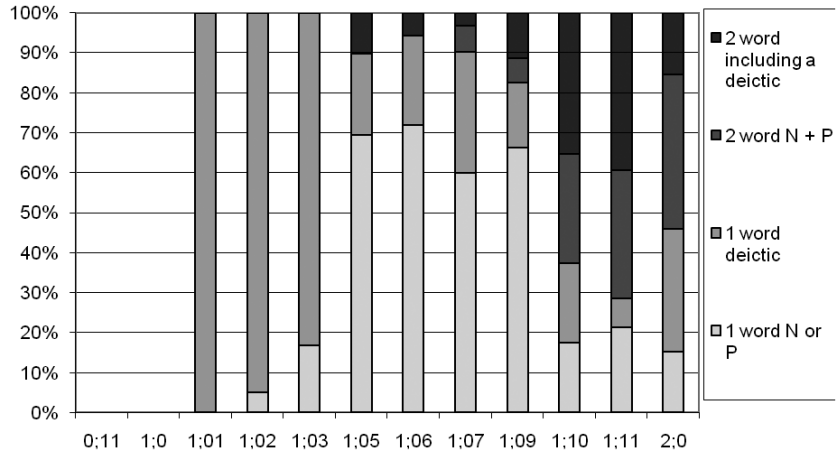

Figure 9. Verbal productions accompanying pointing gestures in Madeleine's data (N = nouns, P = predicates).

In order to test Clark's hypothesis (1978) we coded the type of words Madeleine uses with her co-verbal gestures (Figure 9). We observed that pointing gestures are first used with isolated deictics such as "ça" (that) or "là" (here) or isolated nouns, up to the age of 1;5. After 1;5, Madeleine also starts using pointing gestures with two words including a predicate, and from 1;7 she then uses pointing gestures with two word utterances including deictics or not. At 2;0, more than 50% of pointing gestures accompany complex productions (at least two words).

There seems to be a strong relationship between co-verbal pointing gestures and demonstratives when the child enters syntax. But are demonstratives always

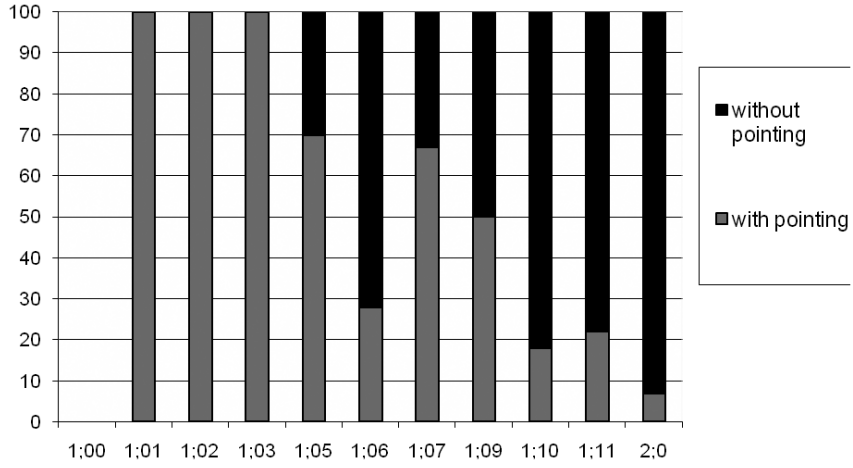

Figure 10. Percentage of demonstratives used with and without pointing gestures in Madeleine's data according to age.

used in complementation to pointing gestures in the hearing child's data? As illustrated in Figure 10, demonstratives are less and less accompanied by pointing gestures: 100% of demonstratives at 1;1 are used with a pointing gesture versus 8% at 2;0.

The use of pointing gestures combined with demonstratives decreases as Madeleine gets older. At 2;0, she produces 79 demonstratives ("ça"/"that" and "là"/"there") and uses pointing gestures twice with "ça", and four times with "là".

