

Eye to I

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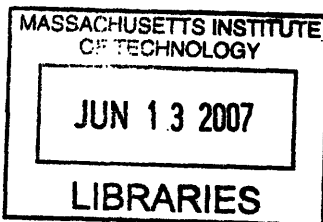
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## ABSTRACT

This is the story of the language of eyes – what they say about our emotions, what they reveal about our intentions, how they interact with our face, and how they connect us to one another. The story follows our experience with eyes from infancy when we first learn to connect looking with knowing. This connection forms the foundation of our social understanding and has evolutionary implications. From there the story moves to gaze in love, and other social encounters. I look at the role of eye gaze in the judgments we make about others – the way in which direct eye contact may affect how likable or attractive we find another person. I then turn to these questions: how much of an eye does it take for us to feel watched? Do pictures of eyes affect us? What about the eyes of a robot – do we respond to them as we do to human eyes? I show that for those who have normally functioning eyes, attention to the eye region plays a critical role in how we learn about the social world and our place in it.

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## INTRODUCTION

My father's eyes tell everything there is to know about him. They are dark and quick and troubled. They are easily excitable. His wild shrub eyebrows cast persistent shadows which lift when he listens to Yiddish songs, when he talks about physics, and when he plays with children and dogs. My father has a wry smile that doesn't involve his mouth at all – it's a squint of sorts, and even as we laugh around him he holds his ocular ground with the careful timing of a stand up comic, until the laugh he'd been hiding in his eyes finally bursts out of his mouth.

My mother's eyes are green and wet.

When we were children my sister's eyes darted from keyhole to keyhole to corners of windows and out from behind walls at inconvenient moments. I wanted nothing more than to hide from her eyes. Now hers are the biggest eyes I know. They seem to swallow the world whole in each blink, lashes fanning the porcelain face in which they're set.

These are the eyes I grew up with.

Over time, my mother's eyes changed too. When I was a child they mainly looked elsewhere. Not at anything in particular, just elsewhere, into other worlds: past lives, roads not taken, worlds of ifs and would'ves. As I got older, she looked at me more, but still not in the way daughters like their mothers to look at them. They were inquisitive eyes – the eyes of someone looking at a strange and unidentifiable creature, though I always got the sense she was looking more for explanations than for what kind of

creature I was. Words accompany every look. We can't always find them but they're there. The words that went with her look were: *Who are you? Where did you come from? How did this all happen?* I can't say what it was about her eyes that spoke those words. Was the lid lowered to just the right place? Were the muscles lining the bottom of her lid pulled in just tight enough? Maybe the language of the eyes works like any other language. "T" and a "d" are barely discernable physically. A slight vibration of the vocal cord is the only difference. But that slight vibration, that voice, makes the difference between "tread" and "dread." Maybe the language of the eyes works the same way. Lower the lid a micrometer more and a different word comes out.

Now that I'm grown, my mother's look has changed yet again. Her eyes have been drier in later years, they've lost that tearful sheen. They are more cynical, but richer too. They no longer search; they seem to have found, something at least. They dart more, and each dart means something depending on where in the conversation her eyes dart and how quickly she returns her gaze to mine. She has a distinct dart of disapproval, one of skepticism, one of envy, and so on. If I say I've quit my job, she looks down and to one side without blinking, and then right back up with a long fixed gaze.

I've seen agile eyes like that in movies – eyes that show emotions the character may or may not want to reveal. I can't imagine how they do it – how they are able to act with their eyes. In a scene in *Autumn Sonata*, Charlotte (Ingrid Bergman) sits at the piano next to her daughter Eva (Liv Ullman). Eva has just finished playing an unsatisfying rendition of Chopin's second prelude and Charlotte explains that this piece is full of pain and full of restraint, and in order to play it right both must be conveyed. Charlotte, a

professional pianist, begins playing. The camera focuses close up on her face in profile. Her eyes never leave the piano. Eva then lifts her head and looks at Charlotte, directly into the camera with a look that shows both pain and restraint so perfectly it's gut wrenching. And they stay that way, Eva looking at Charlotte and at the viewer, for a seemingly endless stretch of time, as Charlotte plays Chopin. Finally the gaze breaks for a few seconds. Eva looks down, and then back up again in the same position as before and holds the gaze again, and again it makes me squirm and I have to restrain my discomfort. I have watched this scene over and over, sometimes letting it wash over me and other times trying to dissect what makes it so potent. The corner of Liv Ullman's mouth turned down like a bass clef, the angle of her head, ever so slightly lowered, the skin on her face hanging loose – these are the markings of pain – they match the almost discordant notes of the music. But the gaze, the prolonged, unrelenting, gaze which remains fixed without words, without action – that is how the notes are played. That is the restraint and the pain of restraint, and it's what keeps me almost paralyzed in my seat, glued to the screen while wanting at the same time to look away.

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Eye contact is an intimate act. It's something that can happen only between two beings, not three, not five. It's not the same as peering into someone's mouth or nose or forehead. It is an experience in which we might be aroused by the unknown – before any words are uttered, we can only imagine what is going on 'behind' the other person's eyes. Or it's an experience in which we are aroused by the knowing – knowing what someone

is thinking or feeling and communicating both the feeling and the knowing through the eyes in a wordless exchange. This is the eyes' triumph over language.

A gaze can be so powerful that time and space seem to disappear and all we sense is an intense connection with another – a sort of engagement with another being. Some feel it with animals too – a dog, a cat, a monkey. My father once stared into the eyes of a buffalo and in that moment he swears there was an understanding – a recognition that each of them was a living being with its own perspective – and that any move made by one would cause the other to react. So they stood motionless, eye to eye. This recognition doesn't happen when we looking into the eyes of a cricket, for example. We do not feel engaged in the same way. We are not likely to look into its eyes and feel affection or fear. Maybe its eyes aren't big enough to tug at our heart strings. Maybe its diminutive size makes it inconsequential to us. Maybe it's harder for us to get a sense of what the cricket's point of view is because we can't quite see what it's paying attention to. Whatever the reason, there is a kind of engagement, I'll call it "vital engagement," that we feel when we look into eyes that seem to have a presence and intelligence behind them.

Throughout history, the eyes have held a certain power. In Buddhism and Hinduism, a third eye often represents enlightenment, or clairvoyance. In Judaism, the angel Metatron had 365 eyes and was almost god-like. The Evil Eye is the eye with which someone who is envious looks at a successful person. The Evil Eye is bad luck and may cost a person his fortune, but one form of protection against the Evil Eye is a Semitic

symbol, the Hamsha, the palm of a hand with an eye in the middle, sometimes referred to as the hand of God.

In every day life we use eyes as signals that help us figure out how to behave. A speaker's upward glance during a conversation might signal that he's thinking, but if he rolls his eyes it means something quite different and we'd want to end the conversation. A glance from across the room at a party could be enough to prompt us to cross the crowded floor. But if the glance is a second shorter, we might stay put. In tango they say that a dance begins with eye contact. Before the dancers have spoken, before they've touched, before they've even gotten close enough to smell each other's perfume, they lock eyes, and the dance begins.

Why is looking into another person's eyes so powerful that sometimes we can't turn away ... so powerful that other times we have to? What can we tell about what other people are thinking by where they look and how they look? Is it possible that there is an evolutionary advantage to being so attentive to eyes? What does another person's gaze tell us about who we are, relative to others?

This is the story of the language of eyes – what they say about our emotions, what they reveal about our intentions, how they interact with our face, and how they connect us to one another. The story follows our experience with eyes from infancy where we first learn about eyes, through gaze in love, and other social encounters. The story then turns to these questions: how much of an eye does it take for us to feel watched? Do pictures of eyes affect us? What about the eyes of a robot – do we respond to them as we do to human eyes? I hope to show that for those who have normally functioning eyes,



attention to the eye region plays a critical role in how we learn about the social world and our place in it.

The journey begins with the context in which the eyes are set – the face.

