Achtung Baby! Exciting Times for Infant Research

Inaugural Speech by Prof. Dr. Sabine Hunnius

change perspective
Babies can be baffling to us. While as newborns they still seem utterly helpless, it takes little less than a year before they have turned into happy, raucous toddlers, who love playing peek-a-boo and communicate by pointing and speaking their first words. How is that possible? The question of exactly which developmental mechanisms underlie the spectacular changes that occur during these first years of life has been keeping developmental psychologists busy for decades. In her inaugural lecture, Sabine Hunnius shows how cognitive neuroscience leads to significant progress in our understanding of early development. Using research into the development of social cognition in young children, she shows how the introduction of neuroscientific methods and a cognitive science approach contribute new insights into how babies develop the ability to understand what others think, feel and do.

Sabine Hunnius studied Psychology at the Freie Universität Berlin (Germany) and obtained her PhD at the University of Groningen for a longitudinal study into attention and looking behaviour in infants. After conducting research at Tilburg University and Uppsala University in Sweden, she joined Radboud University in 2007. Since then, she has served as director of the Baby and Child Research Center. Together with Michiel van Elk, she published the popular science book Het babybrein (The Baby Brain). In 2018, she was appointed Professor of Developmental Cognitive Neuroscience.
ACHTUNG BABY! EXCITING TIMES FOR INFANT RESEARCH
Achtung Baby! Exciting Times for Infant Research

Inaugural speech delivered at the acceptance of the post of Professor of Developmental Cognitive Neuroscience at Radboud University, Faculty of Social Sciences, on Friday 7 December 2018

by Prof. dr. Sabine Hunnius
Mijnheer de rector magnificus,
zeer gewaardeerde toehoorders,

Everyone who becomes a mother or father gets to witness one of the biggest miracles of life: Although babies seem to be born completely helpless, within little more than a year, they transform into totally different creatures. The vivacious toddler who is waddling around, pointing out exciting things she sees, playing peek-a-boo, learning new words at a breathtaking rate, who is giggling and laughing, but also shrieking in frustration when she doesn’t get what she wants - she does not at all resemble the newborn she was just a little time ago who fell asleep exhausted after a couple of minutes of inspecting her nearby environment with long gazes and sluggish eye movements. How can this be?

A BRIEF HISTORY OF INFANT RESEARCH

This astonishment about the dramatic changes that we undergo during the first months and years of our lives marks the earliest beginnings of what would develop into a research field of its own: infant studies. Starting in the 19th century, researchers who became parents started to follow the development of their sons and daughters with amazement and curiosity. They published the very first papers on infant development. One of the most prominent examples is Charles Darwin, who meticulously documented observations of his firstborn son William Erasmus. The notes resulted in his article “A biographical sketch of an infant” which Darwin published in 1877. (In that year, little Willy was actually already 38 years old. This illustrates how wonderfully slow the science of that time was.) Many of Darwin’s records pertain to which behaviors he observed in his baby at what age - when Willy smiled for the first time, or when he first grasped an object to bring it to his mouth. But Darwin also reflected on the mechanisms that might underlie the developmental changes he observed. In January 1841, he writes about his 2-year-old:

“Nothing has struck me more in his intellectual development (...) that [sic] the great quickness of associating any two things together, after they have happened even only twice or thrice (...)”

Many other researchers followed his example, from Clara and William Stern who at the beginning of the 20th century kept diaries of the language development of their three children Hilde, Günther, and Eva, to the great Jean Piaget who based most of his ideas about infant development on observations of his own three kids.

Despite the great fascination and admiration those early baby researchers had for their offspring, it is important to realize that for centuries infants have been seen as creatures with very little mental activity. John P.C. Griffith, a pediatrician of the University of Pennsylvania, wrote in his bestselling book “The Care of the Baby” from 1918:
“When the baby is just born, (...) it is (...) very little more intelligent than a vegetable. Its soul and its intellect are there, but they are dormant (...). (...) It is, in fact, not directly conscious of anything.”

