

WEEKEND

How do we become human beings?

The experiment was simple: Mothers of preemies were asked to hug them, skin to skin. The impact on their lives 20 years later was dramatic. A first, wide-ranging media interview with neuroscientist Ruth Feldman, whose research focuses on the biological basis of the creation of social bonds

Dani Bar On

Just before the interview with Ruth Feldman began, her research associate Orna Zagoory-Sharon knocked on the door to say goodbye before the holiday break.

"Wait! An oxytocin hug," Feldman called out, and jumped off the couch. "At least 20 seconds." The two had an extended hug (albeit less than 20 seconds). Haaretz, shrinking in embarrassment in the corner by the plant, could have gotten the impression that a touchy-feely, hippie-like atmosphere had gripped the Center for Developmental, Social and Relationship Neuroscience at Herzliya's Interdisciplinary Center. However, the meetings with Prof. Feldman and the tour among her lab's shiny devices showed that researchers there are trying very seriously to answer one of the biggest questions of all: how exactly do we become human beings.

"We're studying the biological basis that allows us as humans to create social attachments," explains Feldman, the center's director. "To love, to be parents, to feel empathy, to be in a group, to have a reciprocal connection with another person, to identify another as friend or foe, to create social groups at the national level or even sports teams. What are the biological, hormonal, genetic, epigenetic and neurological systems enabling us to do this?" The short answer? Synchrony – the delicate bond created between mother and infant right after birth.

One of Feldman's first experiments involved 73 preemies born in Israel in the 30th week of pregnancy and weighing 1,270 grams on average. Every day for two weeks, the preemies received one hour of "kangaroo," or skin-to-skin, care. They were removed from their incubators and placed naked between their mother's breasts. A control group of the same size and medical condition only received contact through the incubator.

Feldman and her staff tracked these children at seven junctures in time, over the next 10 years. The findings showed a dramatic impact on the children who had received the kangaroo care.

"They had a better connection with their mother, better adjustment abilities, lower cortisol (stress hormone) levels and lower ADD rates throughout their entire development," says Feldman. "Small differences, created at the start, amplified over the years."

The results of another study, from when the children were nearly 20 years old, are being released here for the first time. The two groups were asked to carry out a task requiring empathy while their brain was imaged. The researchers found that activity in several brain areas was about 50 percent higher in the participants who received kangaroo contact than among the youths who hadn't received the contact.

"We saw more activity in the amygdala and in the prefrontal cortex and a greater connectivity between these regions," explains Feldman. "Previous research showed that maternal deprivation, for example among children who grew up in institutions, suppresses activity precisely in these regions and the connection between them." Additional preliminary findings demonstrate the real difference in the brain structure (and not just its function) between the two groups of preemies, in centers associated with emotional and motor functioning.

"We didn't invent the kangaroo care method," she stresses. "The method became renowned in wake of our research and today every neonatal unit encourages parents to provide kangaroo care. It impacts hundreds of thousands of babies annually, and we're very proud of that."

While Feldman discussed her research, I thought of my 3-month-old daughter and immediately felt guilty. "It's worth synchronizing with her," she advised after I mentioned her. "Was she a preemie?" No, I said, but it's pretty amazing how much influence 14 hours of your life can have.

"You should understand that a preemie is born under specific conditions," notes Feldman. When a baby is born, the mother can hold him or her, while preemies are separated from their mother during the period when their brain is not fully developed and they still need the mother's physical contact. During this sensitive period, even a brief intervention is very significant. For example, songbird researchers showed that the bird needs to hear its song on a certain day, just two or three times, in order to learn to sing it. Specific neurons in the bird's brain change when it learns its song during this exact timing. If you keep the bird from learning the song when

it needs to do so, and play it for the bird 700 times a week later – nothing will help.

Mothers, zebrafish and cocaine

Feldman, born in Jerusalem, moved to the United States because of her parents' jobs. Her academic career began when she was 15, studying music at New York's Hunter College. She was enrolled at that age thanks to a program involving early college admission of students from low socioeconomic backgrounds. After receiving good grades her first semester, she was permitted to continue as a regular student, eventually graduating with high honors with a degree in music composition within three years. Her daughters still jokingly refer to their mother the professor as a "high-school dropout," since she never finished high school.

