# CHILDREN'S PERCEPTIONS OF SCIENCE AND SCIENTISTS
# A CASE STUDY BASED ON DRAWINGS AND STORY-TELLING

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## Abstract

Children's and young people's representations of science may be important dimensions of analysis for studies on public understanding of science. Some images and attitudes about science and scientists seem to form quite early and to be relatively stable during the life, so that studying children's perception means also studying part of the cultural representations of science and technology. We propose here a qualitative analysis of drawings and tales by 8 and 9 years old Italian children, produced in the context of focus groups activities and by reformulating in a novel way the traditional "Draw-a-scientist-test" (DAST). Mythical images, representations of scientists in action, space, time and social dimensions of scientific practice, as well as gender difference in children stories and drawings are discussed, revealing intriguing levels of complexity.

Keywords: representations of science and technology, children, focus groups, Draw-a-scientist-test, qualitative analysis

## 1. Introduction

In recent years, several instruments have been developed to assess public attitudes, interests and understanding of science and scientific processes [1]. Diverse definitions and dimensions of analysis have been proposed for scientific literacy and scientific culture, and several studies were conducted to investigate different typologies of publics for science and technology [2], [3].

Several of these surveys also tried to investigate the social image of scientists and the perception of their role in society (is a scientist weird, intelligent, mad, charming, dull, etc?), looking for the prestige of science as perceived by the public, asking if scientific work is dangerous, if "scientists are helping to solve challenging problems", if "scientific researchers are dedicated people who work for the good of humanity", if they "usually work alone" and if they "do not get as much fun out of life as other people do", and so on. Public confidence toward scientists, compared to other professional communities, was also investigated, asking participants, for example, whether they had a "great deal of confidence", or not in the leadership of various professional groups, including scientists.

However, relatively few studies were focused on children's and young people's perceptions and attitudes on science [4], and most of them had an educational focus [5]. Nevertheless, such age groups seem to be very relevant for the study of public understanding of science, at least for two reasons:

a) according to some scholars, some images and attitudes on science and scientists form early and are relatively stable during the life [6], [11].
b) some levels of the social representations of science that are not easy to declare in a verbal, explicit way, or that are partially biased by some sort of "self-censorship" in surveys and interviews – being felt as politically incorrect in some sense – may be more easily studied in children then in adults

### 1.1. Young people's perceptions and the "Draw-a-scientist-test"

Research in imagery concerning pupil held stereotypes of scientists began in the mid-1950s, when the anthropologist Margaret Mead and psychologist Rhoda Métraux initiated a major pilot study in which images of the scientist held by thousands of American high school pupils were investigated [7]. The researchers' focus was the desire to ascertain "the state of mind of the pupils among whom the occasional future scientist must go to school and of the atmosphere within which the science teacher must teach". The major finding was that the image of scientist held by pupils was "overwhelmingly negative". Mead and Métraux's study was conducted with essay questions, but, as a part of the project, collections were made of visual materials related to the image of the scientist, and these included "children's drawings made in response to the instruction 'Draw a scientist'". From this initial idea, Chambers eventually created the "Draw-A-Scientist Test" (DAST) [8].

In DAST pupils are asked to draw a picture of a scientist. The pictures are then examined to see if they contain features normally associated with stereotypical images of a scientist, such as: lab coat, eyeglasses, facial growth of hair (beards, mustaches, etc.), scientific instruments and laboratory equipment, books and filing cabinets, technology and "products" of science, captions (e.g., formulae, taxonomic classification, "eureka", etc.). Besides this, other features are also recorded in the checklist, such as the size of a scientific instrument in relation to the scientist, evidence of danger, the presence of light bulbs, the sex, race, or ethnicity of the scientist, and figures that resemble Einstein or "mad scientists". Chambers found that the number of these indicators increased with the age of the child, so that by the 4th and 5th year of schooling, "the image, as a rule, has fully emerged". Later, the DAST was modified to include also a quantitative checklist of these stereotypical characteristics (the "DAST-C"), or to investigate the image of "a scientist at work" [9], [10]. Several examples of applications of the DAST exist today [11], [12].

