

Not giving in to sweet temptations calls for self-control. Children are capable of resisting only when their brain is mature enough.



Take a Bite or Resist?

From a very early age, children exhibit an amazing sense of fairness and justice. The older they get, the more compassion and empathy they develop. **Nikolaus Steinbeis** from **Tania Singer's** department at the **Max Planck Institute for Human Cognitive and Brain Sciences** in Leipzig is studying how the social behavior of children changes as they get older, and which of the brain's networks play a role in this.

TEXT **MARTIN TSCHNEHNE**



» Children who have better control over their impulses display enhanced thickness of the dorsolateral prefrontal cortex.

Colorful lollipops, jelly beans, gummy bears – “pester power items,” presented at children’s eye level: sales strategists at supermarkets know exactly why they put all the different varieties of candy right where customers must stand in line at the cash register: because kids grab them up while their parents are unloading their shopping cart onto the conveyer belt. And that boosts sales figures. After all, rather than dealing with their screaming kids every time the harassed parents take away the brightly colored sticky stuff, the little ones are more likely to get their way.

Nikolaus Steinbeis looks like someone who understands children: a friendly, youthful smile, colorful sweater and casual pants. A study of social skills and how they are represented in the physiology of the brain is the last thing that comes to mind when the psychologist from the Max Planck Institute for Human Cognitive and Brain Sciences enters a room full of children and takes out the goodies he’s brought with him: picture books, games, colorful stickers and movie tickets. The Swiss being skeptical of tooth-rotting treats, candy was off limits as incentives in Switzerland, where the series of experiments began at the University of Zurich a few

years ago. But still, Steinbeis is a bit like the marshmallow man in American psychologist Walter Mischel’s experiments in the 1960s. And nothing about him gives any hint that he’s about to plunge the children into the midst of major conflict.

RESISTING TEMPTATION

Mischel gave his test subjects a marshmallow and promised them another one if they managed not to touch the first one – it was all about impulse control. Then he left the room, leaving the children to their dilemma. There was only a camera there to record the chil-



Games in the service of science: Nikolaus Steinbeis uses behavioral tests from the field of game theory along with computer programs he developed himself to analyze the social behavior of children in different age groups.

dren's struggles, their losses and triumphs against temptation. The test results demonstrate that children who manage to resist in this situation go on to be more successful in school and in their working lives. This kind of perseverance, where the reward comes after a certain delay, is associated with success in school and professional life. It's an even more reliable indicator than intelligence. And grown-ups find it extremely amusing to watch the little ones squirming in front of the plate, hardly able to bear the conflict going on inside them.

The Leipzig-based scientist's studies are also about forgoing an immediate reward, about impulse control and about sharing fairly. Steinbeis breaks down complex value systems such as empathy and fairness into small, measurable units. He puts children in front

of a computer screen and asks them to react to quick symbols, he shows them the results of the other players and watches how they behave when they feel like the loser or think they're ahead. Or he gives them play money to spend. Two coins: one colorful sticker. Ten coins: one visit to a Harry Potter movie.

Which of them share and which keep it all for themselves? The scientist's findings show that six-year-olds have a hard time giving things away, while older children are more disposed to sharing.

GENEROUS DICTATORS

The game is called the "dictator game" in its simplest variation. It's well known because of the experiments conducted by Swiss behavioral economist Ernst Fehr, with whom Steinbeis and Tania Singer, Director at the institute in Leipzig, previously worked in Zurich. Scientists working in the field of economic and behavioral research use this lab experiment to study something known as social preferences – in short, altruism. Participants are given a number of coins and asked whether they will give any to another person who isn't in the room. There's no pressure, no discernible benefit, but many do it anyway. Contrary to economic textbook theory, the dictators don't keep all the money for themselves. On average, they give 20 to 30 percent of it away to the other player.