This view only began to profoundly change during the second half of the 20th century. One of the reasons for this change was the emergence of novel research methods, which opened a new window onto the baby’s mind and brought about a revolution in the field. In the 1950s, Robert L. Fantz was the first to discover that even young infants show clearly observable and measurable responses to stimuli in their environment. Although their ways of expressing themselves are limited, they visibly show if something triggers their attention from a very early age. Fantz observed that infants prefer to look at novel things compared to things they already know well. When a baby gets to experience the same stimulus many times in a row, she will pay less attention with every repetition and turn away more and more. If you then show her a stimulus that is just a little bit different than the old one and the baby suddenly pays attention again, you as a researcher know that she must have perceived the difference.

Fantz recognized that this insight offered a way for baby researchers to study exactly how infants perceive the world: whether they can see the difference between light blue and dark blue, distinguish faces from other stimuli, or whether they can hear the difference between speech sounds from their own and a foreign language. From the various studies that adopted this method in the following decades, it emerged that young infants had long been wrongfully regarded as mindless beings that react only reflexively to their environment. Rather, it became clear that from early on, infants explore their surroundings, respond to the language they hear and the faces they see, and that from the day they are born (and even already in the womb) they are able to learn.

**Novel Methods Revolutionizing the Field**

As such, maybe more profoundly than has been the case in other disciplines, the development of novel research methods has transformed the field of infant studies - and it still does. I was lucky that right when I was taking my first baby steps as an infant researcher, I had a PhD supervisor who encouraged me to employ a method with my little participants that until that time very few people had been crazy enough to try: eye-tracking.

Eye-trackers back then were large machines to measure adults’ eye movements in cognitive psychology research. Participants had to sit as still as possible, often using a chin rest, and attentively watch a long series of mostly static stimuli presented to them. If you imagine a young baby in such a setup, you see many difficulties would arise - and so did we. But together with the labs of Dick Aslin and Scott Johnson, in Rochester and Cornell at the time, and Claes von Hofsten in Uppsala, we managed to develop a procedure that used a remote eye-tracker that - thanks to some adaptations - could cope with
the natural movements of the babies. The babies were not hindered by any equipment on their bodies and we could measure where they were looking without them even realizing.

In my very first baby study, I then examined how infants as young as six weeks of age explore their mother’s face while she is talking to them in a natural manner. Until that time, it had been thought that very young babies are not able to learn much from others’ faces as they are unable to direct their attention to the important, most informative internal features of a face. However, unlike what had been thought so far, we could show that even very young infants look at the most informative features of faces. This likely enables them to learn about people, their feelings and about language from early on.

Eye-tracking with infants was a large step forward not only because we could now study how infants look at their surroundings. It also opened the way for developing new paradigms to measure what babies expect to happen in certain situations. As an example, I will show you a study we conducted here in Nijmegen. In this study, we asked whether infants already have some knowledge about everyday objects. We presented infants of different ages with movies of a person who was using several objects, like a cup or a mobile phone. While infants were watching these movies, we measured their eye movements and paid attention especially to whether infants would already anticipate with their gaze how they expected the action to unfold (see Figure 1). Like
this, we were able to show that infants as young as 6 months of age expect the cup to be brought to the mouth (rather than another part of the face) and a mobile phone to the ear.

Does this mean that 6-month-old babies know what drinking is or what making a phone call is? Not necessarily. But it demonstrates that from early on, infants look at their environment and the people in it with great attention. They observe others and start to predict the course of others’ actions based on these observations.

Taking a closer look

I started out my talk with a brief history of baby research. You heard how babies were initially regarded as little more than vegetables. Novel ways of studying babies and new research insights changed that. Starting in the 1970s, infants were now seen as “competent” in their own way. A wonderful example of how the idea of the “competent baby” resonated also in the work of practitioners comes from the book “The Amazing Newborn”, first published in 1985. In impressive black-and-white pictures, Marshall and Phyllis Klaus show how well-equipped, attuned, and responsive even newborn babies are. The series of photographs in Figure 2, for instance, depicts an infant of only a couple of days old engages in an intimate, reciprocal face-to-face interaction with his grandfather. From: Klaus, M. H., & Klaus, P. H. (1985). The Amazing Newborn. Addison-Wesley Longman.
a couple of days old engaging in an intimate and reciprocal face-to-face interaction with an adult. We get to observe how this only 9-day-old boy looks attentively at his grandfather’s face as he is talking to him. We see how the two are looking at one another and how the little grandson even reaches to touch his grandfather’s smiling face.