## **FACE AND EMOTION**

### ***The Face***

Every morning I look in the mirror to meticulously address each part of my face. I dust some powder to dull the shine of my skin and brush on some blush to give the appearance of perpetual excitement. I swish on purple eye shadow because the package it came in convinced me that purple makes brown eyes “pop.” Some days I line my upper lids, also in popping purple. Mascara lengthens my lashes both on my upper lids and my lower lids. (It’s strange to attend to my eye lashes; to think consciously about them so frequently – a glaring gender gap if there ever was one.)

But what does this careful attention get me? My face, as I see it in the mirror each morning looking back at me, is not the face that others see. Others see my face in action – moving and reacting in a way that I can only fake under the bright lights of my bathroom mirror. Others see genuine expressions. How do my eyes interact with my various faces?

In *The Expression of the Emotions in Man and Animals*, Charles Darwin describes the qualities of facial expressions, which he believed are universally recognizable. He writes that in sadness, for example, “the eyes become dull and lack expression...The eyebrows not rarely are rendered oblique ...The corners of the mouth are drawn downwards, which is so universally recognized as a sign of being out of spirits, that it is

almost proverbial.” This is not to say that expressions aren’t used differently in different cultures. In China, for example, it used to be that brides had to cry for days, sometimes months before their wedding, to show their sorrow of leaving their parents’ home. If they didn’t cry, they were thought to be brought up poorly. Individual cultures may have their own ideas about when it’s appropriate to smile, or to cry. But, according to Darwin, a smile is a smile wherever you are.

Long after Darwin, Paul Ekman, professor emeritus of psychology at UC San Francisco and renowned expert on facial expressions, embarked on a life-long journey to classify facial expressions. In 1967, Ekman traveled as far as New Guinea in search of faces. He had already traveled a good part of the world looking for universal expressions, but he wanted to be sure that television and movies and other images that many cultures have access to wouldn’t influence his subjects’ perception of faces. For example, anyone who has seen *Casablanca* knows curves and creases of longing, of regret, of illicit wants.

In the 1970s, after he must have looked at every conceivable brow raise, eye curl, smirk, sulk, and smile, Ekman and W.V. Friesen developed a system of identifying facial expressions, called FACS, the Facial Action Coding System, which Ekman has updated in recent years. For example, the eyebrows raise in surprise and fear. In a smile, the corners of the mouth turn up, and in a spontaneous smile, what Ekman calls a Duchenne smile and which he says is difficult to fake, the muscles around the eyes contract. This smile is named after French anatomist Duchenne de Boulogne, who, in the late 1800s, studied facial muscles. I tried the Duchenne smile under the lights of my bathroom mirror. It’s strange to smile at oneself – to contract muscles in the face the way you might

flex a bicep. The mouth was easy enough. Crinkled eyes were harder to sustain. The resulting expression might've fooled a casual acquaintance, but only for a moment or two.

Ekman's ambitious taxonomy culminated in a distinct set of universally recognized expressions. In a 1992 report prepared for the National Science Foundation by leading scholars, Ekman and others wrote, "Twenty five years of cross-cultural research finds consistent evidence for the universal recognition of six emotions -- anger, fear, disgust, sadness, happiness and surprise." Recently he added contempt to the list. Most of the cues that signal these emotions are in the upper face. The mouth is mainly responsible for signaling happiness, but the eye area (from midway down the nose up to the eyebrows) signals most of the other emotions wherever in the world we find ourselves.

Ekman's taxonomy has come in handy for scientists who probe the link between facial expressions and emotion. Late one night several years ago, one of these scientists, Reginald Adams, assistant professor of psychology at Penn State University, was looking at pictures of faces he'd recently shown people during a series of experiments about emotions and facial expressions. As he sorted through those pictures, he came to a deceptively simple realization, "They're all staring at me." Happy faces, scared faces, sad, angry, surprised – they were all looking directly at him. This got Adams wondering, *do we perceive all angry faces in the same way, or does it depend on where the eyes are looking?* In 2003, he published a series of experiments that would address this new question: how does direction of gaze help us interpret particular expressions of the face?

## *Fear and Anger*

To help answer this question Adams, along with Dartmouth College social psychologist Robert Kleck, conducted an experiment. They showed 32 college students pictures of angry and fearful faces on a computer screen. In some cases the eyes on the face were looking at the viewer and in other cases they were looking away. Each student clicked a mouse button as soon as he could, indicating whether a face showed an expression of anger or fear. The study found that the students recognized angry faces faster when the face appeared to be looking at them than when it was looking away. (The average recognition time was 0.86 seconds with direct gaze and 0.91 seconds with averted gaze). On the other hand, the students recognized fearful faces faster if they were looking away from the viewer (0.89 seconds on average, as opposed to 0.94 with direct gaze).<sup>1</sup>

What do these mathematical acrobatics tell us? What insights could possibly be hidden within a few dozen milliseconds?

Navigating through the rooms at an evening party where we find ourselves face to face with new people, we often engage in a dance of signals. We smile, we stare, we look away, we wink if we're bold, we gaze out of the corners of our eyes if we're not. A flutter of lashes might cause a stir across the room. If someone smiles in our direction, they might approach us. If someone looks away, they probably won't. According to Reginald

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<sup>1</sup> Adams describes his calculations in this way: Every participant was seated before a computer and was presented with a series of faces that they had to respond to as quickly and accurately in an emotion discrimination task (by making a right or left mouse click). There were 30 individuals represented by the photos, each displaying two emotions with direct and averted gaze (direct faces were repeated twice to match the left and right averted gaze in number), for a total of 240 trials (if you divide 240 by 2 emotions, 2 averted gazes (left and right), and 2 direct gaze (doubled to equal the averted condition), you end up with 30). Then the conditions were examined across trials within each treatment condition by computing a 2(gaze) X 2(emotion) ANOVA.

Adams, our pre-verbal ancestors may have danced this dance of the eyes as well. On the phone Adams told me that facial expressions and eye gaze tap into our “approach or avoid” instincts.

Adams believes the results of his experiments have strong implications for our social evolution. “If someone is angry and looking at you,” he told me, “there’s a very high probability that he will approach. This means there is a direct threat to you. On the other hand if someone looks at you with a fearful face, there is probably no threat coming from that person. One says I’m your problem, don’t take your eyes off me.” The other, the fearful look, says the threat is less immediate, but follow the gaze to see where the danger is and try to protect yourself. A fearful face looking somewhere else means *let’s get out of here*. Both cases trigger our fight or flight instincts and we do what we can to ensure our survival. The eyes are beacons of warning.

It’s unsatisfying to talk about eyes over the phone. I want to know how Adams would look at me as he tells me about his work. Is his gaze fixed, with the laser-intensity I’ve seen in some scientists? Or does he have the distracted gaze of someone who’s got too many Big Questions on his mind? I wonder the same about Paul Whalen of Dartmouth College.

Whalen, principal investigator of the Whalen Lab in the Department of Psychological and Brain Sciences, was particularly interested in the eyes of a fearful face. He wanted to know, *how sensitive are we to the facial signs of fear, and what exactly are those signs?* To help answer this question, Whalen looked to one of the oldest areas of the brain, the amygdala.

Whalen and his colleagues showed participants in the study pictures in which all of a person's face was covered up, except the eyes. Just eye whites, iris and pupil were visible. The eyes were open wide as they are when we are afraid. But the image of the eyes was shown subliminally for an imperceptibly brief time and was followed immediately by a neutral face. The participants, who had been hooked up to an fMRI machine that measures brain signals, didn't report seeing it. Whalen looked at the reaction of the amygdala, which is heavily involved in processing emotions such as fear. Even though the participants did not report seeing the fearful eyes, the amygdala registered the image and was electrically active in the same way it was when participants looked at fully exposed fearful faces.

“If you widen your eyes then I know you've detected something. It's a signal that something is happening,” says Whalen.

