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## **How gesture input provides a helping hand to language development**

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## ABSTRACT

Children use gesture to refer to objects before they produce labels for these objects and gesture-speech combinations to convey semantic relations between objects before conveying sentences in speech—a trajectory that remains largely intact across children with different developmental profiles. Can the developmental changes that we observe in children be traced back to the gestural input that children receive from their parents? A review of previous work shows that parents provide models for their children for the types of gestures and gesture-speech combinations to produce, and do so by modifying their gestures to meet the communicative needs of their children. More importantly, the gestures that parents produce, in addition to providing models, help children learn labels for referents and semantic relations between these referents and even predict the extent of children’s vocabularies several years later. The existing research thus highlights the important role parental gestures play in shaping children’s language-learning trajectory.

(150 words)

Gesture serves as a forerunner of linguistic change throughout development: typically developing children take the developmental step in achieving language milestones in gesture before attaining the same milestones in speech, from their first words to their first sentences—a trajectory that remains largely robust across children with different developmental profiles. The question we address in this article is whether the transition from gesture to speech can be traced back to the gestural input children receive from their parents, and the potential effects of this early gesture input for the subsequent language development of the child. More generally, we ask whether the gestures parents produce when interacting with their children play a role in facilitating their children’s language development.

### **1. Role of child’s own gestures in language development**

Children gesture before they speak<sup>1,2</sup>. They, for example, point at an object to draw the adult’s attention to that object or to request that object several months before they are able to refer to these objects with words. Importantly, the earlier the child points at a particular object the earlier the same child will produce a verbal label for that object, suggesting a tight positive relation between early deictic gestures (i.e., points) and early words<sup>3</sup>. At the early ages, children also produce two other gesture types, namely *conventional gestures* that convey culturally agreed upon meanings with prescribed gesture forms (e.g., shaking head sideways to convey negation, extending an open palm next to an object to request the object) and *iconic gestures* that convey actions and attributes associated with objects (e.g., holding cupped hands to indicate roundness of a ball, tilting cupped hand toward mouth to indicate drinking from a cup). These iconic gestures, even though they are fewer in number compared to deictic and conventional gestures, allow children to convey a greater range of relational meanings (e.g., size, shape, action) than they can do so by using only words<sup>4,5</sup>. In fact, 14- to 16-month-old children not only use more

gestures than words in their communications, but they also convey a greater array of meanings with their gestures than with their words<sup>6,7,8,9</sup>.

More impressive, children's early gesture use predicts their later spoken language abilities. Children who use greater number of iconic gestures at 19 months of age go on to develop larger verbal vocabularies at 24 months<sup>10</sup>. Similarly, children who convey a greater range of meanings in gesture at 14 months of age show greater verbal vocabularies both at preschool entry at age 4<sup>11</sup> and at school entry at age 5<sup>12</sup>. Thus the earliest gestures children produce precede and predict oncoming changes in their speech; they both signal the onset of first spoken words and also reliably predict subsequent vocabulary development at the later ages, all the way up to school entry.

After they produce their first words, children continue to use gesture, but now in combination with words (i.e., gesture+speech). Children initially produce gesture-speech combinations in which the information conveyed in gesture overlaps with the one in speech (e.g., 'book'+point at book<sup>13,14,15,16,17</sup>). Soon after, children begin using gesture-speech combinations in which gesture conveys unique information not found in the accompanying speech ('read'+point at book), thus allowing them to convey two ideas—albeit across two modalities. Importantly, the age at which children produce their first supplementary gesture-speech combinations predicts the age at which they produce their first two-word combinations<sup>3,18</sup>. Even after they begin to produce two-word combinations, children continue to use gesture along with speech to convey increasingly complex sentence-like meanings, and these gesture-speech combinations, once again, precede the emergence of similar sentence structures in their speech<sup>19,20</sup>. For example, the child produces the iconic gesture PUSH while saying 'I play with stroller', thus conveying one action meaning in speech (push) and one in gesture (play) several

months before expressing the two action meanings together entirely in speech (e.g., ‘I play with stroller by pushing it’). Previous work on typically developing children’s gesture production places gesture at the cutting edge of language learning. Gesture not only precedes and predicts oncoming changes in speech, but it also develops in conjunction with speech and is often used to convey information that is not easily expressed in speech, particularly during periods of developmental change.