Charlotte

As far as Charlotte's data is concerned, our hypothesis was that points would increase in parallel with other signs, since points are fully integrated in the linguistic system of LSF.

The results of Limousin's experimental coding of Charlotte's productions between 7 months and 2 years old are illustrated in Figure 11.

Charlotte uses what Limousin has coded as signs (excluding points) quite early on (11 months) and as of 1;0 they are already more frequent than the other categories. Limousin did not differentiate pointing gestures and pointing signs since there were no formal features to enable her to distinguish them in most cases. Pointing gestures/signs seem to play an important role throughout the data.

Figure 11. Number of signs, non intelligible signs (NIS), pointing gestures/signs and other gestures according to age in Charlotte's data.

Charlotte is already using them quite frequently at 10 months and combines them with other signs very early on. She is already using a self-pointing gesture/sign followed by a gesture that could be interpreted as a sign for HAT at 8 months. There seems to be no clear distinction between this possible first combination and later combinations of pointing + sign. At 10 months, Charlotte produces strings of pointing gestures such as SELF-POINT + POINT to yoghurt + SELF-POINT. At 15 months, she looks at the observer and signs FANNY POINT-TO-OBSERVER FANNY. Around the age of two years, she is producing combinations such as: SELF-POINT EAT POINT (to box of cheese that her mother is opening), then SELF-POINT WANT YES (with head) POINT (to box of cheese). At 2;07, Charlotte can sign more complex productions including pointing. She explains for example how her father got angry at her the other day when he got home but how he was wrong in interpreting what she had done and made her cry: THAT'S-NOT-IT NO DADDY HOME HERE (vertical point) DADDY ANGRY SELF-POINT CRY.

Illana

In order to address the issue of the possible transitional role of pointing gestures in Illana's data, it is worth mentioning that we observed the same major stages at comparable ages as those described in other studies of language development, in mono- and bilingual contexts in Illana's language production. The little girl's first pointing gestures were identified at 8 months, which corresponds to what is known about children acquiring a sign language (and Charlotte in particular). The onset of the one-word stage for Illana was essentially at the same time for both oral words (10 months; she was filmed with her hearing mother) and signs (11 months; she was filmed with her deaf-signing father), and fits squarely within the period in which first words appear in monolingual acquisition of French and in monolingual sign language acquisition. Likewise, the first occurrence of sequences of two signs was found in the same session as the first occurrence of two-word strings, and, once again, this timing is consistent with what is known about monolingual French acquisition and with what is known about bilingual bimodal language development. However, as we have seen in the section on self-reference, she uses fewer marked forms than Madeleine and Charlotte.

In order to make qualitative analyses of the data, the issue of the distribution of pointing gestures was addressed. All the possible combinations including a pointing gesture were analyzed. The two following examples provide illustrations of two rather clear situations of pointing used in isolation and in a syntactic combination. The first one corresponds to the session when Illana is 8 months old, she is pointing at the observer behind the camera, and her mother says "you're showing Marion": this is a single pointing gesture with no other item. The second example is when Illana is 15 months old: after her father has signed PHONE GRANDPA,

Illana signs GRANDPA and points at the phone. Her production combines a point and a lexical sign. It is interesting to observe that even in the context of a repetition (the father has produced the same content in the previous utterance), Illana does not reproduce the two lexical signs. Several explanations or interpretations could be given (cognitive overload, clarification of the location of the object …), but there are no combinations of two lexical signs at 1;5 in Illana's data, we only note them in the data as of 1;10. However, Illana starts combining points and signs and points and words as early as 1;1 (examples include POINT + PAPA in LSF; POINT + "tiens"/"here" in French).

Combinations of more than one element, whether they are sequential or simultaneous, are always preceded in time by exactly the same combinations with a pointing gesture serving as one of the elements. Our analysis of combined elements showed that they display a rather rich variety and quite interesting complexity, even at early stages. The order in which combinations emerge is not random. The first occurrence of each new kind of combination (oral/gestural/mixed, simultaneous/sequential) INCLUDING a point precedes the comparable one WITHOUT a point.