Horror movies come to mind: the edge-of-your-seat moments in which the characters who managed to survive spot the killer by following the bulging eyes of a scantily clad woman in her last moments of on-screen life. On a Friday night, in a theater full of viewers – some pressing close to their dates, some reaching for popcorn – our most primitive reactions are tapped. Under a collective brain scanner, amygdalas throughout the theater would light up like fire-flies when the unsuspecting characters met their inevitable end, each one wide-eyed as they took their last breath.<sup>2</sup> Watching moments like these, our ancestors might have chosen fight or flight. But we pay \$10 for these seats. We stay put.

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<sup>2</sup> An article in the April 2, 2007 issue of the journal *Social Cognitive and Affective Neuroscience (SCAN)* suggests that the amygdala does not play as crucial a role in the recognition of fearful facial expressions as

## ***Happiness and Sadness***

It's easy to imagine that threatening expressions are signals, and the eyes mark the source of the threat. But does gaze serve only as a beacon of warning? What about the less threatening expressions? What difference does it make whether the eyes of a happy face look towards us or away?

Reginald Adams' included happy and sad faces in his experiments as well. As in the first experiment, students (this time 28 undergraduates) were asked to click a mouse button as soon as they knew what kind of facial expression the image on the computer screen showed. He found that a happy face with eye contact was recognized faster than a happy face with averted gaze (0.60 seconds with direct gaze and 0.62 seconds with averted gaze). A sad face with averted gaze was recognized faster than a sad face with direct eye contact (0.626 seconds, as opposed to 0.641 seconds with direct gaze).<sup>3</sup>

The question of evolutionary benefit is trickier here. In the case of fear and anger it's easy to speculate that whichever combination of expression and gaze allows us to spot threat more quickly, that's the one that is most useful to our survival. In the case of happiness and sadness it's not as clear. Perhaps our quick recognition of happy faces looking directly at us is an aid in spotting allies, whereas a happy face with an averted gaze does not affect us at all. Or perhaps spot more quickly the look that feels good to us – a happy face looking at us is more pleasing than an unhappy one, and more pleasing than a happy face looking away. Another possibility, which Adams suggests and which

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previously thought. The article is entitled "The BOLD signal in the amygdala does not differentiate between dynamic facial expressions" and is authored by Christiaan van der Gaag, Ruud B. Minderaa, and Christian Keysers, all of the University of Groningen, Netherlands.

<sup>3</sup> Participants saw a total of 240 images in this part of the study.

seems most likely, is simply that we are more attuned to those faces that indicate a potential action towards us. Both happy and angry faces directed at us signal potential actions towards us – a vital engagement – while fearful and sad faces may be more likely to prompt the bearer of those faces to avoid rather than approach us.

While these instincts served survival purposes for our ancestors, the remnants of these instincts are still with us. We are no longer fleeing from bison. For the most part, we have learned that there are better conflict resolutions than to pounce on each other in anger. But millions of times a week we react to faces and gazes. Sometimes our reactions are conscious, other times they occur in such a brief instant that we're not aware they happen – a spark of attraction for a stranger on a subway, a momentary flash of fear of a face in a dark alley, a barely perceptible wave of compassion for a sullen face on a street corner, and if we're lucky, a routine surge of affection for the joyful face that greets us at the end of the day.

But when does this all begin? When do we first learn that eyes carry important information? Scientists like Adams and Whalen agree that this insight originates in early infancy. But what is it exactly that we're learning and how does it help us navigate the social world before we even utter our first words?

### **MINDREADERS BY THE FIRST BIRTHDAY**

Barron is a 2 ½ ft tall 2 ½ year old painter. His kitchen walls display his prolific talents. Squiggles and splashes and dots reflect entire universes that are invisible to me. Only Barron knows the hidden riches of a pale green brush stroke thrust defiantly to the



very edges of the page and beyond. Barron's mother, a longtime friend of mine, tells me that he often asks to see her face up close. "I love you, mommy," he says, "let me see your face." He recently painted a picture of her face, or part of her face, to be exact. There was a face for sure, with eyes in the right places. But though he thought he had finished the painting, he'd left something out. He held the picture up to his mother's face to measure the resemblance. "Oh I forgot mommy's mouth," he said, and drew two horizontal parallel lines in just the right place to fix his mistake. I wondered how Barron could forget the mouth. It's where kisses and raspberries and smiles come from. It's where all the sounds of mommy come from – mealtime sounds and bedtime sounds, and the definitive explanations of the what's and why's of everything. The mouth is where all the good stuff comes from. How could it be forgotten?

In a 1965 study, Dr. Theodore Shapiro of Weill Medical College of Cornell University and Dr. John Stine<sup>4</sup> examined the drawings of young children. The way I like to imagine the scene is this: 3 and 4 year old children are lined up side by side, each with an easel in front of him and her. Each child artist is given a palette of oils. Each one is wearing a smock. Behind them stand two scientists in white lab coats, holding clipboards and pens. In my version they wear glasses and tap their pens to their mouths as they examine the pictorial riches before them. *That one's no Picasso*, they'd snicker. *And even worse, that one is!* It probably didn't happen that way, but what did happen was this: most of the 3 year olds in the study drew eyes on the faces they painted. Almost all the 4 year olds drew eyes. But like Barron, most of the younger children left out the mouth. Three quarters of the 4 year olds did draw mouths, but very few (only 22%) of the 3 year

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<sup>4</sup> Affiliation unknown

olds drew them. With his updated picture, Barron's artistry was years ahead of its time – 1 ½ years to be exact.

Why would the eyes be more memorable than the mouth in the earliest years of life?

Scientists use several methods to help them understand a child's mind, and both the child's eyes and mouth function as communication devices. It has been widely accepted that a child's interest is measured by a smile or a prolonged gaze, and disinterest measured by averted gaze and a neutral face (no smiling). In his first two months, a child needs only a pair of eyes to induce a smile. Show him a mask with two dots for eyes, and he's happy. But show him a real face with the eyes covered and he doesn't find it amusing, in fact he doesn't react to it. A profile with one eye hidden also isn't enough to make him smile. Both eyes have to be there to elicit a reaction.

In 2000, Cambridge University psychologist Simon Baron-Cohen and his colleagues showed that from birth, children gaze longer at faces with eyes open rather than eyes closed. There are still questions about whether the infants are responding to the bright, moving bits that adorn a maternal orb, or whether there is an innate eye detection mechanism that jump-starts the infants' social learning. But by about 4 months, a child can tell that his mother's direct gaze means she's looking at him.

It's only between 5 and 6 months that he begins to respond to mouths, and even then he prefers to look at eyes. At 6 months old children look two to three times longer at a face that's looking at them than at a face that's looking away – they are aware of a pair

of eyes on them. Maybe that's why one of the first forms of social interaction with a child is the game peek-a-boo.

Baron-Cohen believes that watching other people's eyes goes a long way towards turning us all into mind readers, and mind reading is a skill we need to navigate the social world. He proposes a built in Eye Direction Detector which "the modern human infant possesses as part of its evolutionary endowment...It detects the presence of eyes or eye-like stimuli, it computes whether eyes are directed toward it or toward something else, and it infers from its own case that if another organism's eyes are directed at something then that organism sees that thing. This last function is important because it allows the infant to attribute a perceptual state to another organism (such as 'Mummy sees me')." Eyes give us a glimpse into people's intentions, a skill whose building blocks begin in the first year of life. Eyes help us interpret facial expressions (angry vs angry at me), and they help us see which objects in the world people are paying attention to. With this knowledge we are well equipped to take steps towards understanding others and predicting what they do. These early steps eventually form what is often called Theory of Mind, a mechanism that allows us to understand that others have their own minds, beliefs and goals that are not necessarily consistent with ours. We fully develop this ability by age 4. Without it, people would appear to us as unpredictable objects with awkward, dangling parts.

### ***Her Eye On The Apple: Reading Goals***

Tracking eyes helps a child see what others see – it helps him see through other people's eyes, in a sense. By 6 months, children look in the direction of an adult's gaze if

it's signaled by both the eyes and head. And by one year, they can use the eyes alone as pointers to what a grown-up is looking at and therefore attending to.

