

# Uta Frith's thoughts on the Theory of Mind and Autistic Deficit: Dialogue between Art and Neuroscience

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## Abstract

The contemporary scientist and German developmental psychologist at the Institute of Cognitive Neuroscience of University College London, Uta Frith has mainly focused her research on autism spectrum disorder and the related theory-of-mind deficit. To explain the autistic mentalistic deficit, the psychologist has used a specific tool: art, her initial pursuit cultivated at the Universität des Saarlandes, in Germany. Thus, this work seeks to reconstruct the artistic influences on Uta Frith's scientific efforts, highlighting how the dialogical intersection of two seemingly distant disciplines, like art and neuroscience, can generate surprising new networks of signification and an understanding of the intrapsychic and interpsychic worlds. Art challenges us to develop moments of neuroscientific knowledge. On the other. In contrast, neuroscience offers the opportunity to develop further insights into the role of visual perception in contemplating works of art.

## Keywords

Uta Frith, Autism, Theory of Mind, Art, Neuroscience, Georges de la Tour, Mirror Neurons

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## 1. Introduction

What does it mean to take on another person's perspective? How does one arrive at evaluating social objects? What conditions push an individual to make mental inferences and automatic deductions about others' behavior and the underlying intentions governing that individual? These and other research questions prompted the curiosity of the German Uta Frith, contemporary scientist and developmental psychologist at University College London's Institute of Cogni-

tive Neuroscience, and her research group to undertake a quest to explore how the autistic brain functions [1].

Fascinated by the autistic cognitive system and its enigmatic brain functioning, the psychologist's research has focused mainly on autism spectrum disorder and its related difficulties. Together with her research group, she has posited several theories on autism, including the theory of mental blindness and of weak central coherence.

The former has been confirmed by studies and neuroimaging techniques and explains autism's inability to intuitively mentalize. The second theory has demonstrated that individuals with autism have a special ability to identify and localize details and, at the same time, an inability to process the context [2].

However, although her research is known internationally, little is known about her family and pre-psychological training.

Born in Rockenhausen in 1941, Uta Frith was raised in Kaiserlautern and attended a boys' classical studies high school. She then enrolled at the Universität des Saarlandes, in Germany, where she had the opportunity to study various subjects, including art history, probably influenced by her family's great interest in this discipline. Uta Frith's father, Wilhelm Aurnhammer (1907-1984), was an expressionist artist in Munich. He had been part of a circle of young artists to whom the Nazis denied the right to exhibit their works of art. Following the war, she became an enthusiastic art teacher, mainly adopting a geometric style. Inspired by the landscapes of southern France, she created hundreds of sketches of rocks and trees. Her father's artistic influence undoubtedly explains his daughter's choice to first study art history at Saarland University in Saarbrücken and then move on to experimental psychology [3].

The history of art became the very tool the psychologist used to explain the-theory-of-mind deficit in her book *Autism: Explaining the Enigma*, using a painting from 1635. By examining the perception of art as an interpretation of sensory experience, scientific analysis can, in principle, describe how the brain perceives and visually processes a work of art. This allows for a dialogic intersection between two ostensibly distant areas of knowledge: the science of the brain and art.

## 2. Mentalizing through Art

When interacting with people, one quite automatically tries to understand what they think or believe in order to act better in the social interaction itself, by using a specific tool and mental-processing mechanism defined as theory of mind (ToM) [4], understood as the ability to attribute beliefs, feelings, desires, and intentions to oneself and to others [5].

People with autism have a theory-of-mind deficit because they cannot implement this representation processing of their own and others' mental states, and so, nor of understanding or predicting others' behavior [6]. The term "mentalization", essential to all forms of social communication, has been assigned to this

inability to attribute mental states [7], whose impairment in autism explains the lack of reciprocal social sensitivity [8].

This mental blindness plays an important role, for example, in interpreting works of art. Frith selected the Caravaggio-inspired, *The Cheat with the Ace of Diamonds* by Georges de La Tour (1593-1652), exhibited at the Louvre Museum, to explain autistic mental blindness in her book, *Autism: Explaining the Enigma*.

