CHAPTER 2

Imitation and the Generative Mind

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This chapter describes challenges of proposing a different understanding of a well-known phenomenon, imitation (and its development in young children). The first challenge was to study imitation as a shared motor activity in a two-person perspective, instead of as a solitary tool for learning or forming mental images. A related challenge was to analyse imitation as a multifaceted phenomenon involving a hierarchy of mechanisms according to what, when, and how you imitate. This led to challenging the assumption that people with autism spectrum disorder cannot imitate and claiming, "Yes, they can!" Finally, hyperscanning two brains during synchronic imitation allows assessment of interbrain synchronization. From this an ultimate challenge emerges: to see imitation in its substitutive role as a multiplier of symbolic creations in a two-person generative mind. More generally, I explain how such a perspective builds on the philosophical framework of Henri Wallon that I encountered early in my career and that stood in opposition to the then-prevailing Piagetian paradigm.

Initial Interest in the Field

In my final high school year I developed a strong interest in philosophy, particularly the part dealing with what, in the 1970s in France, was called psychology. Indeed, there, psychology was not yet a discipline per se, and the influence of Auguste Comte, working against subjectivism and articulating positivism, remained strong. "You cannot stay at your window to see yourself passing along in the street," he said. Earlier, Comte's approach had questioned how to consider relationships between feelings and the mind, paving the way for psychoanalysis. In the 1940s, though, a philosopher and neurologist, Henri Wallon, was the first professor to teach at the renowned *College de France* in Paris with special attention to child psychology and education. Gradually the buildup of the discipline was being institutionalized, but the process remained troubled by the question of its unity and

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thus its core subject matter. And there I was in my mid-twenties, hesitating between studying young children's minds with Piaget or young children's feelings with Freud.

I had, in fact, the privilege of attending courses by Piaget at *La Sorbonne*. He used to read his courses without a glance at the students and would, at a certain moment, look at his clock and stop reading, sometimes mid-sentence: it was time to leave and get the train for Geneva! The reading resumed the following week, picking up exactly where it had previously stopped, even if that meant resuming mid-sentence. Fine, Piaget was a bright thinker, but his social skills were found wanting. He failed to engage his audience – *Why* study "epistemic" children instead of real living ones? Fortunately, at the Sorbonne there were also courses by disciples of Henri Wallon (1938, 1942) like René Zazzo, which is how I heard another story about human development, wherein newborns emotions are first and guide social and cognitive development. That absolutely corresponded to my interest in early communicative development. Incidentally, and without knowing it, I had elected a difficult path.

Substantive Shape of the Field and Embeddedness as a Guide

How to be a young French developmentalist in the late seventies but not a member of the Piagetian Centre of Genetic Epistemology? For several reasons this was not a comfortable position at all – all my friends and colleagues in the field were Piagetian; all the thematic proposals to receive funds were Piagetian themes; and the situation in the realm of developmental psychology in France was that of a great debate between Piaget and Wallon.

While Piaget was a Lamarckian, Wallon was a Darwinist. Following Darwin, Wallon's view was that the main milieu for humans, in particular, human infants, is the milieu of other humans. Wallon considered that "to study human beings apart from society is to dissect their brain." "Indeed," he added, "there are entire areas of the brain operating exclusively on social targets" (Wallon, 1938*).* This visionary statement preceded by forty years the discovery of the "social brain," a set of richly interconnected cortical structures all devoted to the processing of human stimuli. You can easily imagine the break with Piaget's theory in which children develop based on their own actions, and early exchanges are with the physical environment. By contrast, Wallon was focusing on individual adaptation based on the development of interactions with the social milieu. His thesis was that infants' first exchanges with their environment are emotional exchanges,

through a direct empathic correspondence. This, for me, was the source of a commitment to explore how human development is fundamentally socially embedded.

Rejecting the solipsistic study of epistemic subjects, I started a PhD thesis aimed at testing the role of imitation in social development. I became a member of the *Laboratoire de Psycho-Biologie de l'Enfant*, founded by Wallon and now directed by his disciple Zazzo, my thesis supervisor. Coincidentally, in the same building, two floors below, was the laboratory of cybernetics. Aware that cybernetics was challenging the theory of information processing, I was curious to find out more about how that overall framework viewed social interaction and started attending their weekly seminar. There I discovered Wiener's theory of communication in natural and artificial systems and started to translate the general notion of "social context" into a more precise definition of *social interaction as a bidirectional loop between partners*.