Michael Tomasello, co-director of the Max Planck Institute for Evolutionary Anthropology, recently conducted a very simple experiment. He asked adults to look up to the ceiling either with just their eyes or with their whole head and the eyes closed. He then watched to see where children of about a year would look. The infants usually followed the adults' gaze up to the ceiling when just their eyes went up, but not so often when the head looked up and the eyes were closed. This deceptively simple experiment captures a remarkable feat – the child uses a pair of eyes to find what another person is paying attention to. Using eyes as a guide, the child infers what's on the adult's mind. In a January 13, 2007 Op Ed piece in the New York Times, Tomasello wrote:

The idea is simple. Knowing what another person is looking at provides valuable information about what she is thinking and feeling, and what she might do next. Even young children know that when a person is looking at one toy and not another, she most likely prefers that toy and may reach for it.”

It's one thing to follow the eyes of another person; it requires an additional skill to conclude that gaze means attention and therefore thought and possibly action. At around 9 months infants start to understand that other people have goals and that their behavior reflects those goals. Shortly after that they learn the role of the eyes in revealing others' goals.

Once a child connects gaze and attention, the next step is to connect gaze towards an object with a facial expression. In 2002, Ann Phillips and Henry Wellman, both in the Psychology Department at the University of Michigan, and Elizabeth Spelke, currently professor of psychology at Harvard, conducted a series of studies which tested whether, and at what age, children learn to put eye gaze and facial expressions together to predict others' actions. In Spelke's experiments, a child watches an adult interact with two almost identical stuffed toys. The adults do one of two things. Some look joyfully at one toy and then pick it up. Others do something more unexpected. They look joyfully at one toy, but pick up the other one. In all cases, they are picking up the toy – the only difference in these scenarios is where the adult looks before they pick it up.

Using the notion that children look longer at situations that are new or surprising, Spelke and her team measured the children's reactions to these scenes by how long they stare at each one. The 8 month olds in the study looked just as long at both scenarios, implying that they weren't surprised by anything they saw. But the 12 month olds looked longer at the scenario that seems a little off – the one in which a happy expression towards one toy was followed by an embrace of the other toy. The 12 month olds, Spelke concluded, have certain expectations: when an adult looks at an object in a certain way, the child expects a certain kind of behavior. When that expectation is not met, the child is understandably surprised.

This kind of mind reading may seem incidental, but in fact it's a precursor to skills that are critical to our social existence. These predictive powers will eventually help us make sense of others' actions. (A woman shuffles through a box of toys and because

she looks into the box we understand she is searching. Imagine the same scene with her eyes up to the ceiling.) Reading eyes helps us communicate. (An office mate tells me *this is such a mess* and I know what she means because her eyes are fixed on the book case.) It helps us work cooperatively with others. (Two friends are talking. Their fixed mutual gaze keeps me from interrupting.) These early intention-detectors are also forerunners of the fight or flight gaze interpretation mentioned earlier. (Beware the angry gaze!) And they trigger our empathetic impulses. (A woman looks adoringly at her child and we can't help but sense her joy.) These activities are second nature to us in adulthood, but we learn the ropes in infancy.

By about 12 months children develop another important ability – they are able to understand the idea of a shared world. This goes beyond recognizing that an adult is attending to an object. With this new ability, the infant knows he is part of the scene. This skill is known as “joint attention” or “shared attention.” The child and the adult can attend to the same thing and know the other is attending to that thing. Here are the roots of vital engagement. Joint attention has been implicated in everything from language learning to emotion regulation. Simon Baron-Cohen writes, “What does one need in order to be aware of a shared universe? What can give you the feeling that you have made contact with someone else’s mind, and that someone has made contact with yours?” He proposes an innate shared-attention mechanism that relies on the information we get from watching where others are looking. This sharing of experience is a big deal for a small child. We see what others see and so we share an experience. We are both living beings in the same universe.

According to Tomasello, the way in which our eyes have evolved makes it easier for us to engage in shared attention. Humans are the only primates who have eye whites, he writes. Apes have a murky brown color instead so the contrast between their iris and the rest of their eye is not as sharp. This makes it harder to tell which way an ape is looking.

Tomasello believes the design of our eyes has evolved alongside our social abilities. In his New York Times article, he proposed the “cooperative eye hypothesis” and suggests that “especially visible eyes made it easier to coordinate close-range collaborative activities in which discerning where the other was looking and perhaps what she was planning benefited both participants.”

“If we are gathering berries to share,” he wrote, “with one of us pulling down a branch and the other harvesting the fruit, it would be useful – especially before language evolved – for us to coordinate our activities and communicate our plans, using our eyes and perhaps other visually based gestures.” Our eyes might have served as pointers, in a sense, to facilitate close group interactions.

But learning to use eyes as intention detectors must be only part of the story. If infants understand that when an adult looks at an object she perceives that object, then what happens when the infant realizes he is the object of attention?

### ***The Apple of Her Eye: Reading Emotion***

When Barron was a baby, his mother’s eyes were on *him* and our conversations changed. Previously, she and I had talked eye to eye across lattes and glasses of wine, dissecting the past and predicting the future. Now, the future was in her arms, and he was

hungry. Some have estimated that during breast feeding, a mother spends 70% of the time looking at her child's face. Psychologists have long thought that in sighted children, attachment between mother and child relies heavily on direct gaze. Maxson J. McDowell, a psychiatrist in New York, believes a child sees himself for the first time in his mother's eyes. In a 2004 article in the Journal of Analytical Psychology, McDowell wrote:

Just as the infant's body develops 'within' the physical container of the mother's body and her actions, so the infant's sense of self develops 'within' the psychological container of the mother's inner life. That is, it develops 'within' the mother's awareness of an inner response to the infant...If the infant could speak the infant might say: I see that my mother sees me as lovable, so I see myself that way too.

According to McDowell, the mother and child sense each other's inner lives in part through the eyes. There are other factors as well, of course, and if the child's vision is impaired, the sense of each other's inner lives develops through the other senses. But a sighted child will not only look more at eyes than other parts of the face, but will also look more at eyes that are looking at him or her. Some suggest it's the movement and the contrast of the eyes that make them irresistible to infants: dark circles within gleaming white bulbs darting from here to there. Maybe, suggests McDowell, it's that the movement of the eyes alone can signal to the infant when his mother is paying attention to him. If her eyes follow him, he knows he is the center of her attention. The other senses, like hearing and smell, offer no clue to the child that the mother is paying attention – the infant can't tell when his mother is listening to him, unless she responds



explicitly. It's instant feedback to the child whether he is or isn't seen. For a child who is relatively helpless in the world, it is important to know that someone is watching attentively – to know that his needs and wants can be detected. And the feedback goes both ways. Some studies have shown that a mother plays longer with a baby who makes eye contact with her. The parent and child engage each other.

While scientists and mothers have known for decades that babies react to and prefer faces that are looking at them, functional MRI technology now allows us to peer inside the brain to see beyond the child's overt behavior. This is high tech mind reading. We now see not only how children behave, but also how their brains react when someone looks directly at them.

Toby Grossman, a research fellow at the Centre for Brain and Cognitive Development at Birkbeck College, used this technology to find out how the minds of 4 month old children react to eye gaze when faced with an angry face. In his 2006 experiments, Grossman and his colleagues showed children pictures of angry faces, neutral faces, and happy faces. In each case, the eyes were either looking straight ahead at the viewer or looking off to one side (with the face straight ahead in all cases).

The 4 month olds had different neurological reactions to the angry face looking at them than to the angry face looking away. Evidently, based on the direction of the eyes, the infants can tell the difference between an angry face that's 'about me' and one that is 'not about me.' This fMRI result doesn't necessarily mean that the child's overt behavior reflects his brain power at 4 months. But the mind is often sensitive to information before we can make use of it. "Eye gaze," says Grossman, "is a very important factor in emotion

perception and is of great importance in social interaction in general.” It is “part of the development of our social brain.”