Importantly, in addition to signaling oncoming changes in children’s spoken language abilities, gesture also serves as a reliable index of both potential individual variability within typical development and delays in attaining milestones for children with atypical developmental profiles. The close coupling between gesture and speech in typical development comes from studies on sex differences in language development. Girls, on average, produce their first words earlier than boys<sup>21,22</sup>. Interestingly, girls also produce their first pointing gestures to indicate objects earlier than boys<sup>23</sup>, showing a female advantage in the onset of first words as well as its nonverbal precursor, the pointing gesture. Female advantage in gesturing also becomes evident in later sentence learning. Boys, on average, produce their first sentences later than girls do (e.g., ‘drink juice’<sup>24</sup>). Interestingly, boys also lag behind girls in producing their first gesture-word combinations conveying similar sentence-like meanings (‘drink’+point at juice<sup>25</sup>). Gesture, when considered in relation to speech, thus provides the first reliable sign of individual variability in children’s emerging sentential abilities, which appears in boys later than girls.

The gesture-speech system also remains closely tied to the emerging oral language system in children with atypical developmental profiles. Previous research with children who are delayed in the onset of expressive vocabulary has shown that gesture use is a good predictor of later vocabulary development<sup>26</sup>. Late talkers who did not perform well on gesture tasks and who

gestured very little went on to exhibit delays in producing words one year later, whereas children who performed relatively well on these gesture tasks and who gestured at higher rates had vocabularies at the appropriate age level one year later. Thus, early gesture provides a reliable tool to differentiate between late bloomers and truly delayed children. The closely timed progression of gesture and speech has been shown not only for children whose early words are delayed, but also for children whose first sentences are delayed. Children with early unilateral brain injury who exhibit significant delays in their early multi-word speech also exhibit significant delays in their gesture-speech combinations conveying similar sentence meanings<sup>27</sup>.

Previous research on children with different developmental disorders (e.g., Autism, Down syndrome) also suggests similar patterns. Children with Down Syndrome rely heavily on gesture to compensate for the difficulties they encounter in spoken language, thus producing gestures at rates comparable to<sup>28</sup>, or, in some cases, even higher than typically developing children<sup>29,30</sup>. There is also evidence showing that children with autism spectrum disorders typically gesture less, but they also talk less compared to typically-developing children<sup>31</sup>, thus producing proportionally comparable amount of gestures as typically-developing children. Thus the existing work on overall rates of gesture production suggests that children with developmental disorders do gesture at the early ages—even at different rates, and these gesture rates are closely tied to their spoken language abilities.

There are a few studies on early gesture-speech combinations produced by children with developmental disorders that also suggest similar patterns to the ones produced by typically developing children. One such study, examining the gesture-speech combinations of 5 children with Down Syndrome, ranging between 37-56 months of age, showed these children produced gesture-speech combinations at comparable rates to typically developing children; but the

gestures in most of these combinations conveyed the same information as the speech it accompanied ('cookie'+point at cookie)<sup>28</sup>. Another study<sup>32</sup> followed two children with autism (28 months, 32 months), and showed that one child followed a path from gesture-only communications to gesture+speech combinations and the other was already conveying gesture-speech combinations even in the first observation. None of these children were yet producing multi-word speech utterances. Together these studies show that children with developmental disorders might follow a similar pattern of development as typically developing children, from gesture-speech combinations to speech-only expressions in achieving different language milestones, also accompanied by delays. Thus research on children with atypical developmental profiles suggests that the gesture-speech system remains a robust aspect of the language learning process across different learners, including children with genetic or acquired developmental disorders.

## **2. Role of parents' gestures in their children's language development**

At the early ages, children spend considerable amount of time surrounded by adults, particularly their parents. As a result, they do not only gesture themselves, but also routinely observe others gesture. We know from previous work that parents modify their spoken language input when communicating with their children<sup>33,34</sup>. For example, compared to speech directed to adults, parents' speech to young children is characterized by exaggerated intonation<sup>35</sup>, shorter phrases with simpler syntax and lexicon<sup>36,37</sup>, and a greater number of imperatives, interrogatives and repetitions<sup>38,39,40</sup>. These modifications, in turn, serve numerous functions for the language development of young children—from maintaining attention and facilitating turn taking<sup>41,42</sup>, to helping infants parse the speech stream and more easily identify new linguistic information<sup>43,44,45</sup>.