That is why my first studies of early imitation did not concern its role in the development of mental images from a Piagetian perspective but, rather, were focused on its role as a *shared motor activity in a social context*. The studies were all situated in kindergarten where a room was reorganized with the same design and format replicated across several kindergartens: the field laboratory. Note that this is not the approach of human ethology, which considers, for example, kindergarten as a natural niche only to be described. Rather, we introduced parameters allowing for the test of hypotheses. The dyads of young preverbal children were organized without an adult present, to preserve toddlers' behavioral spontaneity. The room was reorganized with dual sets of objects to test a Wallon-prompted hypothesis that a primary way to communicate with others before language is to share the same motor purpose, what we translated as imitating synchronously.

That is precisely what I saw: preverbal toddlers aged from eighteen to thirty months, interacting freely with a peer without the lead of an adult, widely engaged in imitation, and doing so in a unique way. Without being taught, they took advantage of the fact that imitation is dual-faceted: we can imitate but we can also be imitated. These two facets constitute two roles that can be traded. Toddlers follow an implicit code for role switching when the model accepts to take a dual object offered by the imitator; the imitator thus becomes the model. This simple strategy is the prelude to a conversational use of social cognition.

Introducing a number of variations on this basic dyadic setting and observing how the children interacted, we concluded that synchronous

imitation offers the most efficient means of joint attention and joint action for preverbal children. Also, when the experiment was extended with the same design to older children aged around forty-two months, it was obvious that dual objects were no longer a matter of interest to them: because the means of communication had changed, the scenarios were symbolic ones, with or without objects. Language now offered the wonderful capacity to communicate about imagined past, present, and future. Older children are verbal partners. For them, the communicative role of synchronous imitation is no longer useful.

To me, such findings generated ipso facto four comments:

(1) There exists a form of imitation extensively used by toddlers, and this is *spontaneous imitation*; in contrast, all conventional imitation scales and experimental designs are based on forced imitation.
(2) Spontaneous imitation has a specific form that includes the three main parameters of any communication: synchrony, turn-taking, and joint attention.
(3) The specific form of spontaneous imitation, compared to observational learning or pantomime, means that imitation is not a unitary phenomenon – evidence that experimental designs and descriptions of imitative deficits in autism tend to ignore. As a matter of fact, the answers to three questions – imitate when, imitate what, and imitate how? – suggest there are several forms and functions of imitation requiring different components of executive functioning that result in different brain activities.
(4) Imitation is vicarious in its functions, some forms disappearing and others emerging in the course of development, a pattern that is one index of human plasticity.

Note that the conception of imitation as a complex phenomenon emerged at the beginning of the 1980s when Andrew Meltzoff had just started to demonstrate the existence of neonatal imitation. His demonstration helped draw attention to imitation as a "like me" phenomenon along with other more classical definitions, and added the kind of imitation I described as an early developmental milestone, where the alternate use of the two facets of imitation – imitate and be imitated, the synchrony of production and reproduction – and the sharing of a topic make it a genuine preverbal communicative system, as defined by Jerome Bruner (1982). And all this work laid the foundation, a few years later, for "rehabilitating" long-ignored immediate imitation via a volume I co-edited with George Butterworth, the first book entirely devoted to imitation in infancy.

Climate Change: Toward a Two-Person Perspective with New Paradigms and Inspirers

Thanks to Wallon's theoretical inspiration, I was already studying imitation as a two-person system with a two-person design of dual objects, while the climate in developmental psychology was rapidly changing. The methodological revolution of the "psychological baby boom" had revealed newborns as active, selective, and discriminative partners. T. Berry Brazelton's group advocated the competence of young infants as active partners in mother-infant interactions. The mother-infant situation started serving as a methodological paradigm for the conception of a "two-person" psychology, widely adopted since. Introducing the concept of co-regulation, Alan Fogel linked the dyadic perspective advocated by the Brazelton group and the theory of dynamical systems, included in the cybernetic perspective. Within this framework, the telegraph model inspired by the theory of information processing, where the decoding of the message engages each interlocutor individually and successively, is replaced by the orchestra model, where the partners "play" their performance simultaneously. The orchestra model fits particularly well the synchronous aspect of imitation as a communication system. Further, the concept of intersubjectivity developed by Colwyn Trevarthen offered the opportunity to deepen the Wallonian analysis of imitation as a vehicle of synchrony.