The test seems to produce similar results to structured interviews, suggesting that the technique assesses well test takers' perceptions of scientists [9]. However, this method has three main limitations. Firstly, being thought mainly as a tool to analyze "defects" in the image of science in pupils, DAST-like studies focus only on deficits and stereotypes. While the test is suited to quantify the list of the most common stereotypes around scientists, it cannot return the whole image of scientist in its complexity, and don't show how and from which sources it is constructed. Secondly, it gives a quite static photograph of the scientist and does not permit to enter into the details of student's perceptions of what real science is: its processes, methods, etc. Thirdly, it is not always clear whether the DAST measures the students' stereotypes or if students tend to depict the scientists in such a stereotyped way in order to make their drawings recognizable. When we ask someone to draw an artist, or a professional swimmer, he will depict such characters in a stereotyped way in order to guarantee that the asker recognizes he understood the task and knows the topic.

In order to overcome these limits, we decided to use children drawings in a novel way, suited for a qualitative analysis of different levels of image of science and scientists.

## 2. Methods: focus groups, story telling and drawings

Being interested not only in the static, iconic image of scientists, but also in the dynamical aspects of how children imagine and represents scientists in action (practices, social interactions, the use of technology and instruments, as well as the epistemological tools), we used a methodological strategy based on focus groups, enriched with a DAST-like activity in a narrative environment. Children drew a scientist, invented and told a tale involving him/her and other characters and, finally, discussed together about science and scientist in the context of writing a letter to other children about the topic.

The method of focus group was chosen because it offers the possibility to set the discussion within a context. Focus groups allow people to argue on some issues comparing each person's views with the others'. They permit shifting participants' point of view thanks to group dynamics [13]. Even if this approach was originally created to collect behaviors and opinions within an adult public, it was shown to be useful to access the opinions of children, too [14]. Group dynamic has several advantages on classical individual interviews or observations:

- Children can enjoy feelings of sharing and control within peer groups;
- Children's concentration, reasoning and contributions are enhanced when working within a peer group;
- Group dynamic allows us to take advantage of the synergy among the different opinions expressed by a participant to the peer group, creating a comfortable environment for the discussion;
- Every new issue can initiate a snow-ball effect, lighting up the discussion between the participants;
- The "de-institutionalized" context in which activities are played increases the spontaneity of children's answers.

### 2.1 Sample and guideline

We carried out six group discussions (each about two hours in length). Eight participants (8-9 years old Italian children) were selected randomly in pre-existing groups within third grade school classrooms, in order to provide a relaxed and supporting environment were children who already know each other would feel comfortable and confident [15]. The classrooms were chosen in different geographical areas (six locations throughout Northern, Central and Southern Italy), different urban sizes (small towns vs. medium or large cities) and, consequently, different social and cultural backgrounds[1]. With the aim of minimizing the influence from the scholastic environment, group discussions were carried in spaces outside the classrooms, like labs or gyms of the school. Inside each group, gender composition was mixed. Before running the six groups discussions, we checked and improved the main structure of the activities and discussion guideline by means of two pilot focus groups.

The choice for children of third grade classes (8-9 years-old) was made on the basis of their development and of the school curricula: while at this age children begin indeed to set their views of the world, including those about science and scientists [16], systematic science teaching to them has just begun, so that such views are not so strongly based on

[1] The locations were the following: Scuola Giovanni Falcone, in Assago (Milan); Scuola Cardinal Ferrari, Milan; Istituto Comprensivo di Via Giulia, Rome; Scuola Mameli, Palestrina (Rome); Istituto Comprensivo Fiorelli, Naples; Scuola Giovanni da Palestrina, Modena; Scuola Martiri per la libertà, Budrione, (Modena); Scuola S. Anna, Verbania.

school inputs. In order to understand with children which is their perception of science and scientist, a guideline of discussion based on a tale and drawings was built up. This framework allowed to prevent formulating too direct and binding questions and to alternate moments of spontaneous discussion to reflective phases. Within the standard setting of focus groups (a moderator, an observer, and a recorder), each discussion began by asking the children to draw a scientist and to present this character (name, activities, and background) to their peers. In a second phase, children invented a tale with three characters previously introduced by the moderator: a child, a scientist and the "Dunno", a Don't-Know-What creature. The presence of these three characters helped to engage the children in an imaginative activity and feel empathic and sympathetic to the situation [17]. The third part of the discussion was thought as a reflexive moment: a collective writing of a letter to another classroom to describe what is science, who are the scientists and what they do.