**LITTLE BABIES - BIG KNOWLEDGE?**

However, maybe the idea of the competent infant, the notion that infants come into this world equipped with all types of skills and knowledge might have been taken too far by some during the last decades, or at least much further than might be reasonable to assume. Many skills that we see emerge in an explicit fashion only in later childhood, as part of an intricate developmental process, such as the understanding of numbers and magnitudes, theory of mind, or morality, to name just a few, now have been studied in babies. As such, it has for instance been claimed that infants in their first year of life can do addition and subtraction of small and large numbers, that they understand what others can know and what they cannot know, and that they can even tell right from wrong from the first days of their lives. There are many infant labs all over the world working on finding indications of complex cognitive and social-cognitive skills in younger and younger infants.

In my view, this is worrisome. In that, I agree with Yale developmental psychologist and historian of science William Kessen who warned that “demonstrating the splendor of the infant’s mind” seemed to have become a “race” and the “central task of the developmental psychologists who watched babies”. But why is this problematic? I think that there are two main reasons: First of all, when these studies were repeated, often they yielded different results. Actually, we now see a torrent of failures to replicate many of these spectacular findings. At other occasions, researchers might have interpreted babies’ looking behavior as an indication of a certain ability, whereas there were simpler explanations available. This is the case for the examples I just mentioned, but it is also something we encounter frequently in many areas of our work on the early development of social cognition.

Let me give you an example. When we, for instance, first asked the question how infants get to understand what others are doing, one answer we found in the literature was that they have an early emerging capacity to assess the efficiency of another person’s action. The leading idea was that infants just know the most efficient thing to do in a certain situation and that this helps them to predict and understand what others are doing. To put to the test this dominant assumption at the time, we designed a study in which a little cartoon cow could choose between an efficient (short!) and an inefficient (longer!) path to get to his friend the sheep on the other side. Again, eye-tracking helped us here, because with their gaze, infants showed us which of the two routes they expected the cow to take. Interestingly, we found no indication that
9-month-old infants expected the cow to act in an efficient manner - so to go for the short path whenever possible. If anything, it seemed most likely to them that the cow would keep on doing what it had done before - if it had taken the long path repeatedly, they predicted that it would take it again. Only after these and several more studies in which we showed that there was actually little convincing evidence for an inborn or early emerging efficiency bias, could we move on to study the real question of how infants get to understand the actions they observe in others.

And this brings me to the most important reason why I look critically at research efforts that are primarily aimed at finding traces of a certain skill in younger and younger infants. They obstruct the view on what actually should be studied, which is development. Describing what is there at what month in early infancy is not the same as understanding developmental change. Rather we should be posing the question how a novel skill can come into existence and how it transforms as development progresses.

What are the developmental prerequisites for it to emerge and what are the learning mechanisms that it is based on? If we want to make progress, we need to move from mapping development to understanding development, from chasing traces of capacities in younger and younger infants to uncovering developmental mechanisms that drive the changes we see.

UNDERSTANDING THE DEVELOPMENT OF NOVEL SOCIAL-COGNITIVE SKILLS

Again, let me give you an example from our own research on the development of action understanding. I showed you already that infants of only a couple of months old predict the course of an action they observe, for instance actions performed with a cup. The interesting question now is: how do babies get to make these predictions? What are the mechanisms that underlie the development of action understanding?

In order to look at the target location of an action that you see unfold, you need some kind of internal model that generates a prediction about where the action will end. A recent popular theory is that our own motor experiences, so the representations of actions we have performed in the past, feed into models to predict actions that we observe in others. It has even been suggested that we can only perceive and understand in others what we can do ourselves. So according to these ideas, every new action babies learn should provide them with the ability to predict this action also in others, because there is now a rich, multi-faceted representation of this action stored in their neural motor system.

We tested this hypothesis by examining two groups of infants: babies who could crawl but not walk yet and babies who could already walk. Those two groups of babies watched movies of other babies as they were walking and crawling. When we measured the infants’ brain activity while they were watching these videos, we indeed found that the motor areas in their brains became more active when they saw an action they could do themselves compared to one they could not do yet. But were they also better in predicting the actions they had experience with?
In a next study, we modified the stimulus videos by adding an occluder, so that the moving baby was first visible for some time, then disappeared, and then reappeared from behind the occluder. Again, we measured the babies’ eye movements, this time with the goal of assessing how well-timed their visual predictions were. You can see the results of this study in Figure 3. The closer the values are to the horizontal line, the better our little participants were in predicting the reappearance of the baby from behind the occluder: Infants who were proficient crawlers but inexperienced walkers were more accurate in visually predicting the timing of other infants’ crawling compared with walking. Babies who were experienced in both walking and crawling performed equally well for both observed actions. It thus appears that active experience with actions provides young children with internal models of these actions so they can start to predict them in others.