And there were parallel events and advances. An international symposium in 1991 was an opportunity to meet Luigia Camaioni and co-edit a book on new perspectives on communication development. In line with dynamic systems theory, the enactive account focused on synchronization as a key principle in cognition. Synchronization, as co-regulation of tempo, is considered one of the most pervasive non-linear phenomena observed in nature. In the same spirit, researchers began arguing that interaction is central to understanding social cognition. And here was imitation as a communicative system. Brazelton's group demonstrated the capacity of infants as communicative partners through two-person designs: the still-face procedure and a system of two videos allowing each partner to see and hear the other. The system of two videos was temporarily built by the BBC for Colwyn Trevarthen and Lynn Murray to test the emotional regulation of interaction between infant and mother. Once the experiment was done, the system was deleted.

My research team perfected the design and built a double video platform where we could present continuously to the infant the mother's behavior,

sometimes contingent and sometimes noncontingent (i.e., when the mother's image was desynchronized). All infants aged eight weeks reacted negatively to their noncontingent mother and avoided imitating her. The double video platform was replicated by, among others, Vasu Reddy, to study infant response to their desynchronized *self*-image, and by Tiffany Field, with whom we developed two parallel experiments involving depressed mothers, one in Miami and the other in Paris. We also used the double video in our two-person brain scanning procedures.

Clearly building on Wallon's theory with additional theoretical and experimental perspectives, I came to be part of the subfield that framed two-person perspective and participated in numerous symposia. I invited major contributors in the field to an international conference in Paris and a book on emotional development co-edited with Darwin Muir was published in 2005.

At the same time, in neuroscience, Marc Jeannerod and others were developing knowledge of the neural coupling of action, the simulation of action, and the observation of action: the fact that doing, imagining doing, and observing doing recruit the same brain activations. Thus, the brain activity of an individual "embodies" the presence of the social other. It is no longer possible to conceive of the brain as preparing and reacting only to the actions of the individual. Rather, brains react to what individuals see others doing in relation to what they can do. The concept of *shared representations* was born, in parallel and consistent with two-person neuroscience.

Impedimenta

While the two-person perspective spread widely in the literature concerning ordinary behavioral development, autism spectrum disorder (ASD) was still largely studied from a solipsistic, that is, isolated single-person perspective. Why not adopt our two-person procedure for nonverbal children with ASD? This was my naive idea. Naive indeed, as I rapidly understood that the literature was clear: persons with ASD do not imitate. Thus, I found myself in the foolish position of promoting the use of spontaneous imitation in people who cannot imitate! Nonetheless I persisted, struck by the claim that you can imitate, or you cannot, without any consideration of the basic question of what, how, and when. Moreover, autism is a test case for the evaluation of the two-person perspective as a model for social development. Since two-person situations involve a live other, it seemed reasonable to wonder what children with

ASD – individuals for whom social interaction and communication are fundamentally dysfunctional – are capable of in such settings. Judgments about the social use of imitation in ASD has usually been indirect through clinical evaluation of levels of imitation, or a homemade list of typical performances. Experimental designs have only explored the capacity to learn through imitation.

Imitation as a Communicative System in ASD and Advanced Role in Two-Person Neuroscience

To explore the use of imitation as a means of communication, a two-person perspective can be especially informative. Thus, in a series of studies we have used situations like those with typical toddlers. For example, dyads comprised of a child with ASD and a child without met in a dual object setting. We discovered that, in this context, children with ASD, even those who are nonverbal, *can and do imitate freely familiar, meaningful actions* – surely a potentially significant finding. But getting it published proved problematic.

Our first article was rejected because the dyads were not matched on developmental age! It's true – I did not organize sessions involving a two-year-old non-autistic infant and an autistic seven-year-old child with a developmental age of two! Instead, the autistic children were matched on chronological age with a partner presenting a mental deficit. To be expected by reviewers to match on developmental age, whatever the aim of the study, is like a ukase, in the sense of an arbitrary command! The fact that I am not an English native writer but a French one may also have played a part in the rejection, with French researchers seen at the time to be failing in methodological competency! In retrospect this seems obvious, in part because replications co-authored with Tiffany Field were published easily.