## 3. Data analysis and results

We used semiotic analysis to read and interpret the figurative elements in children's drawings [18], while content analysis was our tool to investigate the verbal part of both focus groups and letter writing [19]. Categories for content analysis were individuated by looking for frequent recurrences of some contexts and concepts in the discourse and in the invention of the script for the story. Such dimensions are reported in Figure 1. While the differences between geographical areas seemed not strong, quite a lot of diversity in representations was observed between children coming from families of immigrants of different regions of the world (Asia, Africa, Eastern Europe, etc.). Children quotes presented in the results section have been chosen because they represent a common tendency found among participants or because they contribute to show the range of views[2].

### 3.1 Mythical and emotional dimensions

In other works, we have stressed out how some recurrent elements in adults' social representations of S&T can be identified [20]. Since early times, knowledge and technique have been associated to at least three correlated but different "dilemmas", characterized by a positive pole (marked by fascination, enthusiasm, excitement) and a negative one. All of them are strongly present both in fictional and non-fictional representation of science, as well as in children perception of S&T:

- A "forbidden fruit dilemma": the search for knowledge can represent a violation of social, natural or religious kind and, as such, be punished. Myths or legends in almost all cultures re-invent this level in several forms (the biblical one, Prometheus, Ulysses are just some examples)
- A "Sorcerer's Apprentice dilemma": knowledge is power and power must be controlled. The risk of losing control is always present
- A "Golem dilemma": knowledge is transformation of nature. The barrier between different beings or even between the living and the not living can be violated by means of S&T.

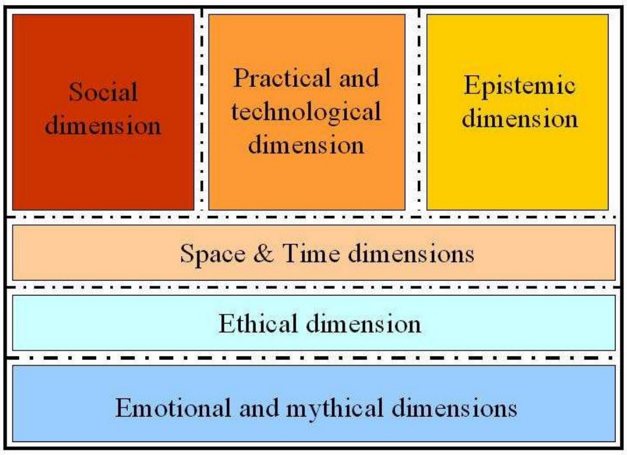


Figure 1 Dimensions of analysis

In children representations we found these very same elements, expressed in quite a dramatic and explicit way. For example, they depict in several ways the idea of the very powerful nature of scientific knowledge. Some children represented this connotation quite dramatically: scientists with several arms and hands meant an amplified capacity of manipulating and controlling reality.

[2] In some cases, in reporting the results, respondents have been distinguished as F (female) or M (male). Numbers appearing alongside these letters (F1, F2, M1, M2, etc.) illustrate that different participants of the same gender were speaking. In the other cases, we just mark children's answers with "C.", and moderator's interventions with "Mod.".