The painting depicts four people: a woman and two men are seated at a table and playing cards; a maidservant stands behind the lady. The lady and the maidservant look curiously at the player on the left. In turn, he looks towards the observer while hiding two aces behind his back. Not only is the lady looking at the player on the left, she is also pointing at him with her right index finger. Meanwhile, the player on the right is looking thoughtfully at his cards.

To understand the drama taking place, some mental inferences must be made, as it is impossible to know the characters' mental states. However, they can be deduced if we make some mental inferences regarding the variety and plurality of each of the characters' perspectives. Their facial expressions, gestures, and gazes are essential elements that guide the observer toward deductive interpretations of the canvas. If it is mentalized, then it is understood that the painter has portrayed a situation in which someone is cheating.

The aces hidden behind the back of the player on the left are clues that let us understand that someone is cheating. According to theory of mind, we automatically infer that the other players do not know what they do not see.

Another clue is the maidservant, who scrupulously observes the cheating player as if she had discovered the cardsharp and wanted to communicate this to the lady. While the maidservant probably knows, the cheater does not know that she knows, as his facial expression is very unruffled. Another clue is the lady's index finger, which seems to be pointing at the cheater as if she had realized the situation.

The last clue is seen in the player on the right who does not look up from his cards. Consequently, the painter seems to want to tell us that he is unaware of the drama unfolding and, accordingly, we conclude that, most likely, he will be the one cheated. Therefore, let us note how this artistic experience has determined, through contemplative observation, the possibility of connecting with the world depicted by the painter due to the activation and dialogic interaction of the cognitive and emotional functions.

As an observer, any of us can cognitively and emotionally agree with the depicted characters' beliefs and intentions as endowed with a theory of mind that pervades our perception and interpretation of the artistic and social worlds.

### 3. Art and Neuroscience: Dialogic Knowledge

In 1959, the molecular physicist who later became a novelist C.P. Snow stated that western intellectual life is divided between two cultures: the scientific, which deals with the universe's physical nature, and the humanistic (literature and art),

interested in the nature of the human experience. Snow argued that scientists and humanists “should build bridges, to further the progress of human knowledge and to benefit society” [9].

Uta Frith’s use of Georges de La Tour’s *The Cheat with the Ace of Diamonds* to explain the difficulty of mentalization in the autistic syndrome leads to considering the relationship between two areas of knowledge: art and neuroscience.

An important contribution to the dialogic intersection of these two sciences was made by Austria-born Erik Kandel, an American neurobiologist, neuroscientist, and professor of biophysics and biochemistry at Columbia University. In 2000, he was the first American psychiatrist to win the Nobel Prize in medicine for studies on the physiological basis of memory retention in neurons. Kandel used reductionism as a reference model to break complex concepts and forms down into their essential components and bring them together for a study of the brain and art, identifying a powerful energy in this reductionist approach. He argues that scientists use reductionism to solve complex problems, while artists exploit it to elicit a new perceptual and emotional response in the viewer. Thus, according to Kandel, science can shape how we enjoy works of art and help us understand their meaning [10].

The question of how we respond to figurative art was first addressed by Alois Riegl, Ernst Kris, and Ernst Gombrich at the Viennese School of Art History. They achieved international fame at the turn of the twentieth century for attempting to make the history of art a scientific discipline based on psychological principles. Riegl stressed an obvious psychological aspect of art, namely that art is incomplete without the perceptual and emotional involvement of the observer, who not only works with the artist to transform the two-dimensional figurative image into a three-dimensional representation of the visual world but also interprets in personal terms what is seen on the canvas, thus adding meaning to the image. Riegl called this phenomenon the “involvement of the observer” [11].

Drawing on ideas derived from Riegl’s work and the insights beginning to emerge from cognitive psychology, the biology of visual perception, and psychoanalysis, Kris and Gombrich began developing a new version of this concept Gombrich dubbed “the part of the observer” [12].

Kris also argued that every image arises from experiences of conflict in the artist’s life and the observer, based on the experiences of their own conflicts, recapitulates in small part the artist’s experience in creating the image [13].

To appreciate what neuroscience can tell us about the observer’s perception of an artwork, it must first be understood how our visual experiences are generated by the brain.