This is a finding that challenges the long-dominant concept of *Homo oeconomicus*. The model starts from the idea of a completely rationally thinking per-

son who, faced with a decision, weighs up all of the available alternatives based on his or her own decision-making criteria, and only then selects the optimum choice. But we aren't that objective. There's something called a social conscience, a moral conviction, that things should go well for other people, too. Of course people are envious, greedy and mean at least as often, also without any rational evaluation. But how do these kinds of value systems develop, and which networks in the brain play a role in this?

Working with his colleagues Boris Bernhardt and Tania Singer at the Max Planck Institute in Leipzig, Steinbeis plans to find out by studying children between the ages of six and thirteen. Relatively big kids, really, given that childish egocentricity begins much earlier, doesn't it? And can't even younger children be observed sharing, empathizing and giving a bit of what they've got to others? "True," admits the scientist. "But it's not the origins of these behaviors we're interested in. What we want to do is observe how behaviors evolve, and connect this with changes in the brain. This age group is ideal for that."

In the phase between starting school and reaching puberty, children's knowledge of norms and standards has already been formed. The youngsters have done quite a bit of their growing up by then. They have a concept of the fact that it's fair for others to get a little bit of what they've got, too. But have their brains reached the same stage of maturity?

Variation number two: the "ultimatum game." Now the responder can also react. If the responder rejects what

» Envy and gloating diminish as soon as impulse control and emotion regulation improve.

Science is clearly fun: Nikolaus Steinbeis and Tania Singer, though, need a great deal of sensitivity when dealing with the children and adults in their tests.

the proposer offers, both of them get nothing. So the proposer has to think very carefully:

How will the other person react? How would I react if it were me? A *Homo oeconomicus* would accept everything offered. It's better than nothing, after all. However, in real life, people don't react that way. They are indignant if someone offers them a pittance while keeping the lion's share for themselves. They'd rather have no reward for either of them. As a rule, the share that players offer is between 40 and 50 percent. Offers below 30 percent are frequently turned down.

So what's needed is empathy and knowledge of social norms. Whereas the dictator need only follow his or her own sense of justice and fairness, anyone playing the ultimatum game has to guess how the other will react. They have to adopt and sum up three standpoints simultaneously: their own interest in getting a reward, their sense of fairness, and the other player's sense of justice. Because, as the scientists' findings have confirmed, people generally won't be content with a few crumbs.

The use of magnetic resonance imaging (MRI) enables the Max Planck researchers to measure the size and activity of individual regions of the brain while playing the game. What they found is that the brain weighs up such complicated interrelationships in a special region of the cortex known as the dorsolateral prefrontal cortex. It's located just above the temple, right where you'd tap yourself on the forehead if you wanted to show how brainy you were. The region is most notably active during highly complex operations, when telling a lie or forecasting the fu-



ture, weighing up pros and cons or making long-term plans. Moreover, when assessing a situation and using acquired norms and one's own experience to predict how another person will react is also when this area of the brain comes into play.

THE BRAIN TAKES TIME TO DEVELOP

The dorsolateral prefrontal cortex matures at a relatively late age. Consequently, older children should be able to deal with tasks like these more confidently. The findings of researchers in Leipzig indicate that this is indeed the case. Older children factor the possibility of being turned down into their offers and are firmer in their convictions and reactions. Six-year-olds, on the other hand, are easier to persuade and can end up accepting offers they previously regarded as unfair. Although they already have a

keen sense of fairness, they give in more easily to temptation.

Anyone who's ever watched children in the schoolyard swapping trading cards or, indeed, ever wanted to swap one major league player for another major league player, knows the power of temptation and persuasion. Children may have values and beliefs, but they're not firmly enough entrenched to reliably control their behavior. All it takes is a couple of years' age difference, and the best cards always end up in the hands of the bigger kids.

The scientists measured stronger brain activity in the dorsolateral prefrontal cortex of the older children, particularly in the left hemisphere of the brain. Irrespective of age, children who are better able to control their impulses have more nerve fibers there, too. Furthermore, the researchers noticed a surprisingly large discrepancy between a child's belief and its actual behavior: of the 85 percent of younger children



who wanted to reject an offer they thought was unfair, only just under 13 percent actually did so in the end.