A second series of articles was immediately accepted. In those studies, the purpose was to evaluate the capacity of nonverbal children with ASD to recognize that they were being imitated. I revisited Ed Tronick's still-face design to examine, instead of the classical three blocks – Mom interactive/Mom still/Mom interactive again – another version: unknown still adult/unknown imitative adult/unknown still adult again. The results showed significant behavioral changes according to the block. Not concerned with the adult during the first still face, the autistic children became interested when they were imitated. Moreover, they tested their imitator's intentionality by varying their use of the dual object and controlling that the

imitator follows. During the second still face, they initiated positive social behavior to make the adult come back to an active state. If nothing else, this was a great methodological change in the way to question people with ASD: nothing like family questionnaires or solitary experimental designs involving solitary individuals. Instead, a live social situation that could have occurred in the course of their daily routine: that is, being ignored. Replications of the studies took place, one in Sweden and several in Tiffany Field's lab; all were successful.

Building on that research and during one of my visits with Tiffany, we designed a study whose aim was to evaluate parents' use of imitation in their everyday interactions with their ASD child. The study was structured in three blocks of six minutes: during the first block, one parent was asked to play freely with their child in a room set up with my usual dual objects (umbrellas, cowboy hats, sunglasses, dolls, balloons). The parent and the child were being filmed and I was watching them through a one-way mirror. We discovered that all parents tried to force the child to play with them, putting the hat on their head, telling them what to do with the balloon in an authoritarian style; and the children were trying to avoid the parent's demands. For the second block, the parent left the room and I entered. Without asking the child anything, I started to play with one sample of the dual objects on my own. (Trevarthen says I am a clown!) After a while, the children all took the corresponding dual object and started to imitate me, obviously relishing it (with the parent observing the episode from behind the one-way mirror). For the third block, it was the parent's turn again. It was pure magic to see them act differently – observe the child, letting them be free to behave, imitating them, awaiting their invitation to do the same in synch: a truly beautiful two-person interaction involving the mother or father. This, then, was akin to a wordless lesson where the parents showed how eager they were to do their best, as well as demonstrating how powerful *imitation* is as a nonverbal means of communication.

From that moment on I started to delineate a form of therapy where the alternation of roles is left to the child's initiative (i.e., a unique way of developing spontaneous imitation), in contrast with a behavioral change at the adult's initiative, as in the approach of my colleague Brooke Ingersoll. My resulting book (2014) was translated into English, then into Italian and Greek, and its Turkish and Spanish versions are in preparation. This goes to show how a study conceived in an informal setting underpinned by an agreeable international collaboration can steer a career.

In 2000, I moved to La Salpêtrière Hospital to supervise an interdisciplinary team focused on development: epigenetic neurocybernetics, developmental psychopathology, and social neuroscience. From neurocybernetic scholars I learned that turn-taking emerges from synchrony, and from us developmentalists neurocyberneticians learned that bidirectional synchronous signals lead to interaction via imitation. In this context of collaboration, we designed an "emotional robot" able to alternate imitating an autistic child and reacting to being imitated.

Our brain studies of imitation took place around the time of the discovery of mirror neurons by Giacomo Rizzolatti's team and were stimulated by that discovery. Indeed, thanks to this discovery we know that there is almost no difference in how the brain responds to performing an action and seeing the same action being performed. In this emerging overall framework, imitation was soon considered the critical phenomenon supported by the Mirror Neuron System (MNS). And moving one related step further, Marco Iacoboni and his colleagues described, in a series of papers, an "imitation network" where the MNS is activated twice, given that the individual not only observes, but also does what they observe. Our experiments showed similar brain activations when imitation was forced, but an activation of the dorsolateral prefrontal cortex involved in social cognition was added for spontaneous imitation. In other words, we had obtained a demonstration that different types of imitations exist, supported by different brain activations.

From that point on, many questions arose; for example, what happens in the brains of two subjects each observing the other doing what they feel they are doing? The imitation network could not answer that question as it was dealing with the solitary performance of one subject. And the answer remained out of reach for neuroscientists until the beginning of the second decade of twenty-first century. Then a fascinating technique was designed allowing a simultaneous scan of two brains: the best way to develop two-person neuroscience. But the use of the technique was still limited. Pioneers like Hasson and colleagues recorded social perception of the same scenario by two or more persons but did not record their social interaction. The obstacles arose from the fact that experimental constraints of neuroimaging are incompatible with the need to let people interact freely.