In addition to speaking, parents also gesture frequently when they talk to their children. However, compared to spoken language input, we know relatively little about the gestures that children see in their everyday interactions with their parents and the potential impact these gestures might have on the language learning process. The few existing studies focused on three key questions regarding gesture input: (1) whether parents modify their gestural input to fit to the communicative needs of their children, (2) whether parents provide models for the different types of gestures and gesture-speech combinations for their children, and (3) whether early parental gesture input has any effect on later language development of their children.

### **2.1. Do parents modify their gestures to fit to the communicative needs of their children?**

Research on the complexity of gesture input thus far suggests that parents modify their gestures to accommodate the communicative needs of their children<sup>8,9,46,47</sup>. Bekken<sup>48</sup> examined the gestures mothers produced when talking to their eighteen-month-old daughters and compared these to gestures the same mothers produced when talking to an adult. She found that mothers not only gestured at a lower rate, but also produced simpler gestures involving mostly points at objects when they addressed their children than when they addressed the adult. Several other studies extended these findings to a broader range of ages and languages: Iverson and colleagues<sup>8</sup> analyzing maternal gestures at two age points (child age 16 and 20 months) in spontaneous mother-child interactions showed that Italian mothers used predominantly simpler gestures, namely *deictic gestures* to indicate objects (e.g., pointing at bike to indicate bike) and *conventional gestures* to convey culturally prescribed meanings (e.g., shaking the head to mean no), and very rarely produced iconic gestures conveying detailed semantic information about objects. The patterns remained the same for children learning English in the United States. Özçalışkan and Goldin-Meadow<sup>9</sup>, analyzing maternal gestures at three age points (child age 14,

18, and 22 months) also in spontaneous mother-child interactions, showed that American mothers predominantly used deictic and conventional gestures in their nonverbal communications addressed to their children, and very rarely produced the more complex iconic gestures. Similarly, British mothers interacting with their 20-month-old children produced largely deictic gestures, which accounted for 90% of their overall gesture production<sup>49</sup>.

Not surprisingly, almost all of the gestures that parents produced in these studies accompanied speech, forming gesture-speech combinations. The function of the gestures in these combinations varied however, from *reinforcing* ('Look at the bear'+point at bear) or *clarifying* ('Look at it'+point at bear) what is conveyed in speech to *adding* new information not found in the accompanying speech (i.e., *supplementary*; 'Can you give a hug?'+point at bear<sup>46</sup>). Importantly, majority of the gestures in the gesture-speech combinations produced by parents conveyed the same information as the accompanying speech, possibly making it easier for a child with limited vocabulary knowledge to more clearly understand the referent of a word<sup>8,9</sup>. On occasion, parents also used gesture to clarify a referent, but typically at lower rates than they use gesture to convey new information not found in the accompanying speech<sup>9,49</sup>. Taken together these findings point at a *gestural motherese* somewhat akin to *motherese* in speech, characterized by higher rates of *simpler gesture forms* (points, emblems)—indicating objects or conveying culturally shared conventionalized meanings, and *simpler gesture-speech combinations*, typically conveying the same information across the two modalities.

## **2.2. Do parents provide models for children's gestures and gesture-speech combinations?**

Children use gestures in word-like ways before they begin to produce words and use gesture-speech combinations in sentence-like ways before conveying sentences in speech. Can we trace these developmental changes back to the gestural input children receive from their

parents? Previous research provides strong evidence that parents provide models for the different types of gestures and gesture-speech combinations children produce—models that could play a role in helping children learn language<sup>4,9,46</sup>. As shown in earlier work<sup>9</sup>, gesture accounts for a higher percentage of total communications for children than for parents; 70% of the communicative acts produced by 14-month children include gestures, compared to only 10% of communicative acts produced by parents—even though the two groups remain comparable in terms of absolute numbers of gestures that they produce at this early age. More importantly, the relative distribution of different gesture types in children’s repertoire begins to approximate their parents over time. Parents produce deictic gestures most frequently followed by conventional gestures, and then by iconic gestures—a pattern that remains unchanged between child age 14 to 22 months. The children follow the same pattern as their parents in the relative distribution of the different gesture types that they produce, using more *deictic gestures* than *conventional gestures* and more *conventional gestures* than *iconic gestures*<sup>9</sup>.