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Last summer I sat on Coney Island beach watching a young boy splash in the ocean. His father sat on the shore, keeping a close eye. The boy, about five, jumped small waves, dunked himself under water, and kicked water up as high as his head. And in between each dip, he looked back to see if his father was watching. If the father was indeed watching, the boy went on happily. If not, he splashed his way out of the water, ran through the sand to where his father sat, placed two eager hands on his shoulders, and said, "Watch me!"

Had I watched that scene today, I might wonder which part of the boy’s mind was flickering on and off as his father’s eyes rested on him, then off, then on again. I might wonder how does that “watch me” impulse evolve? What function does it serve? How does it touch our adult lives and our daily social exchanges?

## **THE EYES HAVE IT**

When I was in middle school, my friends and I used to challenge each other to staring contests. The goal of the contest was to look into someone’s eyes as long as you could without laughing or looking away. The first to do either lost. Looking back now, it seems silly. Why is a prolonged gaze so challenging that a child’s game emerged from the struggle? Why, even in adulthood, are we careful not to stare too long at someone?

Social psychologists Robert Kleck and Judy Hall believe that direct gaze will make any facial expression appear more intense. Hall, a professor at Northeastern University, says “People have their limits with gaze – it’s very physiologically arousing.” Our heart rate increases, our palms moisten and our brains are taking note that we’ve connected to another person. Like others, she speculates that the arousal comes from the potential for action. “It’s an evolved response. If someone is that close it can be very dangerous. It’s an alerting thing. If someone is one inch from you, your body says ‘notice!’ Whether you see [the closeness] as wonderful or awful that’s another step.”

“Normally it’s uncomfortable to stare,” Kleck explains, “because for our ancestors, eye contact was a threat.” Some remnants of this reaction to gaze are still palpable. I interviewed a Harvard Business School professor who told me, “You have a very fixed gaze. That may make some interviewees self-conscious.”

“No one has mentioned that,” I responded.

“I don’t have the good graces to ignore it,” he smiled.

But generally, if the facial expression is non-threatening, says Kleck, eye contact offers positive feedback. Direct gaze signals attention and when someone is attentive it makes us feel liked. “What about love?” I ask him. Think about how often the average person looks at you on any given day, he says. Of course you’re going to be affected if someone pays more attention to you than the average person.

It’s hard to resist that logic of love, but I suspected there was more to it than that. How is it that eyes ensnare us? I’ve had crushes that have lasted only as long as our glances were unspoiled by introductions and small talk. The gaze alone was enough to

induce a trance of attraction, an intoxication of sorts. Some species poison their mates to the point of paralysis – just long enough to get the job done. Maybe our eyes are our poison. Maybe we stare each other into submission, paralyzed long enough to fall for each other – long enough, perhaps, to willingly reproduce. This vital engagement is vital indeed, but what really happens during this trance which magnetically pulls us to each other?

### *Love*

The racy magazine *Cosmopolitan* has long served as a how-to manual for young love-struck women. One article claiming to help women answer the question “is he looking for love or sex,” quotes an expert: “Holding intense eye contact for more than five seconds doesn't happen naturally, so he may be using the look as a seduction technique to get you into bed.” Another *Cosmo* article entitled “The Silent Ways He Says I Love You” makes the opposite claim. If “you catch him staring at your eyes,” it means he loves you. “Guys are guarded when it comes to showing emotion,” the article claims. “If they lock eyes for a full-tilt, unabashed stare, they're lowering their shield to let you in. ‘I'd never hold that sort of eye contact with anyone else, but an intense gaze with my girlfriend reflects how comforted and captivated I am by her,’ says Chip, 29.”

Flirting advice stresses the importance of eye contact, though any pro knows that the real trick is the dance between looking towards and away from your object of affection with the timing of a prima ballerina.

*Cosmo* wisdom aside, eye gaze plays a big role in attraction and scientists have been trying to decode that mysterious link for decades. In 1970, Harvard psychologist

Zick Rubin created a “love scale” on which couples reported how intensely they loved each other. He then measured how much eye contact they made while talking with each other and found that the more a couple reported to love each other, the more eye contact they made. Whether this study is convincing or not, it conjures up a persuasive array of bulletproof, laser-beam on-screen gazes that precede a long-awaited kiss. Images of new lovers locked in each other’s eyes are as wonderfully commonplace as images of long-time partners comfortably directing their gaze elsewhere, secure in the knowledge that out of sight does not mean out of mind.

More recently, in 1989, Art Aron, behavioral psychologist at the State University of New York at Stony Brook, conducted his own study. He asked people to write stories about what happened when they last fell in love. Aron found that eye contact played a surprisingly large role. Among those who fell in love at their first meeting “our eyes connected” was a major factor. He found a similar sense of connection in 1998 when he brought pairs of strangers into his lab and asked them to perform a series of tasks designed to help them get close to each other. In one task, pairs who had never met before looked into each others eyes without talking for 2 minutes. The couples reported that this exercise made them feel extremely close. One of the first couples who participated in this study later got married, Aron told me.

When I asked him why he thought the eyes had that much power he surprisingly said he never thought about it. Maybe, he speculated, eye contact represents honesty and openness. Maybe it indicates directness. “The single strongest most common indicator in accounts of falling in love is eye contact,” Aron said. People want to feel a reciprocal

liking and eye contact often serves that role. I wondered if Kleck was right; love emerged when someone we thought well of showered us with gazes.

The strong link between love and eye contact that Rubin, Aron and others have found, might be explained in part, with the findings of another research team at University College, London. In 2001, Knut Kampe, Chris Frith and colleagues found that when people looked at an image of an attractive face looking at them, this activated the same areas of the brain that release dopamine when we are rewarded. When the eyes of an attractive face looked away, fMRI measurements showed less activity in the reward systems of the brain. In other words, an attractive face that's looking at us is a kind of gift.

Neil Macrae, professor of social cognition at the University of Aberdeen, pushed these findings even further. His question was, *does gaze affect how attractive we find someone?*

In an article entitled *The Look of Love*, which appeared in *Psychological Science* in 2005, Macrae, along with colleagues, conducted two experiments. One asked the question, "How likable are you?" and the other asked, "How attractive are you?" In the first experiment, subjects looked at animated faces of attractive women, in some cases shifting their gaze towards the subject, in other cases shifting away. On a rating scale of 1-5 the subjects were asked to rate how likable the women were.

The ratings were higher when the target faces were turned towards the rater, giving the appearance that the faces were paying attention to them. When the rater was 'engaged', the rating was more favorable than when he or she wasn't. The authors

concluded that gaze shifts affect how we evaluate others. Translation: we find people more likable when we think they like us!

In the second study, the male participants rated the images of women who were looking at them as more attractive than the women who weren't looking at them. The female participants, on the other hand, did not experience this bias. Whereas likeability is a factor that was relevant to both the men and the women in the study, attractiveness was only relevant to the men. The female participants were not affected by gaze shifts when asked to rate the attractiveness of women's faces. The simple gesture of direct eye contact seems to play a role in how we see people in contexts that are socially relevant to us.

These studies of love in the lab seemed to all support the same claim. Whether we observe behavior or the brain, narcissism fuels love – we are deeply affected when someone takes enough of an interest to look at us. It's captivating to be locked in a gaze by the light of a candle or the moon. But is gaze the only allure our eyes hold? What about the eye itself? What I remember most about candle-lit eyes is the center of the eye – the color of the iris and the pupil, widening and constricting.

### ***The Better To See You With***

Pupil dilation has been studied for decades and has been found to correspond to arousal, both sexual and emotional. Eckhard Hess, formerly professor of psychology at the University of Chicago, was one of the pioneers of the field of pupillometry. He conducted a series of experiments in the 60s and 70s, which showed that men's pupils enlarged when they looked at artificially enlarged pupils in women. He and colleagues

showed male viewers two pictures of a woman that differed only in the pupil size of the model. In one version of the picture the pupils were very large and in the other, very small. The male viewers found the women with the enlarged pupils more attractive than those with the small pupils, but none of them noticed the difference in pupil size. Many studies since then have shown that our pupils dilate when we look at images that we find arousing. This claim, I decided was worth putting to the test.