Examination of the criteria we have mentioned before (such as the kind of referee pointed at, the kind of relation the pointing gesture has with its environment …) revealed a clustering of the first occurrence of several properties at the same age — 1;7. The first combination of a point whose target is animate with a sign that can be considered to be a verb appears at that age in our data. In the same session, we noted a point towards an absent referent and the first co-occurrence of a point with a French pronoun (fillers like [o], [a]; strong pronouns like "ça" or "c'est" / "that", "it is").

Discussion

Number of pointing gestures

Pointing gestures were used by the three children, independently of the language they were acquiring, and of the modality in which the language was conveyed. However, as we had hypothesized, Charlotte, the deaf child, produced pointing gestures earlier and more frequently than Illana, the hearing bilingual child, who produced pointing gestures earlier and more frequently than Madeleine, the monolingual hearing child. These results confirm those of Hoiting (2009) and coincide with the descriptions of Cormier et al. (1998, p. 7): "Further, we found that deaf children tended to produce more referential gestures than the hearing children did. In fact, it was referential pointing that distinguished deaf infants from hearing

infants. The greater proportion of communicative points in deaf children may be due to the different linguistic environments of the two groups. For deaf children acquiring sign, points become integral to their language. For hearing children, points will always be gestures that add to but are not part of the spoken language." Children surrounded by sign language see many more pointing gestures, which may influence their own production of those gestures. This may explain Charlotte and Illana's early and more numerous points per hour in the data. In addition, for Charlotte, they are her main resource for attracting and directing the adults' attention; she therefore uses them more than Illana who can also rely on other means such as vocalisations.

Although she can rely on vocal means to attract the adults' attention, Madeleine does use pointing gestures a lot, and she also continues to point as she speaks at on older age, at a rate comparable to her mother's co-verbal pointing gestures. Therefore, pointing gestures do not disappear as she gets older, but their functions may be different and resemble adults' pointing gestures (Enfield et al., 2004, Calbris, 2003). At the beginning, pointing gestures are used to attract and direct the adult's attention, to refer to external entities during a period when words are still lacking. As she acquires language, she develops other verbal means to fulfil these functions such as lexical words, demonstratives and personal pronouns. But at the same time, her pointing gestures become specialized in specific communicative functions, such as disambiguating what she is referring to or adding information, just as adults do. Her verbal productions are syntactically richer of course and her use of deictic gestures remains stable up to 3;0, just like her mother's in cases where objects, people and events need to be localized in space, as the following example illustrates:

(1) *Madeleine is 2;0, she is telling the observer that she has a stain on her white tights.*
*CHI: Tu vois, y a pas de caca ici *[she points at a location on her tights that is not stained]* y a du caca ici *[she points at the stain]*.
(You see, there is no poopoo here, there is poopoo here.)

Pointing towards persons and self

For the deaf child, pointing gestures become fully integrated parts of the linguistic system, with no other equivalent fulfilling their functions. Pointing towards persons might be substituted by pronouns in the speech of hearing children, whereas in sign language, they still are the main form for personal reference, and their production even increases as the child talks more and more about herself and others.

Pointing towards the self is the main explicit form used to sign about oneself. Charlotte sometimes used her first name, but this occurred only when she was looking at pictures, just as all children do at this early age (cf. Budwig, 1995; Morgenstern, 2006; Zazzo, 1993). Madeleine on the other hand never points towards herself whereas she does point towards other persons including her interlocutor. From early on, hearing children start using filler syllables (Peters & Menn, 1993) and then pronouns to refer to themselves. Since first person pronouns inherently refer to the speaker, they are non-ambiguous. The use of pointing gestures towards the self seems to be redundant, although they may be used by some speaking children to insist, mark a contrast, or simply refer to self when eating or when loud music is on. On the other hand, referring to other persons with pronouns (including the interlocutor) when they are several participants in an interaction may be ambiguous and may therefore require pointing gestures for clarification.