Parents continue to provide models for their children at the later ages. Children begin to show increased sensitivity to iconicity in gesture comprehension beginning around 26 months of age<sup>50,51</sup>, a period that is also marked with a reliable increase in iconic gesture production<sup>5</sup>. Importantly, this increase in the use of iconic gestures is mirrored by a similar increase in parents’ iconic gesture production during the same age period<sup>4</sup>, once again suggesting a tight link between the types of gestures produced by parents and their children. Acredolo and Goodwyn<sup>10,52</sup> also found that the majority of the iconic gestures young children produce can be traced back to the gestural routines that their parents engage in with their children.

In addition to providing models for the different gesture types, parents also provide models for the different types of gesture-speech combinations for their children. Previous

research that examined the overlap between the types of gesture-speech combinations children and their parents produced showed close similarities, with both children and their parents producing three distinct gesture-speech combinations in which gesture either *reinforced* ('bottle'+point at bottle), *clarified* ('hold it'+point at bottle) or *supplemented* ('thirsty'+point at bottle) the information conveyed in speech<sup>8,9</sup>. One interesting difference, however, was that, unlike their parents, who mostly used reinforcing combinations, children used predominantly supplementary combinations, and increased their use of such combinations with increasing age. This important difference suggests a different role for gesture for the child, namely a novice taking his/her first steps into linguistic constructions in speech vs. the parent who is already an expert in conveying similar constructions in speech (see<sup>46</sup> for a related discussion). Research to date thus suggests that parents provide models for their children not only what types of gestures and gesture-speech combinations to produce but also how often to produce different gesture types.

### **2.3. Do parents' gesture input affects children's subsequent language development?**

Children vary in their spoken language abilities and how quickly they achieve different language milestones<sup>53,54</sup>, and one of the strongest environmental predictors of this variation is the quantity and the quality of the speech input they receive from their parents. Parents who talk more to their children also have children who themselves develop larger and more varied vocabularies<sup>34,55</sup> and show faster vocabulary development<sup>54</sup>. Thus there is a strong positive correlation between the size and growth of child's vocabulary and the verbal input the child receives from the parent. In addition to speaking, parents also gesture to their children, and there are at least two important ways this gesture input can influence language development. First, the gestures produced by parents can directly influence comprehension of parental speech that

accompanies the gesture. Second, parents' gestures can influence children's subsequent vocabulary development—typically by having an effect on the child's own gesture production.

### **2.3.1. Gesture input provides a helping hand in speech comprehension**

Parents gesture frequently when they speak to their children and there is evidence that children can understand these gestures as early as 12 months of age. For example, one-year-old children can easily follow an adult's pointing gesture to a target object<sup>56,57,58</sup>. Most of the gestures produced by parents in these early interactions co-occur with speech, forming gesture-speech combinations. Many of these combinations include gestures that convey the same information as the accompanying speech (e.g., 'look at the caterpillar'+ point at caterpillar), thus providing nonverbal support to children in understanding the meaning of spoken words. There is in fact evidence that suggests that children's initial misunderstanding of the referent of a word is greatly reduced if parents direct the child's attention to the object with a pointing gesture or a related action<sup>59</sup>. In addition to reinforcing combinations, parents also use gesture to provide additional information not found in the accompanying speech, thus providing children with more complex messages across modalities. Existing experimental work shows that children can understand combinations in which a deictic gesture adds new information to speech between ages 1-2 ('open'+point at box<sup>16</sup>) and combinations in which iconic gestures add new information to speech between ages 3-4 ('open'+book gesture<sup>60</sup>). Similar comprehension abilities have been reported for gesture-speech combinations in which a deictic gesture clarifies the referent of a deictic word (e.g., 'this'+point at ball<sup>61</sup>). For example, in an earlier case study by Clark, Hutcheson & Van Buren<sup>62</sup>, a two-year old child was more likely to look at the target object when the object was indicated by both a pointing gesture and speech ('it is up there'+point at toy) than when referred to only by speech ('it is up there'). Gesture-speech combinations serve as useful

input to even older children (ages 3-5), particularly aiding them in their comprehension of indirect requests (e.g., ‘It is hot in here’+point at closed window<sup>63</sup>). Overall, these studies suggest that parent gestures and gesture-speech combinations might aid children first in understanding and perhaps eventually in acquiring new words and sentences, by providing nonverbal support.