A few weeks ago I sat across from the man in my life, Jeff, in a sandwich shop in Concord. “Look at me,” I said. He did. I stared into his pupils.

“They’re not dilating,” I said, not to inform but to accuse. I said I’d read that dilated pupils signal attraction. In the fourteenth and fifteenth centuries, women used to put Bella Donna in their eyes to make themselves more attractive, I told him. It’s a plant extract, an irritant, that makes pupils dilate. How the women of 14<sup>th</sup> century Italy knew its effects is beyond me.

“Belladonna,” Jeff said, “there’s a porn star by that name.”

“Does she have big pupils?” I asked.

“Yeah, her pupils are huge.”

Earlier in the week I interviewed an engineer and his robot. The robot was shiny red, the engineer’s eyes blue and the room brightly lit. As he talked about the robot I looked at his eyes. His pupils were wide open. I couldn’t stop looking. I worried about how he’d interpret my gaze, “possessed” or “blank” or “piercing.” I felt my eyes fixate on his and I caught only every few words he uttered but I couldn’t help it. His pupils



were huge in a brightly lit room, it didn't make any sense. Then I remembered what I'd read and I smiled. Maybe I even pushed my hair behind my ear.

"The roboticist's pupils were dilated," I told Jeff, "and this room isn't even that well-lit."

"I'm not that sensitive to light," he explained.

"That's hardly the point," I said.

"Let's test this right now," I offered, "look at me and think raunchy thoughts." He did. I did. We stared. We thought. The corner of his mouth went up like it does when he thinks raunchy thoughts. This made the corner of my mouth go up. We stared. We thought. It occurred to me that we rarely look into each other's eyes. He wears glasses and there's always a glare. Looking at Jeff's eyes across the table, reflecting on all our evenings together talking about eyes and robots and god and evolution, over wine and cheese and my favorite seeded bread, aptly named Seeduction, my skin began to feel warm.

"It's working!" he said.

"It is," I answered.

#

If love is blind, it seems we go in with our eyes wide open. Our entire bodies respond to eye contact. Heart rate increases, skin heats up, brain chemistry changes – we are entranced indeed. But not all responses are physiological. We remember certain gazes. We assign meaning to them, and when we fall in like or lust or love, we often feel it's something about the eyes that initially connected us.

Some gazes have imprinted themselves in the same recesses of my mind as events that changed my life. My grandfather's resigned look when I came to see him for the first time since he was diagnosed with cancer. The look that became all too frequent at the end of my last failed romance – the one that accompanied *I'm sorry* and *I don't know what else to do*. Jeff's unwavering look the first time we met, when he interviewed me for an editorial job. The mutual look my sister and I struggled in vain to avoid at a wedding sermon given by a lisping rabbi – the look that burst the dam of laughter beyond repair. These are some of the gazes that even on second hand reflection call up the same emotions I felt when I experienced them for the first time. But these are rare.

From our earliest days we know we look to the eyes for clues about thoughts and emotions. We respond not only to eyes, but to things that resemble eyes (two dots placed side by side suggest eyes to a child). We perform for our parents calling “watch me!” when their attention wavers. We learn the close tie between seeing and perceiving — between the eyes and the mind – and we experience a sense of vital engagement when we know we are the ones on another being's mind.

But we aren't always watched when we feel watched. We think someone is looking at us from behind – we turn around and no one is there. Someone seems to be staring at us in a crowd but when we look their eyes are not on us. The eyes in a painting appear to follow us around but only in the movies do they really follow. Why are we sometimes tricked into feeling watched, and how easy are we to fool?

The eyes on my childhood doll Lola made it easier to turn her into a playmate, but when I poked her eye so hard it turned upward, I wasn't bothered by the distortion. A

close up photograph of a face is powerful and intimate and I can almost persuade myself that the eyes are looking at me. But it's not so convincing that I'd have trouble tearing the photograph in two. On the other hand, living eyes that are no longer living are difficult for me to dissociate from the life they once had. I don't eat fish when the eyes are still set in the face; I can't pull the head off a shrimp when those little black bulbs are attached. The insinuation of life is too strong. The life extinguished, too palpable.

Why do eyes that don't see trick us and how much of an eye does it take? How far from the real thing can we get and still feel engaged? Eyes are as vital and mundane as breathing – are we even aware of how they affect us?

## **EYE SEE YOU**

### ***Eye on You***

Psychologists at the University of Newcastle had similar questions. In 2006 they conducted a study at the coffee house in the University's Psychology Department. The coffee house works on the honor system. The prices for coffee, tea and milk (the only products on sale) are listed on a small poster and buyers are expected to leave their payments even though there is no attendant present to collect the money.

The story goes that the woman who ran the shop suspected that not everyone was leaving what they owed. So the researchers, Melissa Bateson, Daniel Nettle and Gilbert Roberts devised a simple experiment. Each week, for ten weeks, they put a different banner alongside the price listing. One week they put a picture of a pair of eyes, the next week flowers. They alternated eyes and flowers each week and each time the pictures

were different from the time before. So, no pair of eyes was repeated and no floral picture was repeated.

The eyes were photocopied images from photographs of people in magazines and the region from the bridge of the nose to just above the eyebrows was shown. Some of the models faced the viewer directly and others kept their faces slightly turned, but in all cases, the eyes faced forward. Each of the five eyes were expressively different. One gazer was angry. His eyes were opened wide so that the entire iris was showing and the whites of his eyes were prominent. Other glances were more seductive and playful and even expressionless.

Forty-eight members of the Psychology Department had access to the coffee house. The experimenters did not directly observe the participants. Instead, they recorded the amount of money that was left by the consumers, and monitored the coffee, tea and milk supply.

What the researchers found over the course of the ten weeks defied even their expectations. On average, when eyes were shown near the price list, customers left 2.76 times more money than when flowers were shown. Each week that an image of eyes was shown above the price list, consumers left more money than when the flowers were shown. The researchers concluded that the images of the eyes “motivate cooperative behavior because they induce a perception in participants of being watched.” “The human perceptual system,” they wrote, “contains neurons that respond selectively to stimuli involving faces and eyes.”

What the researchers did not discuss was that according to their graph, which plotted the amount of money left when each image was shown, customers left more money during the two weeks that male eyes were shown and they left drastically more money during the week when an angry man's eyes were shown. The difference is quite startling, though these examples may be too few to generalize. The slowest week gathered an average of about 2 pounds (during this week a flirtatious woman's eyes were watching). The most lucrative week gathered an average of about 7 pounds (the angry man).

If we are so sensitive to eyes that even a photocopied pair is enough to make us more honest, more cooperative in a sense, how else might our eye-sensitivity be exploited?

### ***Eye Robot: Meeting the Machines***

A few months ago I stood in front of a creature, the likes of which I've never seen up close. This creature was a humanoid robot named Domo. Domo has no face, just a set of eyes mounted in metal. He has arms and hands and torso. On the surface, Domo is little more than metal and wires squeezed together to form a moderately convincing human-like silhouette. But Domo is much more than that.

Aaron Edsinger, Domo's creator at the MIT Artificial Intelligence Lab, hunched over his computer typing instructions to the robot. When Edsinger finished, Domo stirred. His head, which until then hung lifeless, inched its way up the way an uncertain child or disoriented adult might; the way Frankenstein might have, awkwardly, as if

learning how to do it for the first time. What would be Domo's face, if he had one, moved upwards and in my direction, and eventually our eyes met.

There is an element of the grotesque in Domo; his wires are reminiscent of exposed veins and his metal, solid bone. But as his face found mine, I smiled, foolishly, inexplicably. And even more inexplicably, I felt the need to introduce myself. I resisted.