The visual system is fundamental for the part of the observer that contemplates a work of art. However, how is it organized? Which of the visual system’s levels of organization come into play when, for example, we look at faces in a painting, like those, and the facial expressions, of de la Tour’s painting?

In humans, the cerebral cortex, the brain’s elaborately convoluted, outermost

layer, is believed to be the most important region for higher-order cognition and consciousness. It is organized into four lobes: occipital, temporal, parietal, and frontal. Located in the back of the brain, the occipital lobe is where the visual information from the eyes enters the brain. However, the occipital lobe's visual cortex is not the only structure responsible for visual perception. Vision is the process of discovering, starting from images of *what* is present in the visible world and *where* it is located. This implies that the brain has two parallel processing paths: one for the *what* and one for the *where*. The *what's* route starts from the primary visual cortex (V1) to then reach other visual areas (V2, V3, V4). Finally, it reaches the inferior temporal cortex, where the processing of faces and objects takes place. *What's* pathway is also the only visual path that leads directly to the hippocampus, a seahorse-shaped fold of the temporal lobe that deals with the explicit memory of people, places, and objects by integrating the information received with previous experiences. Perception integrates the information received by our brain from the outside world with the knowledge learned from earlier experiences. So, when a work of art is observed, it enters in relation with our lifetime of experiences of the physical world, ranging from the people we have seen and known and environments where we have been to the memories of other works of art we have encountered.

On the other hand, *where* goes from the primary visual cortex to areas near the top of the brain. It deals with processing the movement, depth, and spatial information necessary to determine where an object is in the external world.

Therefore, once the information of the *what's* pathway reaches the upper regions of the brain, it is again evaluated, seeking what is constant. An attempt is made to abstract the fundamental, constant characteristics of objects, people, and landscapes. It is particularly important that the current image be compared with images encountered in the past. Even though our eyes provide us with the information we need to act, they do not present our brain with a finished and complete product. From the two-dimensional image on the retina, the brain actively extracts information on the three-dimensional organization of the world. This wonderful, indeed almost magical aspect of our brain means that we can perceive an object based on incomplete information. These biological results show that visual perception is not simply a window on the world but a true creation of the brain.

“The creative power of the mind amounts to no more than the faculty of compounding, transposing, augmenting, or diminishing the materials afforded us by the senses and experience” [14].

#### 4. The Autistic Mentalistic Failure

The necessary and automatic nature of mentalization, whether in social life, looking at a painting, watching a film, or reading a story, is the hallmark of a well-established brain system. Living organisms, hence, need this system to adapt to the world. However, as is known, this synchronization and identifica-

tion operation of mental states (e.g., beliefs, opinions, intentions) could be quite unsuccessful for an autistic eye not trained in understanding the subtleties of social life [15].

Generally, neurotypical children beginning at about four years of age have a the-theory-of-mind mechanism, that allows them to be aware of mental states through a specialized representational system for such mentalistic work—a process significantly impaired in autism [16].

On the one hand, if neurotypical children think that a belief is a kind of representation in the mind, images, on the other hand, can be recognized much more easily than beliefs as they are obviously public and observable. Therefore, having a conviction or a belief is to have an image in one's mind [17].

The well-known Sally-Anne experiment (known as the False-Belief Test) by Frith, Baron-Cohen, and Leslie was tangible proof of the inability of autistic children to attribute mental states, unlike children with Down Syndrome who were better at this operation.

The test presents three different groups of children (non-disabled, with Down syndrome, and with autism spectrum disorder) a scene with the two dolls, Sally and Anne, who respectively have a basket and a box. Sally puts a marble in her basket and leaves the scene. In her absence, Anne moves the marble into her box. Subsequently, Sally returns, and the child participant is asked, "Where will Sally look for the marble?". Children over the age of four, both non-disabled and those with Down syndrome, typically give a correct answer and say that Sally will look in the basket, which is where Sally (falsely) believes the marble to be. On the other hand, autistic children, due to their mental blindness, say that Sally will look in the box as this is where the marble is. However, that information is not available to Sally, and, therefore, the answer is incorrect [18].