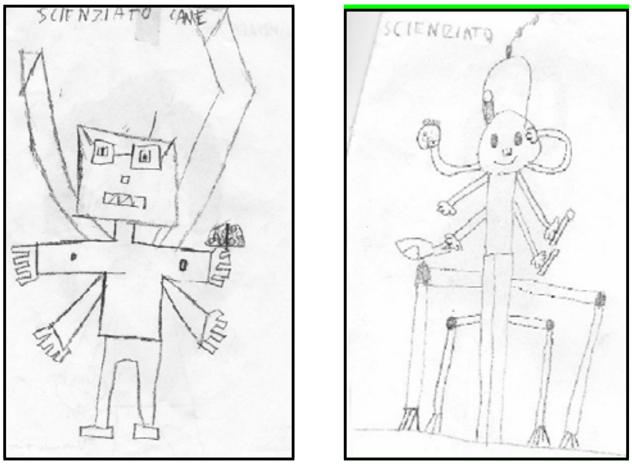


Figure 2 Scientists with many arms: enhanced power of manipulating reality

This power should be kept carefully, because it may cause harms or be misused (the "forbidden fruit dilemma") and can be either controlled or cause various kinds of collateral effects (the "sorcerer's apprentice dilemma"):

C1: "They have vessels with long tubes that may also explode, they can be dangerous…"
C2: "…And then he goes to his lab, and enters the secret code…"
C3: "There is a locked room where she does the experiments… But outside it is like a normal house"
C4: "He has his hair raised, straight, because every time he tries to do an experiment it goes wrong and then he is burned and his hairs raise because of fear…"

Such a power can be used either for good or evil. You may want to be a scientist – according to several children – to "help" or "heal" the world, but eventually also for revenge or "domination":

C1: "He take rats from the sewers, tortures them and transform them in armies"
C2: "…So he became a scientist to take vengeance"
C3: "He could give a magical potion to the Dunno and make him become his slave"


Figure 3 Dangerous science

The cultural representation of scientific knowledge as the capacity to transform reality and manipulate living beings is always present in children drawings and stories:

C1: "He made an experiment that may let an animal take another shape"
C2: "He wants… do you know that white cotton? He wants to make it in different colors and also to make it bigger or smaller…"

Of course, this characteristic is one of those that more strongly resemble magic power. Several children represented this by means of the idea that scientists work with "potions" (also because several focus groups were run during the hype of one of movies of the Harry Potter's saga):

C1: "…They make a potion to make plants grow out of nothing…"
C2: "And he goes home, makes a potion… take an animal, maybe a mouse and transform it in a hamster…"
C3: "He/She has a potion in his/her hand that can make good things into rotten ones"
C4: "He transforms old things in new ones… Transforms the broken skateboard in a new one"
C5: "He invents a potion that manage to transform invisible people into visible one"

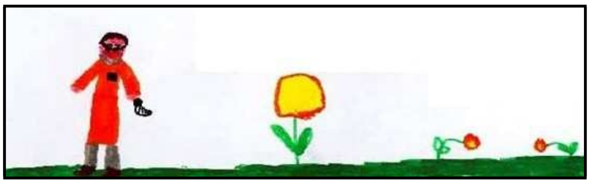

Figure 4 Scientists transform reality

These magical connotations in children's image of science and scientists are not so different from those often found in general cultural representations (movies, novels, arts). They take some evident elements from the stereotypical image of chemist, constructed in XVIII and XIX centuries from some ancient elements of the image of the alchemist. The scientist's lab is filled up with tubes, alembics, colored liquids and vapors. On the other side, a professionalized image of the scientist (white coat, gloves, etc.) and strong biological connotations are also present. Several authors stressed out the fact that these elements became stronger and stronger during XIX and XX centuries: the scientist is not only an alchemist working on inorganic substances, but also someone who manipulates living matter [21]. Today, children draw and tell it by using a lot of images and symbols coming from biology or biotechnology:

Moderator: "How does he/she prepare potions?"

Child: "Whit animals, with blood" / "He take a green potion from a leech" / "He took blood from some animals and mixed it"

Mod.: "What are potions?" [Based on a question by another child]

C.: "They are liquid things with blood and other ingredients"

Associations between science and medicine are very often present (in spite of several children stressing out some difference between scientists and "doctors"), as well as the idea of tests with animals and the associated ethical problems:

M1: "Scientist makes us healthy and also heals the world… He makes potions to heal his sons' illnesses"

M2: "He makes a medicine… A medicine that stinks"

F1: "She tries the medicine on a rat and heals it… But it only functions on animals, not on men…"

Mod.: "And then? What does she try?"