Naturally, this triggers negative emotions of weakness, jealousy and frustration in those who feel they've been cheated. "It's only when children reach the age of four or five that they begin to compare themselves with others," says Steinbeis. "Three-year-olds won't usually be bothered if someone else manages to do something better than they can." What's responsible for that is evidently the activity of a region deep in the brain's interior, the temporoparietal junction. It works like a switch for aligning intrinsic and foreign states and needs.

WHEN THE RULES OF THE GAME CHANGE

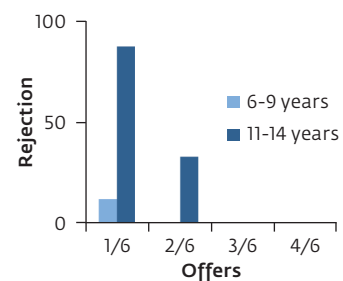
That switch is easy to study in the dictator game. It's enough to change the game rules slightly: increase the possi-

top: For the dictator and ultimatum game, players are given a certain amount of capital. It's only play money, but it's still a great temptation for the children.

middle: One-sixth isn't enough: Children aged between 11 and 14 almost always reject an unfair offer. Even a one-third share is sometimes turned down. Six- to nine-year-olds, on the other hand, accept such offers most of the time.

bottom: Virtual section of the brain: Weighing up complicated social problems triggers activity in the dorsolateral prefrontal cortex (red). In younger children, this region isn't yet sufficiently mature. They are less good at adapting their offers to the situation.

ble gain, give the players the option of first protecting their own gain before having to give anything away; give the other player a bigger reward if you yourself get relatively little; or relinquish what you have so that the other player also gets something. Using the MRI, the scientists can also observe what effect it has on the brain when





you've given it your best shot but are outdone by an opponent. The power game is an opportunity to be fair and generous – or an occasion for pettiness, greed and revenge.

Among six-year-olds, feelings of envy and gloating are especially pronounced. As they grow older, however, these often diminish. Evidently, children of this age already have a highly developed awareness of the happiness of others. It's their ability to control their impulses that lags behind.

The temptations are great, and their knowledge of social rules and expectations is often fairly well developed, too – the only thing lacking is the strength to act on this knowledge.

MEDITATION IMPROVES SOCIAL SKILLS

This sounds like difficult and painful experiences. But why do older children and adults manage it so much better? Improved self-control is how the scientists in Leipzig explain the diminution of jealousy and gloating. "Don't forget the regulation of feelings," adds Steinbeis. "Through meditation, for instance: we are capable of freeing ourselves of needs. We can train insight. Think of what Buddhist monks can do. That's going to be very important to all of us."

The researchers' long-term goal is to use MRI to seek out the critical periods in a child's development when such capabilities are especially easy to cultivate. Steinbeis points out parallels in language development: "A language acquired by the time a child reaches the age of five or six is so embedded in

Tania Singer is one of the co-founders of social neuroscience as a research area. Her new e-book, which contains examples of exercises from Buddhist meditation, also reflects her ambition to explore new avenues in the communication of science.

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the brain that we call it a first language. Everything that comes after it is represented differently. It's always a second language, even if it's spoken very well. So there is clearly a critical period when the brain is able to process certain types of stimuli particularly efficiently. And we strongly suspect that the same is true of certain aspects of social behavior."

Expecting preschoolers to stay true to their principles or to be able to exercise reliable impulse control is simply wanting too much too soon. Mapping out individual brain regions and their functions in controlling emotions and behavior was a first step for

the neurosciences. Observing changes in complex but controlled social situations is a second. Selectively altering

structures in the brain by means of stimulation, learning or training will be the next one. ◀

TO THE POINT

- The manifestation of social behavior in childhood follows the course of development of the underlying brain regions, such as the dorsolateral prefrontal cortex and the temporoparietal junction.
- Since many of these regions are relatively late in maturing fully, younger children are less able to predict how others will behave, and find it hard to resist their own impulses.
- Similar to language acquisition, scientists suspect that there are one or more critical periods for social behavior where it should be possible to exert special influence on certain social skills.



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