No matter how crude the eyes, there is something powerful in being the object of a being's gaze. This is what roboticists are counting on when they build their robots' eyes. Domo's eyes are as big as golf balls and just as spherical. Wires worm out of the sockets and only gray plastic lids cover part of his upper eyes. His irises are blue and his pupils are black. They are clearly fake. But still. Edsinger says that before Domo had eyes people were much less interested in interacting with him. "They'd come over and look but they lost interest quickly." Domo's eyes drew people in. Edsinger himself used to focus on the hands in Domo's early days, but when he mounted eyes in the sockets, his attention shifted. One of the difficulties in getting the eyes to behave like human eyes is the way they move, Edsinger tells me. When we talk with someone, our eyes scan their faces. Our eyes move from their eyes to the mouth, maybe even to the nose, and all around the face, a fact I must've known, but never stopped to think about. Domo's eyes don't do that. And still, I smile, not into thin air, but at Domo.

Domo's eyes are similar to humans'— they have lids, pupils and his irises and are colored blue. But the eyes are human-like beneath the surface as well. They are cameras with which the robot takes in the world, and what it sees informs its reactions, just as what I see informs mine. Domo's cameras are much like cell phone cameras, according to

Edsinger, and several computer programs turn the pictures into meaningful images for Domo. Thirty times per second, the frame grabbing program turns an object in Domo's range of vision, perhaps a face, into a digital picture, like a jpeg. The face-detecting program then lets Domo know that he has seen a face and should pay attention to it by keeping it centered in its field of vision. This means turning his head to follow the face wherever it moves. When I step to Domo's left, his face follows mine. I move back to the right and he follows me again. I sense I am watched -- he sees me and I see him and any actions that follow will involve us both. Putting eyes on a robot "pushes our Darwinian buttons," says Edsinger. We are used to reacting to eyes that react to us. Any other response is unnatural.

Domo was built as a prototype of robots that might assist people who need an extra pair of helping hands. His ability to find a face and to appear as if he's paying attention is in service of that goal. Scientists like Edsinger believe that this ability will make people *want* to interact cooperatively with Domo, thereby making him more useful. But some scientists build robots whose sole function is to be sociable. These socialite robots are well-schooled in appropriate responses to a social exchange. Their brows might furl, their lids might lower, their mouths might pinch and pucker, each reaction designed as a response to a person's tone or position. But it's the eyes that signal a kind of awareness. They let us know we are the object of attention, and when a pair of eyes turns to us, says Edsinger, it's hard not to take it personally.

Kismet, the world's most famous sociable robot, was built to simulate the child-caretaker relationship. She has child-like features and communicative abilities and when

she was working (she's since retired), her eyes were her most salient feature. Her eyes are big and green; they could scan faces and made eye contact. Her eyelids moved, her eyebrows let her audience know when she was surprised or angry, her neck reached forward and her mouth, a pair of rubbery tubes, smiled and frowned.

Videos of Kismet show her interacting with others who couldn't help but respond to her with drawn out "aaaaws". She's endearing. She's cute. And according to Edsinger, her eyes are a big part of why people wanted to interact with her. Kismet's creator, Cynthia Breazeal, director of the Robotics Life Group at the MIT Media Lab, holds her own eyes closed just a second too long when she blinks. She tells me eye contact is used "to coordinate minds," even if one of those minds is gray matter and the other gray metal.

It's not that it's difficult to forget that these robots are machines, it's just remarkable how much effort it takes not to feel a connection, much like one would with the eyes in a painting. It seems that no matter how rudimentary a form robots take, whether they have a face or not, if they are sociable robots, they have eyes.

One robot I visited in his early stages was designed to be a weight loss aide. I saw him virtually naked, without the smooth, cylindrical gray body that the pictures of his future form promised. But the eyes were in place. They were ping pong balls, cut in half, with black circles drawn in the middle with magic marker, as if a child had drawn them. The eyes themselves don't do anything for the robot. That is, they don't take in any information – the camera is located above the eyes. They are there only for our benefit. They are crude, but they appear to follow faces. Cory Kidd, the yet unnamed bot's creator, said he put in the eyes to make the robot appear more friendly, to engage the



users more. Like Edsinger, Kidd says that people stop by and can't help but interact with the robot as they walk by him in the lab. He believes the ultimate users of this weight loss aide are more likely to keep up with their diets if they feel an engagement – a vital engagement – with the machine. And though the make-shift eyes currently serve only as place holders, I find myself taken in. Ping pong balls or not, they appear to be alert and paying attention. They appear to be watching.

It's tempting to assume this reaction is common only for those who aren't faced with the day to day mechanics of these robots. Surely working with the robots' nuts and bolts day in and day out desensitizes the scientists to the robots' leers. But this is not the case. Rodney Brooks, Director of the MIT Computer Science and Artificial Intelligence Laboratory, builds humanoid robots. Brooks tells me that when his students were working on Cog, Kismet's predecessor, they had to put a screen between themselves and the robot. They felt watched to the point that it disrupted their concentration. "They were annoyed at themselves for being affected in this way," he said, "because intellectually they knew what was going on."

Brooks believes that the easiest way for us to interact with machines, is not by reading instruction manuals, but by interacting with them in a way that is most comfortable for us – socially. While we may not know how to interact with robots, most of us are already skilled at interacting with humans, and the features that most signal humanness will make human-robot interaction easier. According to Brooks, robots' eyes are a critical feature of the *humanness* of a machine. We know what it means, he says, when a being looks at us. We have an intuitive response – we know it's paying attention.

And in the case of Brooks's students, even knowing the inner workings of the robot, even having been a part of its construction, couldn't break the illusion of consciousness they'd created.

I found myself sucked into that illusion when I first saw Leonardo, Cynthia Breazeal's latest creation. Breazeal and others collaborated with Hollywood's Stan Winston Studios to create a life-like creature that resembles the Ewoks on Star Wars. But, unlike the Ewoks, Leonardo is on its way to becoming autonomous – he will move on his own and respond to his surroundings. I saw Leonardo in action briefly, but I was stunned. This time I didn't smile – my muscles tensed and I was utterly speechless.

Leonardo does what few robots in the world do. He looks at an object in one direction and turns his head in another direction, keeping his gaze fixed where it was. As he fixes his gaze on me, I feel an unfamiliar self-consciousness. I know how it feels to be looked at by a stranger. I can guess from a range of possibilities what that stranger might be thinking – he likes my hair, he doesn't like my lipstick, I look like his sister, he's tired and his eyes just happened to rest in my direction, and so on.

But it's eerie to feel sussed out by a robot, especially one that looks like an alien.

This simple gesture of looking at one thing while turning his head towards another has an uncanny effect. It gives the illusion of a purposeful mind and it gives the illusion of a complex mind. The complexity comes from what seems to be Leonardo's attention towards two things at once. As his gaze is focused on me, his face turns towards something else that has also captured his attention. This dual focus of eyes and face create the appearance of competing interests, of multiple thoughts...of intelligence.

Leonardo appears conscious. His lingering gaze tricks me into believing he is looking with intent. He means to look at me. Why? What does it mean to be vitally engaged with a robot?

A gaze demands a reaction, even if the only reaction is to look right back. Even if the only reaction is to look away. Leonardo seems to expect some such reaction from me, but none of the rules of social engagement need apply. I could stare into Leonardo's eyes for as long as I want without making him uncomfortable. In fact I do stare longer than I would at a person. I could make whatever facial expression I want and Leonardo wouldn't know how to read it (not at this stage in his development anyway). None of the rules of social engagement need apply. And yet, to some degree, they do. If he is looking at me he is aware of my presence and if he is aware of my presence, we are on each other's "minds."

I know only a world in which looking at something generally means being aware of it – thinking about it. The thinking may be no more than a fleeting thought but something is happening in our minds when we look deliberately at a thing. What do creatures like Leonardo "think?" What information is he gathering? How will he use it? I have no inkling what an appropriate response to this kind of gaze might be. But all the uncertainty makes me tense. While the other robots were cute, Leonardo appears too capable of unfamiliar thought to put me at ease.