Although the nature of the pointing gesture (gestural vs. linguistic) was not the major issue in our study, it is important to recall that we did not observe pointing gestures towards the self instead of the other or the reverse. We cannot confirm Pettito's main arguments for the discontinuity hypothesis between pointing "gestures" and pointing "signs". Our dataset is not large enough to assume that the child did not produce any at all, yet this phenomenon was not captured here.

Development of pointing gestures and words/signs

The main "continuity" issue we addressed was the status of pointing gestures in the transition from one- to two-item utterances and the entry into syntax. We had at our disposal extended information concerning the development of Madeleine's pointing gestures in parallel to her acquisition of words. The data revealed the transition from pointing gestures with non-intelligible speech, to pointing gestures + deictics, to pointing gestures + nouns or verbs, to pointing gestures + two words including a deictic or not. This is consistent with Clark's argument (1978) that pointing gestures facilitate children's use of deictics. We observed this phenomenon as the proportion of pointing gestures used with deictics decreased. Before the child started to make two-word utterances, her pointing gestures mainly accompanied deictics. In Charlotte's data, we clearly observed how her use of points parallels the development of other signs, which combine in more and more complex ways. Blondel and Tuller (2008) confirm that pointing gestures are a key feature of transitional stages to more complex LSF syntax, as well as to more complex bimodal productions in Illana's data. The analysis of the bilingual, bimodal child supports the conclusion that the characteristics of pointing gestures, at 19 months, can be indicative of their grammatical status. However, this does not mean that there is a clear-cut break between gestures and signs, nor that pointing

gestures, as co-verbal gesturing, 'disappear'. Studies on adult signers provide some insight on that issue. Pizzuto (2007) suggests that pointing gestures and pointing signs coexist: the pointing-gestures point at the Extralinguistic reality. And the pointing-signs point towards the Intralinguistic reality (Pizzuto suggests that the adressee's eye gaze is a good criterion to make the distinction).

Illana has an intermediate profile (compared to Madeleine and Charlotte) from a quantitative perspective. From a qualitative perspective, Illana's pointing gestures share a rather complex distribution with those of Charlotte: they get grammaticalized[11] in the period corresponding to the two-word stage and they are associated with rich combinations of manual items and non-manual parameters. Since this data is still being transcribed and analysed, future analyses will help us understand the development of her bilingual bi-modal system. A question we keep in mind for future research is the possible equivalent of vocal prosody associated with pointing gestures by hearing children (Leroy et al., 2009).

For the three children, it appeared that we clearly lack quantitative and qualitative data concerning the way adults use pointing gestures in child–adult and in adult–adult free interaction. Future research should therefore help us better understand what children produce in the light of what adults use when talking or signing to children.

Conclusion

The main purposes of this study were twofold. Our paper first aimed at investigating and comparing the development of pointing gestures (overall; towards persons; towards self) in the productions of a deaf signing girl acquiring French Sign Language, Charlotte, a hearing girl acquiring French, Madeleine, and a hearing girl from a deaf father and a hearing mother, acquiring both French and French Sign Language simultaneously, Illana. We hypothesized that the modality of the input children receive and the language(s) they are acquiring would influence the onset, the quantity and the quality of their pointing gestures. Our results corroborated this hypothesis: (1) both Charlotte and Illana produce pointing gestures earlier; (2) Charlotte produces more pointing gestures in general and more pointing gestures towards persons in particular than Illana, who also produces more pointing gestures than Madeleine. This is consistent with Cormier et al.' s (1998) findings. In addition, both Charlotte and Illana produce pointing towards self, whereas Madeleine produces none. But Madeleine develops other linguistic means to refer to herself.