She studied and played jazz on the piano and trombone, and was enchanted by the cooperation between the musicians when they improvise together. "I wasn't much of a player, but old-time players are familiar with this experience of entering an altered, flowing and creative state," she says. When she realized that a music career wasn't in the cards, she decided she wanted to study this synchronized experience – "how we can be together with another person," as she puts it.

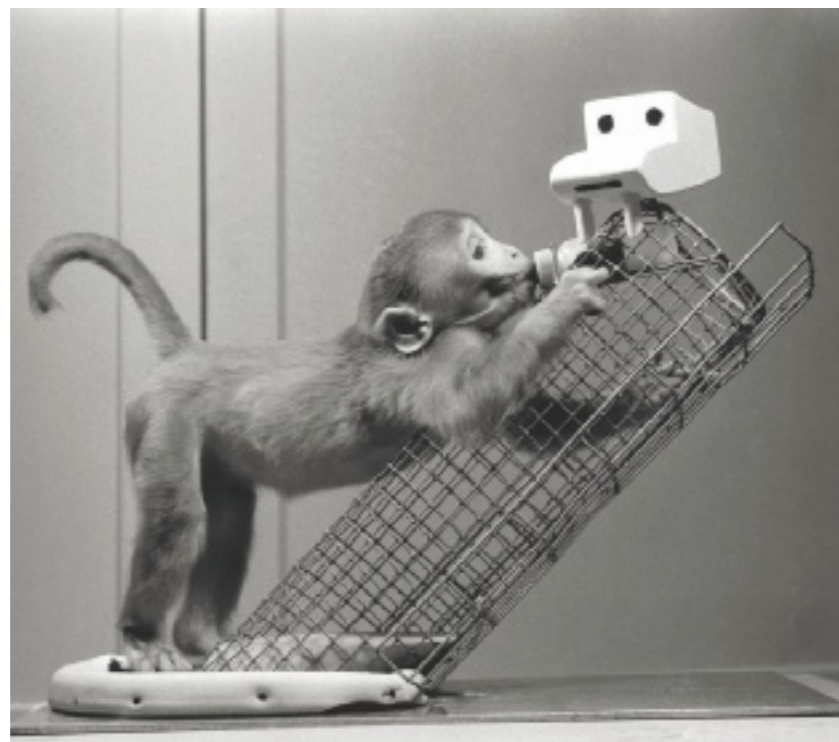
Feldman earned no fewer than three master's degrees, starting with music therapy in New York. After meeting the man who became her husband in the United States and returning with him to Israel, she completed degrees in neuroscience and clinical psychology. She wrote her doctoral dissertation in developmental psychology on synchrony in mother-infant relations. While studying, the couple had four girls and a boy.

Upon return from a post-doc at Yale University in 1995, she joined the Bar-Ilan University faculty as a researcher. About 20 years later, she moved to the IDC. The neuroscience center she runs there includes the Loraee West Laboratory for Brain Research and Human Development, and the Simms-Mann chair. Feldman also heads a public clinic for young children and their families.

Feldman's impressive lab, which she moved into a year ago, is the pride of IDC. Costing over a million dollars and set up according to her detailed requirements, it takes up an entire floor of the library building. The lab includes a large observation room where subjects can interact with each other more or less naturally, while researchers record their brain activity, and film and observe them behind a one-way mirror. Researchers use computers to analyze video clips with micro-second precision and to generate data on the synchrony of gaze, affect, vocal signals and body movements between interacting partners.

In the hormonal and molecular biology lab, Zagoory-Sharon and her staff use robots in analyzing blood, saliva, urine, breast-milk, sweat and hair samples. In yet another room, with special ventilation equipment, they recently began to analyze feces samples, in order to try and measure the synchrony of gut bacteria between youths who live in Sderot (the town near the Gaza Strip that has been the target of Hamas rockets in recent years) and their mothers. According to Feldman's long-term research, half of the children in Sderot develop psychiatric disorders and half do not. Her goal is to discover what characterizes the gut bacteria that is associated with resilience in the face of chronic trauma.