![Figure 3](image_url)

Figure 3: Results from a study in which we measured babies’ eye movements with the goal of assessing how well-timed their visual predictions of the walking and crawling movements of other babies were. The horizontal line represents the moment when the baby shown on the screen reappeared from behind the occluder and the values indicate the latency of the first look there. Adapted from: Stapel, J. C., Hunnius, S., Meyer, M., & Bekkering, H. (2016). Motor system contribution to action prediction: temporal accuracy depends on motor experience. *Cognition, 148*, 71-78.

But if we think back about our initial findings, that already at the age of 6 months, infants anticipated with their gaze that a phone is brought to the ear and a cup to the mouth - this is of course long before the age at which they can actively use cups to drink from and mobile phones to make calls. This means that babies must also be able to learn to predict actions in other ways. From their earliest days on, infants observe other people’s actions in their environment. Imagine a young baby sitting at the breakfast table with his father. Every morning during breakfast time, while sitting in his infant chair, this little boy observes his parents’ behavior, such as how his father is drinking from his cup. So maybe the baby just learns to predict what his father is doing based on his repeated observations.
However, that might not be as easy as it sounds. After all, most daily actions do not occur in an isolated fashion, but for babies, they must look like a long, confusing stream of events (see Figure 4). Even when observing a relatively simple situation at a breakfast table, there are not always clear cues to tell us what the person we are watching will do next. However, within the intricate series of actions, certain actions are very likely to follow one another: If the baby sees the hand grasping the cup, it is very likely that the person is going to bring it to the mouth to take a sip of tea. As such, action sequences, like many other types of sequences in our environment, contain statistical regularities. We know from previous research that humans, including young infants, are very good at detecting such regularities in visual and auditory sequences, an ability that is called statistical learning. Whereas it has been studied mainly in the context of language acquisition and perceptual development, we wondered whether it might also be one of the mechanisms underlying the emergence of action understanding. So can babies pick up such regularities and use them to predict actions they see in others?

To test whether statistical learning indeed plays a role in the emergence of action prediction in infancy, we invented a toy on which six unique actions could be performed. With this toy, we created videos of an experimenter performing long continuous action sequences. Hidden in this action sequence, there was a statistical regularity. A certain action was always followed by a specific other one - just like in the breakfast scene.

Figure 4: An illustration of how most daily actions do not occur in an isolated fashion but within a long, intricate stream. However, within the complicated series of actions, certain actions are very likely to follow one another, like grasping the cup here is always followed by it being brought to the mouth.
grasping the cup is always followed by it being brought to the mouth. These two actions thus formed a pair, with the one being predictable once the other one had occurred. If young children are able to extract such regularities, they should at some point start predicting the second action of the pair before it occurs. And this was what the infants in our study did: they learned these action pairs and made predictive eye movements to the correct next action in the sequence. Once the babies learnt to predict the next action of the sequence, they also showed predictive brain activation in their neural motor system. Visual statistical learning skills thus do extend to the domain of action and are a mechanism that allows infants to learn to predict, and ultimately understand, the actions of other people. Our next steps are to explore whether statistical learning and bootstrapping may lie at the basis of many more social-cognitive abilities that emerge in infancy and early childhood, and how they contribute to intricate skills such as understanding what others are feeling and thinking.

Looking across the borders of the field: fundamental developmental science has direct practical implications

Maybe you are now thinking: Well, this is all quite interesting, but why do we really need to know all this? Do any of these insights actually make the world a better place for babies? If you are, you are not alone. During the recent years, we have seen a shift in public opinion and science policy in the Netherlands. Increasingly more importance is attached to applied research that aims to find concrete solutions to practical problems, assess interventions, or find treatments for disorders, while less resources are being allocated to fundamental research. However, it is important to realize that, especially in the field of infant studies, exactly this type of fundamental research aimed at just understanding development better has crucial implications: for the work of practitioners, and for the lives of parents and their babies.