### **2.3.2. Gesture input provides a helping hand in subsequent language development**

The amount and the types of gestures parents produce when talking to their children play a significant role in shaping the language-learning trajectory of their children. One possible way input gestures might have an effect on child vocabulary is through its effect on child gesture. Existing work in fact suggests close correlations between parent gesture and child gesture—both in overall amounts and types of gestures produced. For example, parents who gesture more typically have children who gesture more themselves than children of parents who gesture less<sup>8,11,64</sup>—a pattern that holds across cultures<sup>65</sup>. Furthermore, children growing up in cultures in which adults use a larger repertoire of a particular gesture type such as iconics (e.g., Italy), develop larger repertoire of iconic gestures themselves compared to cultures in which the adult repertoire of such iconic gestures is smaller<sup>66</sup>.

Interestingly, parent gestures not only promote gesture production in their children but also predict their children’s subsequent vocabulary development. Studies examining parent-child interaction showed strong correlations between parent gesture and child vocabulary size. Iverson and colleagues<sup>8</sup>, in a study with 16- to 20-month-olds, found a strong positive relation between the amount of maternal pointing and child vocabulary size. Similarly, a study by Pan, Rowe, Singer & Snow<sup>55</sup> with 14- to 36-month-old children showed that children whose parents produce greater amount of pointing gestures also showed faster vocabulary growth than children whose parents produce fewer pointing gestures. Similar results have been reported with 15- to 21-

month-olds; Tomasello and Farrar<sup>67</sup> found that the frequency with which parents indicated objects within the child's focus of attention using gesture and speech at 15 months of age correlated positively with children's vocabulary size at 21 months of age. Some of the more recent work shows that parents' gesture use predicts children's gesture use, which in turn predicts language development, in some cases more than 2 years later<sup>11,12</sup>. One such study, examining the mediating effect of parental gesture on children's vocabulary development with 14- to 42-month-old children showed that the amount of parent gesture at 14 months was positively related to child gesture use also at 14 months, which in turn predicted child vocabulary at 42 months<sup>11</sup>. These studies show that parents show variability in the gestural input they provide to their children—both in types and tokens, and these gestures in turn predict children's own gestural repertoires and can even influence the size of their vocabularies several years later.

Looking at the gestural input provided by parents of children with developmental disorders, we also observe similar patterns in the complexity of the gesture input that they provide in relation to their children's later spoken language abilities. For example, parents of children with Down Syndrome, in addition to providing simpler spoken language input, also provided higher density of gestural input to their children with Down Syndrome (one gesture per utterance), who typically exhibit motor problems in producing words<sup>68</sup>. Previous work on gestural input provided to children with autism also shows that parents of children with autism rely less on conventional means of indicating objects (i.e., distal pointing or using words) in interacting with their children, but use more physical acts (e.g., tapping or shaking an object), as compared to parents of typically developing children<sup>69,70</sup>. The parents of children with autism also show more variability in the number of verbal and nonverbal attempts they make to draw the child's attention to a target object. It is a likely—yet currently unknown—possibility that these

differences in parents' gesture input to children with developmental disorders might lead to differences in children's language development at the later ages.

In summary, previous work indicates that at the early stages of language learning children use gesture to augment their linguistic resources, both at the lexical level and the sentence level. Parents provide models for the different types of gestures and gesture-speech combinations that children produce, models that could help children learn new words and sentence structures. Research in other domains of cognitive development, such as math-learning, hint at the benefits of multi-modal presentation of information to novice learners. School-aged children who incorporate the gestures modeled by their teachers in solving an arithmetic problem were more likely to benefit from instruction on the task than children who did not incorporate such gestures into their problem solving routines<sup>71,72</sup>. Applied to a language-learning context, it is possible that children model the gestures and gesture-speech combinations that they see their parents produce, allowing them to understand and perhaps practice these new semantic meanings. Parents, in turn, might respond to their children's nonverbal communications, providing children with the target word and/or sentence at the right time. In fact, we know from previous work that mothers in addition to providing gestural input, routinely translate their children's gestures into words<sup>73</sup> and gesture+speech combinations into sentences<sup>74</sup>; thus providing their children with the critical input to advance to the next stage in their language development. The existing research also highlights the importance of parents' gesture input—not only for success in imminent word and sentence learning, but also for later vocabulary development, typically by having an effect on the child's own gesture production itself. Overall, research up to date highlights the important role parental gesture input plays in children's immediate and later language development, rendering nonverbal communicative input as an essential factor in the language learning process.