F1: "She tries with other medicine, and goes on trying and trying. Finally, she manages to heal him [the "Don't-Know-What"] with a lemon candy, […] she had candies enough for all the world"

M1: "There was this scientist who lived in a big house and had a lot of bottles to make experiments and many animals in the cages"

Mod.: "Did he make tests with animals?"

M1:"Yes, he invented the potions"

Mod.: "And how did he?"

M1: "He took things and mixed them, he putted them in a small bowl and made dogs drink them… and after is they died…"

M2.: "…He did not give a damn!"

M1: "… but he used old animals!" […] "With these ingredients he could invent medicine to use and sell"

So, children say that scientists are normal people (see also next paragraph) but also that, on the other side, they are people owning a special kind of powerful knowledge whose language, tools and instruments are "not for all": the scientist, in this sense is the "Other".

Children express this "otherness" both by means of realistic pictures and fantastic ones. Scientists can wear white coats and work in laboratories separated by society with locked doors and robust walls. But their otherness can also be depicted symbolically by means of strong physical, psychological or biological fantastic characteristics: the scientists drawn by children can be robots, green monsters, mutant humans or aliens.

However, while some scholars emphasized that children express a stereotypical (and/or "distorted") representation of scientists, we think that that they in fact show us the very fundamental elements of what the actual social representation of science is: mad scientists, and scientists-sorcerers are some ancient images linked to knowledge in general and also to scientific knowledge, and children do actually cover this ancient skeleton-images covering them with the contemporary mediatic "flesh" taken from movies and cartoons:

M1: "I make him green… Do you know like what? Like aliens: he also has green hairs"

M2: "Mine one is an alien… No, he is more than alien… He is an asteroid and he also comes from Mars… He is the mad scientist"

M3: "His name is Mad" / "They say that there are also mad scientists…"

M4: "His name is Mad Doc Richard. Of course, he has no hair, because he cut them. He seems an alien"

M5: "He is a robot, he has wings and four hands… He uses one hand to take off his head…"

M6: "And then I call him like the green monster: Goblin"

M7: "He was already a bit crazy: he was born a bit crazy…"

### 3.2 Space, Time and Social Dimensions

a) Scientist as a social animal

Lonely men and women dressed in white coat, holding a test-tube. These are the scientists characters draft by children involved in our research. Other distinguishing signs are the stereotypical ones, mediated by television, cinema and comics (glasses, standing hair, lab details all around).

The "otherness" of scientist is strongly perceived by children, but not in a banal way: unlike most adults, many children say that everyone can possibly become a scientist, can choose to "be a scientist". At the same time, science practice and its implied knowledge make the scientist, to children eyes, a special, not normal person. Together with features of "social normality", that we found being more stressed by females than by males children, the scientist maintains an aura of exceptionality. He/she can have friends, boy/girl-friend, sons and common hobbies, but very often he/she carries out his/her activity by his/her own, or surrounded only by colleagues, spending a life deeply focused on the laboratory. In other cases, scientist's job remounts to a hereditary dimension: science comes down from father to son:

M: "Her father won the title of best scientist on earth for having understood what Mars is made of".

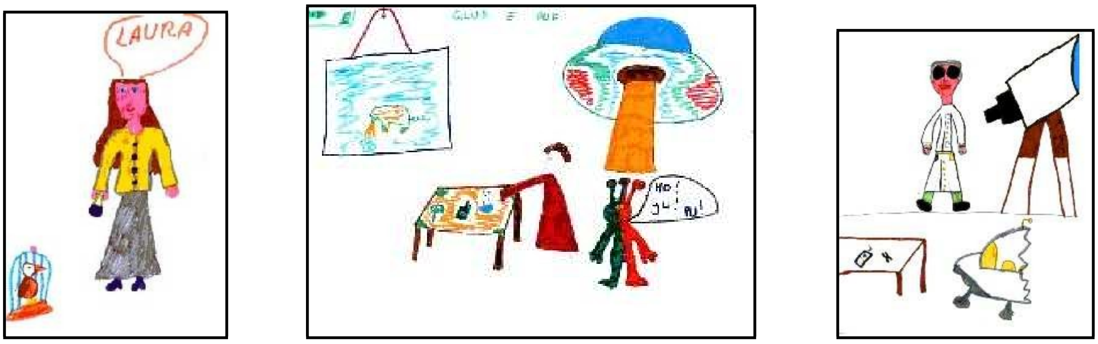


Figure 5 Scientist: "normal" or "different"?