Research has shown that parents who know more about infant development are more sensitive during interactions with their babies and better able to stimulate their child’s development. Therefore, it is important to teach parents about how babies develop. If parents learn amazing facts about their infants’ psychological development, this changes how they look at their children. If you have learned, for instance, how attentively a baby of only a few months old observes the people in her environment, you might start to interact with your baby differently. If you know that babies learn about language long before they say their first words, you might talk more to your baby early on. This is why I think it is crucial to give parents knowledge about their babies and about how babies learn, to make them more attuned and mindful parents.

Moreover, the knowledge yielded by the fundamental infant research of the last decades has provided the scientific foundation for an international movement that is grounded in the increasing realization that the basis of normal and abnormal cognitive and psychosocial functioning in later childhood and adulthood is deeply rooted in the
development during the very first years of life. This insight has recently been expressed in the international manifesto “1001 Critical Days”. It emphasizes that the time up to toddlerhood has more impact on children’s later health, success and well-being than any other period during their life and stresses that the earliest period of child development is a window of opportunity to “get things right”. This and comparable movements have raised societal awareness and made possible many large national and international prevention and intervention programs, for instance to strengthen new parents’ educational competences, support families at risk during pregnancy and the first years with their children, or prevent malnutrition during the early crucial period of brain development. The results of fundamental developmental research thus have a direct impact on infants’ quality of life in many ways.

Achtung Baby! Exciting Times for the Field of Infant Studies

When you read the title of today’s lecture, you maybe wondered what it was supposed to mean. Did I choose it to tell you that I am a huge fan of U2 and the album they recorded in Berlin just after the wall came down? Or did I want to honor Mel Brooks’ satiric movie “The Producers” that these words are a quote from? No, neither of those. It is an expression of my excitement about some recent developments that in my view can push our understanding of infant development further.

At the interface of developmental psychology and cognitive neuroscience, a new discipline has emerged that is devoted to understanding psychological processes and their neurological bases in the developing organism. Developmental Cognitive Neuroscience is an interdisciplinary scientific field that studies the interrelations between neural and cognitive development and examines how the mind changes as children grow up. Combining theoretical approaches from cognitive science and developmental psychology provides the field of infant studies with new perspectives. More than ever before, the focus has moved to understanding the initial makeup of the human mind, discovering the processing and learning mechanisms it is equipped with and uncovering how these mechanisms bring about the developmental changes we see in early childhood.

Research techniques from cognitive neuroscience can help to yield novel insights about early development. I have already talked about how the use of eye-tracking has changed infant research. During the past few years, there has been a movement among infant researchers to find ways to employ more neurocognitive methods with infant populations, like EEG and fNIRS. Together, these techniques offer the opportunity to examine infants’ neural and behavioral development more precisely than has ever been possible before.

However, these complex, sensitive research tools were originally not developed for use with a vulnerable and often non-compliant population, and intricate adaptations are required. Moreover, applying neurocognitive methods to date has bound us to stu-
dying children within restricted, artificial laboratory contexts. Studying development in such highly constrained situations involves the risk of producing knowledge that is only marginally relevant to the real-life phenomena one is actually interested in. Fortunately, recent advances in wireless technologies provide us with unique opportunities. In the future, we will be able to literally unleash the children we study – to free them from the cables and constraints associated with the previous lab-based methods and examine increasingly more naturally-occurring interactions.

One example of this is the precise study of movement kinematics during teaching and learning: Imagine you have to teach a one-year-old how to use a novel toy that can make a rattling sound if you shake it. How would you do that? Probably you would demonstrate it to her. But interestingly, you would not just show her the movement like you would show it to an adult. When adults teach something to a young child, they actively adjust their movements in certain ways. They tend to repeat demonstrations more often and demonstrate action-effects for longer when interacting with their infant compared to an adult. We can now register exactly the kinematic adjustments adults make to convey information and then assess which of those are picked up by infants of different ages and how they influence infants’ learning of a novel action. This will help us understand what combination of cues from an adult - and which interaction patterns between the infant and the adult - are associated with optimal learning, remembering and later imitation.