Our paper also aimed at replacing those issues in the context of the development of language. Our hypothesis was that co-verbal pointing gestures would first

be produced in high amounts as they combine with early single words and then decrease in Madeleine's data as she acquires verbal means of reference. In Charlotte's data, on the contrary, pointing gestures would continue to increase as they combine with other gestures or signs and get integrated in the linguistic system of the deaf signing child. Our results confirmed this hypothesis. Both children use combinations of pointing gestures and a word/a sign from very early on. As Madeleine acquires language, she first produces co-verbal pointing gestures with single demonstratives, she then produces pointing gestures with single nouns or predicates, and finally, most of her pointing gestures accompany complex predicates, with or without demonstratives. The use of gestures with demonstratives gradually decreases. This is consistent with Clark's (1978) hypothesis and with Butcher and Goldin-Meadow's (2000) findings. As for Charlotte and Illana, their points keep increasing and are progressively incorporated into complex combinations of signs.

In French, pointing is mostly replaced by deictic pronouns and adverbs (Benveniste, 1966) in the grammaticalization process of reference to space, events and people. However, when precise location in space is needed in context, grammatical elements are still complemented by pointing gestures. At all ages, gestures in general convey information that is not captured in speakers' words. Co-sign pointing gestures can sometimes be distinguished from deictic pronouns in signing children and adults' production, for example when the arm is extended out of the signing space to show a precise location. Even though they are difficult to tease apart from pronouns, co-sign pointing gestures continue to be used as children become more fluent in sign language. But in LSF, pointing gestures are also grammaticalized into linguistic signs thanks to their anchoring in complex utterances embedded in conversations between the children and their parents.

Despite the possibility to observe some formal differences between pointing gestures and points grammaticalized as grammatical items in sign language, we believe that they form a continuum and that the progression from gestures to words and from gestures to signs in early child communication is not discontinuous (Hoiting & Slobin, 2007; McNeill, 1992). We do not restrict the notion of language to verbal or signed units. Gestures, verbal productions, gaze, facial expressions, postures are all part of our socially learned, intersubjective communicative system, and human beings combine modalities with all their representational skills to share meaning, to refer to present and absent entities and events, to express their projects, their desires and their inner feelings.

Notes

1. Unfortunately, although we are fully aware of its importance (see Leroy et al., 2009; Mathiot et al., 2009), we did not make a detailed study of the role of gaze: the videos for one of the longitudinal datasets were insufficient to make a systematic comparison.

2. The data is part of the *Paris corpus* financed by the French Research Agency (ANR) in the framework of the *Léonard Project* directed by Aliyah Morgenstern and is available on CHILDES (http://childes.psy.cmu.edu).

3. Because of the different modalities, it is quite difficult to compare the three little girls' Mean Length of Utterance according to age. We are in the process of setting a method to count signs and words per utterance and per turn based on various studies such as Hoiting (2009).

4. CLAN is a tool to transcribe and annotate video or audio data supported by the CHILDES project: http://childes.psy.cmu.edu.

5. ELAN is a professional tool for the creation of complex annotations on video and audio resources: http://www.lat-mpi.eu/tools/elan.

6. This category includes pointing gestures and signs since no formal feature could be devised, at least at Charlotte's age, to distinguish them systematically.

7. Pre-signs could be considered as the equivalent of fillers in vocal productions, but the term filler is only used to refer to grammatical elements, whereas Limousin used the category pre-sign for all types of items.

8. We still need to clarify the definitions of "a word" or "an utterance" in sign languages in order to obtain measures comparable to the Mean Length of Utterances in oral languages.

9. For this study, we only included persons and not characters in books or toys.

10. Verbal productions of self reference were coded up to 2;7 in Illana's later data and she starts producing filler syllables in preverbal position in utterances referring to herself at 2;3.

11. The main signal of this grammaticalization process is the fact that they are combined with another sign in two sign productions in what we could call one "intonational unit", with no pause between the two signs and a greater fluidity in their production.

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