In other cases, children realize the challenging component of the research: the conquer of scientist's identity comes through the demonstration of intelligence or prize award:

F: "She participated in a botanic contest… Finally she wakes up, goes to the contest, and wins".

When his/her origin and family are not assimilated to the experience of children themselves ("he/she has a mom and daddy", "He/she is mom's friend"), his/her exceptionality is highlighted by attributing his/her birth or gender to science itself:

M: "he as not a family, a mom… He was born in the world, science created him".

As to their graphical representation, scientists are very often of the same gender of their authors: females draw female scientists, males definitely preferred male scientists. However, females only raise the issue of the scientist's gender:

F: "May I draw a female scientist?"
Moderator: "Sure"
F: "That's good"

The request to draw a female scientist is particularly interesting when the result is compared to countries where the language do not attach any gender to the word "scientist", unlike in Italian. Jarvis noted that the stimulus to draw a scientist figure was preceded by the neutral word "scientist" and outcomes showed how a sample of British male and female children drew almost all male scientists [16].

In our research, in some significant cases certain indecision was experienced in attributing the gender to the scientist:

F: "It's a scientist, so it is a human, between male and female gender".

Indecision in gender attribution is attributed sometimes to the power of science, capable of manipulating biological bodies, sex included.

b) Space

The preferred setting of scientist actions, as we already saw, is inside the lab. Figurative elements referring to it are very often found in drawings: tables-bars, scientific devices, test tubes. Explicit reference is made by descriptions that define the lab as "place of science", describe it as a closed place surrounded by mystery and that requires careful safety measures and protection.

M1: "The experiment room is locked, because there are important things inside which should not be stolen, cans with special liquids".

M2: "He goes to the lab, types the code and enters the lab".

More seldom, the scientist activity is performed outdoors, in order to observe the phenomena on field. In this regard, reference is made to agronomy and to paleontology, one of the most fashionable sciences in the cinematographic imaginary of children (see Jurassic Park). In the same way, the dimension of journey stands out as a very positively connotated one, linked to exploration and discovery

M: "Scientists usually stay all day long in their labs and never come out; whilst the paleontologists do, seeking fossils. They use a device with searching eyes".

F: "She travels throughout the world, to help the world she makes experiments".

c) Time

The axis on which children move in attributing timing to scientists' actions and to science in general, even if not explicitly verbalized, has two directions. The main one starts from the present and is projected toward the future: the scientist invents new things that did not exist before. It is clear the positive value attributed to the mission of scientific advancement. Less frequent but relevant is the direction which from the present backs to the past, set out mainly within the cataloguing aim of natural sciences. Such dimension prevails in the reflexive and verbal phase (the letter writing), as long as children refer to their scholastic experience. In its magic dimension, science is capable of manipulating time to reach its cognitive goals:

M: "There is a liquid he's preparing to invent the time machine, to go forward and backward throughout the time".

Mod: "Why going forward and backward through the time?"

M: "To see how things really are… If he wants to study the dinosaurs, he goes backward to the past".

## 3.3 Ethical dimension

Scientific activity, according to our sample of children, is often strongly linked to an ethical dimension, in which science assumes either a rescuing connotation (the representation of science as progress with no risks and dangers), or, more rarely, a destructive connotation. Both seem to be strongly mediated by the fictional world of movies, comics and cartoons. The prevalent "mission" attributed by children (as it is also by adults and the media) to the scientist is that of the "rescuing science": the scientist becomes the hero of the tale, while his/her figure is placed into an adventurous dimension filled up with media stereotypes. The final goal of the scientist is the "world good", wherever it is from, whatever the scientific field the scientist works on:

Mod: "Why shall your scientist come to the Earth?"