Although the field of infant studies thus benefits strongly from the introduction of novel experimental methods, it is important to realize that not all our questions can be answered solely empirically. Also in this respect, the cognitive sciences have influenced our field, as cognitive modeling and developmental robotics have become increasingly important. Here, theories of human development are implemented in a computer simulation or robot - a babybot. In a recent instance, it helped us to examine which cognitive architecture must be in place to produce a certain behavior. From previous research we know that a young baby will move more when you connect his hand to a mobile with a string. Within developmental psychology, it has been assumed that this behavior of moving more is a clear indication that the baby has acquired a sense of agency, so that the baby knows he is causing the mobile to move. However, we were surprised that our little babybot showed the behavior of moving more in response to the mobile also with a much simpler cognitive mechanism implemented in it. As such, using computational modeling can critically help developmental scientists to explicate their theoretical assumptions, put them to the test, and to generate new predictions which in turn can be tested empirically.

The interaction of infant studies with cognitive science and cognitive neuroscience does the field a lot of good and offers great potential for the future. However, not only does the study of development profit from a close connection with the cognitive (neuro-)sciences, it also works the other way around. In my view, we will only
understand the human brain and mind if we also understand its development. The study of development is crucial because the initial set-up of the human mind and the learning mechanisms it is equipped with provide important information about how the adult mind can be organized.42 Also, a developmental perspective provides a benchmark for every cognitive theory. A valid model of any cognitive capacity must be developable, that is, it must allow for an explanation of how the capacity comes into existence in a graded manner as a result of learning mechanisms or maturational change.43 As such, the exchange between developmental science and the cognitive neurosciences adds novel theoretical perspectives to both fields.

EPilogue

In 1970, three of the founding fathers of modern experimental infant studies wrote a 160-page handbook article on human infancy.44 At the end of their chapter, William Kessen, Marshall Haith, and Phil Salapatek drew a rather sober conclusion, as to them the reviewed studies were “a strange mixture of false starts, wise guesses, tedious documentation, clever design, and a few insights that hold hope.” And they go on: “Comforting and frustrating, the complexity of the infant continues to mock the simplicity of his students.”

Although they wrote this conclusion nearly 50 years ago, and we have attained so much in the meantime, this sentence holds some truth for the current situation of our field. The topic under scrutiny - the infant and her neural, cognitive and social-cognitive development - is a thorny one. Certain paths we have taken and discussions we have led during the last decades were dead ends. However, I hope I could show you today that there are plenty of novel, exciting research avenues that promise real progress in understanding the complex dynamics of early development.

So: Achtung Baby - here we come!

Acknowledgements

I would like to finish this inaugural speech by expressing my gratitude to several people without whom I would not be here today. First of all, I thank the college van bestuur of Radboud University, the dean of the Faculty of Social Sciences, Michiel Kompier, the director of the Donders Center for Cognition, Pieter Medendorp, and the director of the Teaching Institute for Psychology, Ruud Meulenbroek, as well as the NWO Westerdijk program for making my professorship possible.

Working at the Baby & Child Research Center (BRC) is an incredible privilege. This unique research initiative spans different faculties and research institutes and brings together a lively multidisciplinary mix of researchers on a quest to unravel the mysteries of early development. I thank my co-PIs in the BRC, Caroline Rowland, Paula Fikker, and Carolina de Weerth for shaping this amazing research center together with me. I am also immensely grateful to our lab managers Angela Khadar and Patricia
Manko who are the beating heart of the BRC, as well as to the technical support group who solve all the large and small problems that occur when one tries to apply complex sensitive research techniques to tiny babies and rambunctious toddlers. Also, all our research would not be possible without the enthusiastic parents of Nijmegen and Arnhem who participate in our studies again and again with their children.

I would like to thank my lab - the BabyBRAIN group. They carried out many of the fascinating studies you heard about today. Working with these remarkable young researchers is wonderful and exciting. I learn from you and with you every day. And of course this includes also the “old” BabyBRAINers, the young researchers who left the lab after finishing their PhD or postdoc. Seeing you continue your careers so successfully all over the world makes me very happy and also a little bit proud. I am also really moved that so many of you are here today.

I spent my own infant years as a researcher in Groningen, and I am deeply grateful for everything I learned there. My supervisor, Reint Geuze, taught me the basics of doing research and has always been a great model to me in his unstoppable scientific curiosity. From my promotor Paul van Geert I learned to think about mechanisms of developmental change, and my second promotor Anke Bouma awakened my interest in the brain.