Could the treatment that develops be



The 1958 study by Harlow and Kuenne. Rhesus macaques were put in cages with inanimate surrogate mothers. When they were hungry, they went to the wire mother, ate, and immediately returned to the other, softer mother. Getty Images



Feldman. "Hug, hug hug. When you leave home, hug your child, hug your partner. It will lower both side's stress level, and raise the feeling of wellbeing and the ability to enjoy what you encounter during the day. It will also boost your immune system."

Meged Gozani

fecal transplant of the "resilient" into the bodies of the "non-resilient"?

"Nice. Do you want to work here?"

In an era when print journalism is dying and stool research is flourishing, perhaps I'd better not reject such an offer out of hand, I thought.

In any event, one of Feldman's starting points is the classic study conducted in 1958 by Harry Harlow and his wife and colleague Margaret Kuenne with rhesus macaques. The monkeys were separated from their mothers and placed in cages with two inanimate surrogate mothers – one made of bare wire holding a bottle with food, and another clothed but with no food. When they were hungry, they went to the wire mother, ate, and immediately returned to the mother giving them softness and contact. The picture of the little monkeys clinging like a leaf blowing in the wind to the creepy, clothed doll with a frightened look on their faces, is one of the images that is never forgotten by psychology students.

Feldman: "Harlow's insight was that it wasn't about the food but the contact. However, 'contact' is a very general word, like 'motherhood.' It is a word that consists of many components. Contact involves the oxytocin system, the stress system and the immune system. It entails behavioral and neural synchrony. It activates the brain basis of attachment, the connection of dopamine and oxytocin."

In order to decipher this observation, let's start with oxytocin – a neurotrans-

mitter, sometimes referred to as the "love hormone," which is secreted by the hypothalamus. It constitutes the basis of Feldman's theory. From an evolutionary standpoint, the body's oxytocin system is ancient, and can be found in thousands of species of vertebrates. Its role – whether for a person or a zebrafish – is to connect individuals. In humans, oxytocin is released in response to contact (hence the "oxytocin hug"), eye contact, sex, breast-feeding and a variety of social activities.

One question Feldman and her colleagues have tried to answer is what causes the human connection to be enjoyable, pleasant – something we desire and pursue. Indeed, hugs or eye contact aren't necessarily so enjoyable. Why do we derive such pleasure from sniffing our baby? From an evolutionary standpoint, the brain must create a reward mechanism, otherwise we wouldn't. The answer is dopamine.

The oxytocin-dopamine connection in animals was known, but the research by Feldman and her team demonstrated the connection between the bonding system (oxytocin) and reward system (dopamine) in humans as well, at the newborn stage.

"Dopamine gives this connection the energy because oxytocin is a system without much energy," says Feldman. "The connection of dopamine with oxytocin makes it that the strongest reward you have stems from taking care of your baby."

When a parent plays and makes eye contact with the baby, behavioral synchrony is created between them, according to the research model. Both sides are on the same wavelength. Consequently, their brains literally switch to the same wavelength. "You have one developed brain, one not, one connected, one not," Feldman explains. "This synchrony is critical for the child because it introduces him to the social world."

Both brains activate the same areas, release the same hormones, and the heartbeats are also synchronized. The connection between the oxytocin and dopamine systems is created in the baby and strengthened in the parent. Thus, infants learn during early childhood to enjoy another person's company, to want to be in contact with other people. Anyone who didn't experience this synchrony with their parent at the right time will have more difficulty creating the valuable connection between the bonding system and the reward system later in life. His whole life journey may be one of hardship. He's liable to seek his dopamine in other sources, like cocaine, which floods the brain with this neurotransmitter.

"We believe that behavioral and biological synchronous processes are the ones allowing us to form personal bonds," Feldman explains. "When you and I synchronize our gaze or laugh to-

gether, or do any other synchronized act together, it also allows our brain activity to synchronize and to release hormones, and for our heartbeats to synchronize. We learn all this within our early bond with the mother."

When the child is parented well and his abilities develop properly, synchrony develops and expands over time. "Initially, gaze, affective states, vocal signals and body position synchronize. Later, as the child's mental abilities develop, synchrony with the parent also includes more complex actions and brain systems, like mutually recognizing the needs and viewpoint of the Other, the

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ability to feel empathy and to solve problems mutually," the professor explains.

"The more we researched, [the more] we saw how the experience of synchrony precedes and shapes all social skills. It determines the nature of the bonds you will have with friends in kindergarten, and later how much empathy you'll be able to express, how much you can cooperate, how much understanding you'll have for others' troubles."