Attempting to overcome this limitation, our team transposed to a dual recording platform (our double video design coordinated with a double hyper-EEG recording) and started to hyperscan the brains of unfamiliar dyads while they freely interacted through imitating their hand

movements. And EEG hyperscanning indeed showed emergent brainwave synchronization in the two brains. Our team at La Salpêtrière Hospital was enthusiastic about these findings, but experts were not very open to the new technique and the processing of dyadic data; hence our difficulties in having the series of studies published in top journals. But we were simply too early, because the findings are widely quoted ten years on (Dumas et al., 2010).

In parallel with these developments, around 2010 the mirror discovery gained attraction and apparent success in the realm of autism with the thesis of the *broken mirrors of autism*: people with ASD do not imitate because their neurons do not mirror what they see others doing. Did you say they therefore do not imitate? My view: most importantly, *imitation is not a unitary phenomenon*. You can have the capacity to imitate some things, and not others. Nevertheless, numerous excellent neuroscientists rushed to potentially explain the origin of autism through dysfunctional neurons. They compared activations among ASD people during action and during action observation, claiming that neuronal activations are poor during their observations. However, other studies find normal activation of the Mirror Neuron System during action observation or during the suppression of the μ (EEG equivalent). And our own work shows that it is the inhibitory control of the action that is the problem, not the engagement of the mirror system. Many other current works offer a refutation of the thesis of broken mirrors; they also minimize the role of mirror neurons in social cognition.

So, nowadays, we do not hear much about the theory of broken mirrors, and Cecilia Heyes has mischievously asked: "What happened to mirror neurons?" On a related note, and returning to my main theme, some authors, such as Smith and Bryson (1994) or Fournier and colleagues (2010), now consider that difficulties in reproducing gestures and action sequences are also common in diverse types of neurodevelopmental disorders. A difficulty in imitation would therefore not be specific to autism and would not affect all types of imitation! At last, I can say "Yes, they can!" and not be a solitary voice.

Designing the Subfield's Future

Cognitive neuroscience has shown that besides perception-action coupling (*seeing doing and doing*), another remarkable phenomenon is of particular interest as a tool for development of a productive imitative mind: doing and *imagining* doing. Performing an action or to imagine performing it: What is

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the difference for our brain? In articles several decades ago (around 1995), for example, Jean Decety and Marc Jeannnerod demonstrated that imagined movements are subject to the same motor control rules as movements that are actually produced. It is therefore for the individual alone to imagine actions that they have already produced, imitated, or perhaps have never produced but constructed, based on actions stored in their repertoire. This astonishing brain capacity is doubtless a valuable tool to develop a generative mind, not only as a solitary strategy to experience things that one does not live, but also to experience, via shared motor representations, what others experience.

In the future, as brain techniques rapidly evolve, hyperscanning with wireless near-infrared spectrography (NIRS) that is available for investigations of infant and children with ASD will enable brain-to-brain investigations on how two young minds process, imagine, and share simulations during free live interactions. We will know more about how the brain and mind cooperate in ASD (and other conditions).

Developmental psychology will also be considerably enriched. We always try to imagine what the other imagines, but the interesting novelty here is to reason from a two-person perspective, to see the generative mind not as the creation of an individual but of the system composed of a dyad or a group. The by-product is not a simple addition of two generative minds but something qualitatively different emerging from the interaction, with imitation in its substitutive role becoming a multiplier of symbolic creations. In our hyperscanning studies, a bidirectional coupling emerged between participants, that is, the behavior of each influenced the behavior of the other, and interbrain synchronization reflected their cognitive enrichment. Such synchronization may facilitate the transmission of information between two interacting brains in much the same way that communication occurs between interacting regions of a single brain. For this reason, hyperscanning is the future of social neuroscience and imitation is a powerful basis for a beyond two-person generative mind.

For Future Generations

In light of my own career, full of impedimenta and obstacles but also rich in conceptual additions and innovations, I have no advice to give to future generations, merely this recommendation: live your research as a scientific adventure where experience is the best guide; go ahead, be curious about what other colleagues do, even in different fields (this facilitates methodological and maybe even theoretical and epistemological transfers); do not

avoid impedimenta as they are the best impetus to knowledge; and above all, do not accept ideas a priori: facts can indeed defy theories.

Suggested Reading

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