I owe a lot to Claes von Hofsten and Kerstin Rosander from Uppsala University. Their theoretical thinking has greatly influenced my work. I also especially enjoyed the open, creative and collaborative atmosphere in their group that made me realize that if I was ever going to have my own lab, that was how I wanted it to be.

I am also extremely grateful to Harold Bekkering, whom I got to know as the father of one of the little participants in my very first baby study at the University of Groningen. Little did I know that he was also a cognitive scientist and famous professor, and that he would become such an important mentor to me. The decision to come to Nijmegen and work with him was one of the best I took in my career. Thank you so much for everything.

One of the great things about research is that you get to collaborate with people who are so much smarter than yourself and who teach you all these exciting novel things. The Donders Centre for Cognition and the Donders Institute as a whole are unique also in that respect. When I started listing the Donders colleagues with whom I have had inspiring collaborations over the last years, I realized that thanking each of them individually would keep us from having drinks for at least another hour. So I would like to confine myself to thanking all my wonderful Donders colleagues for the pleasurable and exciting collaborations. Of course, I extend my thanks to my collaborators in the Behavioral Science Institute and the Max-Planck-Institute for Psycholinguistics as well as at other universities in the Netherlands and abroad.

Often, I am asked what a baby needs to be happy. My answer is always the same: A loving and stimulating environment. If one thinks about it, this is not so much dif-
ferent from what an adult needs for a happy life. I would like to thank my friends and my family - the Dutch and the German one - for providing such an environment for me - it means a lot to me. I am very happy that so many of you came to Nijmegen today from near, far, and really far. I am especially grateful that my parents can be here today. They have always encouraged me to follow my interests and passion. And I would like to thank Jacques Dane who supported and helped me in so many ways that I don't even know where to start. Dankjewel.

Finally, I would like to thank you all for being here and for your attention.

Ik heb gezegd.
https://www.darwinproject.ac.uk/people/about-darwin/family-life/darwin-s-observations-his-children


The book “The Care of The Baby” was published originally in 1895. The quote stems from the 1918 reprint of the revised edition of 1915 (p. 47-48).


Even the well-known Dr. Spock whose 1945 “Common Sense Book on Baby and Child Care” was groundbreaking and progressive in encouraging a loving, gentle approach to caring for young children, still warned parents not to expect too much of what might be going on in their baby’s mind: “He doesn’t know yet that you are a person or that he is a person. He’s just a bundle of organs and nerves during his first month.” (p. 182).


It is an interesting question in itself why researchers seem to have become increasingly inclined to attribute highly complex cognitive skills to infants. It has, for instance, been suggested that this trend is a response to the paradigm shift that occurred in the field of infant studies in the 1960s (Kessen, 1993), a consequence of a lack of truly developmental thinking (Haith, 1998), or the impossibility of accepting null results given the exceptionally laborious, complicated, and expensive empirical research with babies (Peterson, 2016).


Van Geert, P. (1998). We almost had a great future behind us: The contribution of non linear dynamics to developmental science in the making. *Developmental Science, 1*, 143-159.


https://theconversation.com/we-should-teach-parents-about-how-babies-develop-not-how-to-be-parents-53126


For the Dutch initiative, see http://www.psynip.nl/themadossiers/1001-kritieke-dagen.html

See e.g., http://www.fruehehilfen.de/bundesinitiative-fruehe-hilfen/

In the Netherlands, the program Kansrijke Start was launched by the Ministry of Health, Welfare and Sport in 2018, see https://www.rijksoverheid.nl/documenten/publicaties/2018/09/12/actieprogramma-kansrijke-start.

https://thousanddays.org/


One example of a theory that in its present state is very limited in how it can account for developmental change is predictive processing. This might at first sound contra-intuitive, since cognitive change and learning is at the heart of the theory: According to the predictive processing view, the brain is a prediction machine that is constantly generating, evaluating, and updating predictions about sensory input it receives of the world. Whereas predictive processing can account for incremental change, large qualitative developmental changes, such as the formation of novel predictive models, cognitive reorganization, and changes in how learning occurs, are more difficult to conceptualize within the theory. If predictive processing aims to be a true ‘theory of everything’, then it needs to be enriched with a theoretical explanation of how generative models come into existence and how they can change during development.