In an attempt to investigate the autistic mentalistic deficit, Frith, Baron-Cohen, and Leslie also examined the same children from the Sally-Anne experiment in another experiment that uses comic strips [19].

Firstly, the latter consists of presenting figures that the children must put in order and make up three stories (behaviorist, mechanistic, and mentalistic) that have a logical sense, and with the first figure already in place. Second, the children had to tell the story in their own words. The order of the figures in the story and the subsequent narration determined whether it had been correctly understood. The experiment showed that children with autism had no difficulty with the mechanistic story (e.g., "A balloon burst because the branch "pierced it) or the behavioral one (e.g., "A boy enters a shop to buy sweets. He pays the seller and takes the sweets with him "), as the latter can be described without referring to mental states. However, although very capable, they instead have had serious difficulties in understanding the mentalistic stories.

A mentalistic story makes sense as such only if a state of mind is attributed to the protagonist. For example, a boy puts a chocolate in a box and then goes to play. While he is out (the logic of mentalization reasons "without the boy know-

ing”), an old lady eats the chocolate. When the boy returns, he is surprised not to find his chocolate in the box anymore (the logic of mentalization reasons that “he believed that his chocolate was still in the box”).

The children with autism evaluated in the experiment did not place the figures from the last mentalistic story in the correct temporal order. Consequently, its description was wrong due to a failure to attribute mental states. In this specific case, they could not understand the foolishness of eating the chocolate and described the story as follows: “A boy puts a chocolate in a box. His mom eats the chocolate. The boy opens the box. It’s empty”.

It is evident, from this description, how an autistic child’s mind does not have a mentalistic perspective but adopts a behaviorist grid. It is limited to observing and analyzing the manifest behavior without entering into the implicit and underlying meaning of his interlocutor’s mind to understand the intentions behind his behavior.

In an attempt to explain this mentalistic difficulty in autism, Uta Frith not only refers in her book *Autism: Explaining the Enigma* to the two experiments mentioned above but also uses De La Tour’s painting, referring to a comment on the work by a young woman diagnosed with high cognitive functioning Autism Spectrum Disorder:

At the beginning of the book, there is a painting of some people playing cards. I remember looking at this picture for about an hour, so I could understand how refined the colors were and the quality of the artist’s brushes must have been. Also, the art market of the time appears to have been well-developed since artists were given commissions for such high-quality paintings, with such realistic reproductions of the fabrics of the characters’ clothes. Of course, the most obvious thing about this painting was its remarkable realism and the artist’s skill. I continued reading the book, and I was like, “What on earth? There’s this whole “soap opera” that “normal” people are supposed to understand first: this person’s cheating, and this one knows it, and that other doesn’t. It’s crazy!”.

This example explains the failure of the autistic mind: People with autism are not automatically programmed to think about mental states. Thus, a wide range of expressive possibilities and other networks of significance in the artistic and social world open up, resulting in socio-relational difficulties and the consequent autistic social isolation. “Human beings are essentially social creatures. In what does this social capacity reside? In the ability to love, to feel sympathy, to make friends? Or in the ability to cheat, deceive and outsmart opponents? [...]. Of course, theory of mind also has positive effects: it allows us to empathize” [34].

Empathy involves sharing affect, able to simulate the other’s emotion in oneself, activating a cognitive decentralization. Is a person’s ego therefore penetrable by another ego?

Recently, the neurophysiological research on the mirror-neuron system by Italian neuroscientists Giacomo Rizzolatti, Vittorio Gallese, and their colleagues

has allowed the understanding of others' emotions. The brain areas involved are the parietal lobules and premotor areas, whose neurons are activated both when an action is being performed and when another person is seen performing that same action. The term "mirror" derives from this as it "reflects" the behavior of others in the mind [35].