Only in moments when behavior is synchronized is synchrony also created in brain activity, in hormones and in the heartbeat, which is the process that allows proper emotional development. One of the many studies being conducted now in the Feldman's lab examines whether such synchrony is created when parent and child correspond remotely (like on WhatsApp), as compared to face-to-face communication.

The effects of stress

Feldman has for many years followed three groups of children and mothers. Each of them represents another aspect of risk to the proper development of synchrony. Besides the group of preemies and their mothers, there is a group of mothers and children from Sderot, who live under high levels of stress because of the security situation there, and another group of children born to mothers

suffering chronic depression. The findings were published this summer.

Feldman: "We recruited them when the children were two days old, from hospitals in central Israel. We examined the child's interaction with the mother several times from childhood to adolescence, checked the hormonal levels of the child, mother and father, the child's adjustment, his emotion-regulation skills and his mental health. At age 12, we imaged the child's brain. We found that throughout childhood, the depressed mothers were less synchronized with the child than the healthy mothers. This is expressed nonverbally during breast-feeding, like a smile or by touch, and later you see less verbal synchrony."

The reduced synchrony in behavior led, as expected, to disruptions in biological synchrony. These children did not show the expected elevations in oxytocin in the blood and urine after interaction with their mother, which can be seen among children of healthy mothers. The saliva in these children contained elevated levels of cortisol and immunoglobulin A – a sign of weakness of the immune system and chronic stress. The brain-imaging findings provided additional evidence of difficulties in the mother-child bond: It showed no special activation in their response to a video of themselves with their mothers, which is typically observed in children's brains. Starting at age 6, these children were four times as likely to exhibit a full-blown psychiatric disorder.

During childhood, these problems included anxiety disorders or behavioral problems, says Feldman, offering another not-yet-published observation: "Today, we see more depression among the children, who are now 16 years old."

Although this particular study involved observation of women with chronic depression, even postpartum depression, which tends to be shorter in duration, may lead to long-term difficulties because of the critical juncture at which it occurs, she notes. Thus, it's very important to be aware and to seek treatment in such a case, Feldman adds: "Some 15 to 18 percent of mothers suffer from postpartum depression. It's nothing to be ashamed of."

Gay fathers' magic

The mother is usually the main "attachment" figure for the development of synchrony. However, one of the studies by Feldman and her colleagues shows that, the brain basis of attachment in gay fathers who are the primary caregivers is no less active than that of mothers. That study looked at three groups of parents: straight mothers who were the primary caregivers, straight fathers who were the secondary caregivers, and gay fathers who were the primary caregivers. The researchers filmed the parents interacting with their infants at home. Later, the parents watched these films while undergoing a brain scan with an fMRI. Additionally, their oxytocin levels were measured before and after playing with their children.

The researchers found that while synchronizing with the infant, exceptionally high activity was observed in the mother's brain – five times higher than among the straight fathers – in the center responsible for emotional processing. When the straight fathers synchronized with their offspring, brain activity in the mentalization center, which enables social understanding and empathy, and provides cognitive representation of the intentions of the infant, were measured as being four times higher than among the mothers. The gay fathers beat them both, with high activity in the emotional center, like the mothers, and high activity in the mentalization center, as among the straight fathers.

Feldman rejected out of hand my provocative attempt to characterize gay fathers as "super parents."

"Our findings show, in my opinion, not the superiority but rather the plasticity of the parental brain," she says. "Until 1850, one out of three mothers died in childbirth. Who raised the children? Neighbors and aunts; women who hadn't given birth took in the children. Suddenly, the entire network responsible for attachment in their brains started to activate. This network is very flexible because it is critical for survival."

Feldman adds that when a father spends a lot of time raising his child, the father's emotional brain center becomes more active. "Gay fathers are the heralds of the 'new dads': When you are more involved raising your child, these two brain systems will activate and connect." We'll get back to this.

That study is just one of hundreds that Feldman and her colleagues have published, most of them in leading scientific journals. She is considered a leading, influential and very productive researcher in Israeli circles and abroad. Besides her work at the IDC, she is an adjunct professor at the Yale Child Study Center, and is a former

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