I remind myself repeatedly, deliberately that he is a mechanical device – like a car or a telephone. But it's hard to break the illusion of intent. Is it possible for something that looks like a living being and behaves like a living being not to be perceived as living

being? Our perceptions guide us through both the physical and social world. But our perceptual system is easily fooled. If it looks like a duck and quacks like a duck, then, whether it's a duck or not, we respond to it as if it were in fact a duck.

Since our first meeting, each time I've walked down the corridor in the Media Lab from which I catch glimpses of Leonardo, I tense. This is a new kind of creature, one that just might be clever enough to fool me into behaving as if it's alive. I wonder if I would feel embarrassed doing something stupid under Leonardo's gaze. Or if I could ever look to his gaze for approval. Would I be more likely to pay for my coffee if Leonardo were tending the café in the Psychology Department at Newcastle?

If our eyes, as the saying goes, are windows to the soul, what are a robot's eyes? As these machines become more life-like, and as the windows to their silicon souls give all the appearance of understanding, we will respond to them – we are programmed to. In that case, I might argue, robots' eyes will not only be windows to *their* "soul", but to ours.

## **EYE TO I**

In March of 2005, after a long legal battle between family members, doctors pulled the feeding tube from Terri Schiavo, who had been in a persistent vegetative state for fifteen years. One debate that fueled the battle revolved around the question of whether or not Schiavo was conscious.<sup>5</sup>

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<sup>5</sup> The other debate revolved around whether Schiavo had expressed to her husband the desire to be removed from life support if she should ever be in a persistent vegetative state.

In various reports, particularly from Schiavo's parents, she was said to have maintained eye contact with her mother and track a balloon across the room. These were activities often offered as evidence that Schiavo may have been conscious, despite consistent doctors' statements that such actions were reflexive rather than voluntary. A New York Times article quoted Ronald Cranford, neurology professor at the University of Minnesota, who examined Schiavo: "'She is not visually tracking,' Dr. Cranford has said. 'She is not looking at her mother, she is looking into space.'" At the most basic level, open attentive eyes are such strong indicators of an active mind that it is difficult to doubt even in light of hard evidence to the contrary.

What do eyes tell us about consciousness? I don't need to look at myself to know I exist. Even when I close my eyes something stirs in the darkness – not a voice exactly but a communicator of sorts, circulating signals within. It is only into my own mind that I have this privileged access, but as I watch people flip through the pages of a book, or look both ways before they cross the street, I assume they experience a similar consciousness.

A philosophy professor of mine once told me that as a child he struggled with the puzzle of other minds – how could he know for sure that his wasn't the only conscious mind? I remember a similar conundrum during a family trip when I was young. It took place in my father's car, the site of many attempts to make sense of the world. My father always drove, my mother sat next to him and my sister and I shared the back seat, careful not to cross the imaginary line we drew between us to preserve our respective territories. On this particular trip I wondered, *how can I know for sure that the minds of my father,*

*my mother and my sister are working in the way my mind is working? How do I know they are more than mere objects in the universe I've created in my own mind? All the things I think and feel, all the things I see and react to – do they exist in my world alone? No? How could I be sure?*

The test I devised wasn't worthy of the question and would likely have carried with it some form of punishment. *If I pinched them, one by one, I thought, can I be sure they'd scream, or can I will them not to? And if they scream how would I know that their scream is associated with pain and not a rehearsed response?* I wanted to try it...so much. But I held back and the question remained a while longer.

Now I'd say my professor and I weren't paying attention.

I don't need to look at myself to know I exist, but if a stranger looks at me I believe that I exist in his mind<sup>6</sup>. Just as he might call out my name or point his finger in my direction, his eyes point his mind to me. When my father stood eye to eye with a buffalo, each being was aware of himself and of the other, and while it's hard to say what the buffalo experienced, my father could at least feel certain that he existed in the buffalo's consciousness.

Once I sense that I am present in another person's mind, I can't help but wonder, *who am I in that mind?* If seeing is knowing then what is it that the other mind knows about me when it sees me? I suppose it depends on who's looking. We see ourselves differently in the gaze of those we love, those we don't know, those with whom we have

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<sup>6</sup> Those who are blind sense other beings in different ways, through touch, through smell, through language, through context, through a passing breeze as someone walks by. But there isn't the same kind of spontaneous mutual recognition from across the room.

strained relationships. We are ourselves, yes, but to some extent our personal narratives – what we say about ourselves – are affected by others' gaze. We are different versions of ourselves in their minds and to some degree we carry those impressions with us. Indeed, some of our self identity is formed by how we think others see us. Judgmental eyes, approving eyes, dismissive, loving, hateful, admiring eyes all create a momentary self. We may feel ashamed, envied, liked, hated, inhibited, disdained, important. Gaze can even make us feel ignored or rejected if the gaze doesn't linger. Whatever we believe the gaze conveys, for the moment that version of us exists in the other person's mind and is reflected back to us.

French philosopher Jean-Paul Sartre wrote extensively about "the look." When we look at a man in a park, he suggested, we view the scene from our perspective. We see the trees, the bench, the man himself through the filter of our own consciousness. But what happens when the man looks directly at us? Suddenly we become aware of another consciousness and therefore another perspective. The man views the trees, the bench, even us through the filter of his own consciousness and we have no control over what he sees. He has his own values, his own judgments that affect how he looks at us. As soon as we are seen we are subject to someone else's image of who we are.

As a child in summer camp I danced in my room with the girls I shared a bunk with. The boys were on the floor beneath us but they invariably found excuses to wander the halls of the girls' floor. This was a welcome diversion which we dutifully treated as unwelcome. Despite the fact that I joined my friends in protest, I secretly imagined being watched by curious preadolescent boys. My friends and I used to dance in our room and I

conjured up audiences who I placed just behind the locked door, eyes peering through the keyhole. I danced happily for my imagined admirers until one day I spotted a blink. I immediately stopped – mid-kick, aborted turn, off my toes, feet returned firmly to the ground. This was no imagined eye, this was the real thing. In this eye I was not what I imagined myself to be. I was something other. But what I was I couldn't possibly know.

In *The Unbearable Lightness of Being*, Milan Kundera wrote:

We all need someone to look at us. We can be divided into four categories according to the kind of look we wish to live under.

The first category longs for the look of an infinite number of anonymous eyes, in other words, for the look of the public...The second category is made up of people who have a vital need to be looked at by many known eyes...Then there is the third category, the category of who need to be constantly before the eyes of the person they love...And finally there is the fourth category, the rarest, the category of people who live in the imaginary eyes of those who are not present. They are the dreamers.

My categories are the third and fourth. I am most myself in the gaze of intimate and imaginary eyes. They give me the sense that there's a purpose to my presence in the world. If no one is watching I still exist, but why do I exist? This need for imaginary eyes is likely what made me a writer. Even now as I write I am formulating these sentences for an imagined audience. I'm less trusting of an actual audience.

I think Kundera is right – we need to be watched. We take comfort in the idea that people we have lost are watching over us. We preserve their gaze in part because with it comes the version of ourselves that lived in that gaze.

We seek an approving gaze and fear critical ones. In one of his early films Woody Allen created a character who dreamt that his parents were watching and evaluating his performance when he had sex. My slightly less neurotic version of that dreaded dream is that as I write my most intimate experiences in my journal, my father watches over my shoulder and points out my spelling mistakes.



Eyes are everywhere: parent eyes, sibling eyes, friend, enemy, stranger eyes, pet eyes, portrait eyes, camera eyes, window eyes. We make eyes of things that aren't eyes – two bottle caps above a grimacing rubber band, two weepy eggs sunny side up with a strip of bacon laid below, in crisp austerity. Eyes are among the first things we focus on as infants, and as we grow we learn to use them to peer into the inner worlds of others. We watch and we are watched and so we move through the world.

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