Understanding others' actions and their intentions is a characteristic of our species, allowing us to interact with our fellow humans and establish empathic relationships with them. The mechanisms underlying these social cognitive skills were little known until a few years ago. The discovery of mirror neurons in monkeys and the subsequent demonstration of the human brain also having a mirror system highlighted, for the first time, a neurophysiological mechanism capable of explaining many aspects of our ability to relate to others. Mirror neurons were discovered in the 1990s in the premotor cortex of the macaque's brain (area F5). They may be activated when the monkey performs a purposeful motor act, like when grasping objects with its hand and mouth, or when it observes another individual performing other similar motor acts [...]. Therefore, in more general terms, mirror neurons constitute a neuronal system that relates external actions performed by others with the internal repertoire of the observer's actions, configured as a mechanism that allows an implicit understanding of what is observed. By observing an action, the mirror neurons induce the observer to perceive the same nervous circuit responsible for controlling its execution, namely the automatic simulation of that action [...]. These results suggest that mirror neurons can help understand the purpose of a motor act, even when not fully visible, and thus its ultimate purpose can only be inferred. The results showed that a consistent percentage of mirror neurons are activated when the monkey performs a motor act, both when hearing a noise or observing the same motor act in the absence of that characteristic noise [...]. These data show that by mapping the motor acts observed or heard on the same nervous circuits that control their execution, the mirror-neuron system implements motor simulations used not only for executive control but also to understand the meaning of these motor acts, regardless of the sensory modality (visual or acoustic) with which we experience them [...]. This means that the mirror neuron's response predicts what the agent will do next. These observations suggest that mirror neurons may play a central role in understanding actions and recognizing that the agent's intent in promoting them [...]. Indeed, the most immediate example refers to the use of facial gestures for inter-individual communication. In primates, these gestures have strong emotional connotations (e.g., threat, fear), but they can also be functional in forming relationships between two individuals. This last aspect may have been decisive in evolving that sophisticated communication system that is human language. In conclusion, the discovery of mirror neurons has radically changed our way of conceiving



perception, highlighting the role the motor system plays in it, clarifying the mechanism that allows us to explain a variety of psychophysical results on the relationship between action and perception. Mirror neurons also allow us to functionally explain various, significant aspects of intersubjectivity and social cognition, such as empathy, imitation, and language.

The deficit related to the mirror-neuron system is associated with the neuro-functional alterations present in autism, as shown by the data based on brain imaging. The result was the “broken-mirrors” theory [36], which explains the autistic individual’s inability to see themselves in the other and therefore to have an immediate and experiential understanding.

## 5. The Autistic Brain

During childhood and adolescence, the normal brain goes through growth phases and subsequent synaptic “thinning”. At first, the connections between nerve cells, or synapses, the “threadlike” connections between neurons, proliferate. Additionally, so many connections are created that they are subsequently “thinned” through a “synaptic pruning” process of neuronal reorganization. This process causes a physiological reduction of superfluous synapses in a healthy brain, essential for brain circuits and cognitive functions [21] to develop properly. In contrast, in autism, this process of synaptic pruning is compromised due to the failure to eliminate the large number of connections formed [22].

More recent studies have highlighted anomalies in the synaptic elimination process in which several genes, including MEF2C, FMR1, DLG4, and PCDH10, are involved [23]. In more extensive genetic studies, some 25 candidate genes have been identified for autism, including several coding genes for neurotransmitter/neuropeptide receptors or transporters (e.g., GABA beta 3 subunits, 5-HTT, oxytocin) and other protein-coding genes that play a role in the synaptic function (e.g., neuroligin, shank, synap-sin) [24].

Alongside the aforesaid genetic studies, the neuroimaging techniques (PET, MRI, fMRI), three-dimensional digital representations of molecular and biochemical activity, from which a data set is derived that can be statistically manipulated in 3D space, have supported the idea that not only are many brain areas involved in autistic pathogenesis [25] but also that brain activity during mentalization is weaker in autistic people than in non disabled individuals [26].

Therefore, the challenge of neuroimaging studies has only bolstered the mind-blindness theory [27]. This theory was discussed in the early neuropathological studies of autism. Among these was the study conducted by Brothers in 1990, which suggested that the amygdala, a brain structure found in the mid-temporal region of the brain and involved in several aspects of social and emotional behavior, with particular reference to the ability to recognize the emotions of others, is a crucial structure of the neural network at the basis of social behavior [28]. Furthermore, Kemper and Bauman’s study three years later identified the amygdala’s involvement in the neuro-pathology of a post-mortem

autistic brain [29].