The existing research also has important clinical implications. First it shows that children convey their readiness to take the next developmental step in language learning first in gesture—a nonverbal cue that teachers, parents or clinicians should rely on as an index of the child’s readiness to learn, and, accordingly provide the relevant speech input to help children take that next step. Secondly, it shows that the gestures that the adults working with children themselves produce can influence children’s language learning trajectory, by providing models and having an effect on children’s own gesture production—an important finding that highlights the importance of using gesture as a clinical teaching tool to help children learn a new concept or language ability.

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## CEU QUESTIONS

1. How does early gesture production relate to spoken language development?
  - a) The onset of children's first words coincides with the onset of their first gestures.
  - b) Children who gesture more at the early ages produce fewer words at the later ages.
  - c) Children's gesture production is not related to their language development.
  - d) Children who gesture more produce more words at the later ages.
  - e) Iconic but not deictic gestures predict later spoken language development.
  
2. What best explains children's gesture production after they begin to produce single words?
  - a) Children only use gestures to convey the same information as their words.
  - b) Children first produce gestures that convey the same information as speech, followed by gestures that convey different information from speech.
  - c) Children use gesture increasingly less to convey information not found in the accompanying speech.
  - d) Children gesture very little after they produce their first words, mainly to request objects they do not have names for.
  - e) Children use gestures only to convey additional information not found in the accompanying speech or to clarify a referent.
  
3. What best describes parents' verbal and nonverbal input to their children at the early stages of language learning?
  - a) Parents modify their verbal but not gestural input when communicating with their children.
  - b) Parents modify their gestural but not verbal input when communicating with their children.
  - c) Parents modify their gestural input to their children only in gesture-rich cultures that has a large repertoire of gestures.
  - d) Parents produce many iconic but very few deictic gestures to help children understand what they say.
  - e) Parents adjust both their gestural and verbal input to the communicative needs of their children.
  
4. How do the types of gestures and gesture-speech combinations parents produce relate to children's own gesture production at the early stages of language learning?
  - a) Parents provide models for the types of gestures but not for the types of gesture-speech combinations that their children produce.
  - b) Parents and children use supplementary and reinforcing combinations at similar rates.
  - c) Unlike their parents, children increase their use of supplementary gesture-speech combinations.
  - d) Parents provide models for the types of gesture-speech combinations but not for the types of gestures that their children produce.

e) Parents very rarely produce gesture-speech combinations and these combinations do not resemble the types of combinations their children produce.

5. How does parents' gesture input relate to children's language development?

a) Parents' gestures influence children's language development only in gesture-rich cultures where parents gesture frequently.

b) Parents gesture input does not have any long-term outcomes for children's language development.

c) Parents' gestures have shown to be helpful for children with comprehension but not production of words.

d) Parents' gesture use influences children's gesture production, which, in turn, strongly relates to children's subsequent language development.

e) There is very little evidence that suggests a link between parent gesture input and children's vocabulary development.

ANSWER KEY: 1:D, 2:B, 3:E, 4:C, 5:D

## **LEARNING OUTCOMES**

As a result of reading this article, the reader will be able to:

1. Identify the different ways children's early gesture production plays a role in their language development
2. Select two important ways parents' gestural input contributes to children's language development
3. Compare the similarities and differences in parent and child gestures at the early stages of language development

## **BIOGRAPHIES**

Şeyda Özçalışkan (Assistant Professor of Psychology) received her Ph.D. from the University of California, Berkeley and worked first as a postdoctoral fellow and then as a Research Associate at the University of Chicago. She studies the process of language development and how gesture serves as part of the mechanism of change in this process across different learners and learning environments.

Nevena Dimitrova received her Ph.D. in Developmental Psychology from the University of Lausanne, Switzerland and currently works as a postdoctoral fellow at Georgia State University, funded by a postdoctoral grant from the Swiss National Science Foundation. She studies how maternal verbal and nonverbal input contributes to language development of children with developmental disorders, with a focus on children with autism.