Referring to these studies, in 2000, Baron-Cohen again took up the theory that, in autism, a dysfunctional amygdala may be partly responsible for the impaired social behavior, a distinctive feature of autism [30].

That same year, Howard discovered that, due to a dysfunctional amygdala, people with high-cognitive functioning autism lack the facial emotion recognition of fear, gaze perception, and a face-recognition memory.

Consequently, developmental alterations in the amygdala could be behind the socio-cognitive disorders typical of autism [31].

However, two other alternative models have provided an explanation for broken mirror theory: the EP-M model and the social top-down response modulation (STORM) model.

A main tenet of the EP-M model is that the pattern of behavioural difficulties and strengths in autism, particularly in regard to imitation abilities, does not support a global difficulty in the middle temporal gyrus MNS. Instead, imitation behaviour is served by two routes of three nodes, the inferior frontal gyrus (IFG), the inferior parietal lobe (IPL) and the middle temporal gyrus (MTG), and three pathways between them. Processing of all actions begins in the MTG, which extracts the visual kinematic features (e.g. the motion of a hand) of an observed action. The remaining route is then based on whether the action is goal-directed or not. For goal-directed actions, information is then sent from the MTG via the emulation pathway (E-route) to the IPL. The IPL then processes the action's abstract goal (e.g. grasping a cup to drink). This goal information is then passed on to the IFG, via the planning (P) pathway, where the motor features for action execution are formulated. If the action to be imitated is not goal-directed, this is served by the mimicry route (M-route), a direct route between the MTG and IFG, which provides a direct connection between the visual features of observed actions and motor representations. This allows for automatic imitation of observed action sequences. It is this mimicry route that is claimed to be impaired in autism, according to the EP-M model (34).

The STORM model proposes that autism symptoms stem from abnormalities within the top-down regulation of the MNS, rather than within the MNS itself. In NT (neurotypical) individuals, the MNS processes the visual-motor properties of executed/observed actions, while the medial prefrontal cortex (mPFC) imposes the social significance of those actions onto the MNS. For example, observing someone raising their arm will be processed differently depending on whether they are in a lecture or at a supermarket. This top-down modulation is argued to be reduced in autism, resulting in an impaired ability to utilize the social relevance of observed actions but a regular ability to imitate actions (via visual-motor integration) (35).

## 6. Conclusions

Uta Frith attempts to explain the relational and behavioural difficulties of people

with autism spectrum disorder through a link between brain science and the humanities, which, despite their different methodological practices and cognitive aims, enrich each other with new perspectives and points of view. Overcoming the divide between the two cultures shows how the methodologies and objectives of the scientific discipline are in fact also shared by the artistic discipline. For this reason, both can interact and collaborate with each other in order to produce a mutual expansion of knowledge. Starting from this dialogue, Uta Frith asks how the autistic brain responds to works of art; how it processes perception, emotional and empathic response to create divergent expressions of creativity and new dimensions of intellectual and cultural history. Thus, the psychologist articulately delves into the depths and complexity of the correlations between the neural mechanisms of individuals with Autism Spectrum Disorder and the conscious and unconscious psychic processes that govern artistic interpretation. Thus, Uta Frith has made possible an expansion of the phenomenology of social reality, going beyond the visible; whereas, neuroscience has, at the same time, ever more clearly demonstrated how our species' social intelligence is a social meta-cognition, which consists of the ability to think explicitly about the contents of the minds of others [32]. The union between the closely intersecting and interdependent disciplines of cognitive neuroscience and art is intriguing. "The mistake in our educational system," Gombrich stated, "is precisely in the custom of establishing separate territories and inviolable borders [...]. Art is representation, and science an explanation of reality itself" [33].

Fascinated by the enigma of the autism spectrum, Frith embarked on a quest for knowledge, which, the scientist says, "has included romantic ideas and revealed incredibly strong emotional reactions that I have long understood as a component of the fascination I feel when studying autism. It also includes some hard facts from cognitive neuroscience. I do not believe that it is impossible to combine two opposites: rigorous science and romantic ideas, objectivity and passion. The enigma of autism has given me proof".

### Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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