F: "He's from Mars, he must come to Earth to save the world"

On a less dramatic level, the instrumental and technological dimension of science is evident to children, also from the point of view of entertainment and utilitarian applications:

F1: "he found a chemical invention to make dolls talking and amusing the girls".

F2: "the scientist takes rotten things at a very cheap price and makes them good, so he saves money".

On the other side, with much less emphasis than that posed on the positive role of science, negative representations of scientists are expressed and based on their "destructive" power. Sometimes, scientist is identified with the "mad scientist", who use his/her power to harm, playing the role of the opponent in the tale development:

M: "A terrorist gun-armed scientist shoots people. He machineguns and triggers nukes in houses"

F: "To me, scientists play scientists, those ones who are bad because in the future they are ill and want to keep all medicines for themselves".

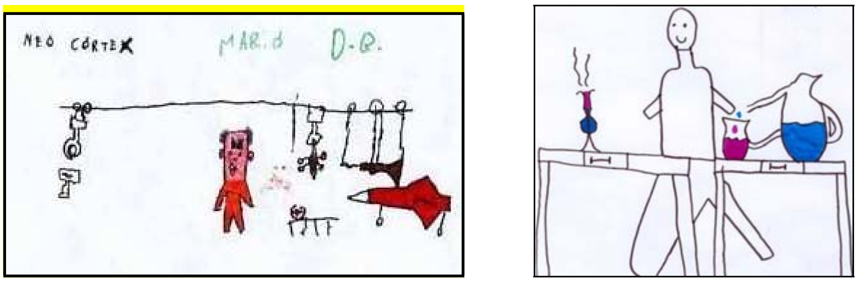


Figure 6 Scientist: evil or good?

## 3.4 Practical and technological dimension

In several drawings of the children, graphical details around the scientist define his characterization and identification. The classical objects of the scientific iconography (test tubes, microscopes, telescopes, lasers, caged animals) are very interesting to analyze, since they represent the repertory of socially shared media images, catch the overall technological dimension of children's image of science and express the strong practical and instrumental roles of the work of scientist. An evergreen symbol of such technological dimension in children drawings and tales is the "machine", the technological inventions:

M1: "He examines them with a device to know how they work, how old they are… where are the others"

M2: "…He uses devices, computers, that kind of stuff […] that detect where fossils are".

Science, then, deals mainly with material objects: rarely, reference is made also to abstract aspects, such as mathematics and calculations, or to quantitative measurements, coherently with the fact that "natural science" and "math" are separated in the school curricula.

Moreover, science, in the eyes of children, defines itself and is carried out through technology. Optical instruments, computers, test tubes and rockets, contemporary icons of techno-science, are thought as extensions of the hands, the eye, the memory:

M: "I'd like to be scientist, astronomer or zoologist, to observe more closely the moon or the bee".

F: "He devises a computer, to be set at morning, which cooks for you, washes the dishes, and so on".

The practical goal appointed to the scientist's work is realized through the invention. Both in children drawings and tales, instruments, like experiments, lead often to invention:

M: "He invents glasses…. plastic wheels… the time machine".

In the tale that children build up within the discussion, inventions often provide the overcoming of the challenge the protagonists meet in every tale. Together with "potions" (a prevalent remedy for the character's problems), time machines are created, as well as devices to turn the characters smaller or bigger, or to understand foreign languages:

F: "The Dunno and the scientist did not understand each others… Maybe she puts on her ears some new device to better understand him, and puts also one to him".

We noted that, while the represented instruments were linked to the discipline that children chose to depict, (astronomy through the telescope, paleontology through digging and detectors, chemistry and biology by means of test tubes, potions and animals), substantial gender differences were found in the representation of the setting of scientific work. While boys preferred scenery built upon technological instruments (telescopes, lasers, spaceships), girls defined their female scientists by means of white coats and test tubes kept in hands. So, while males showed a stronger attention toward techno-science, we noted in females an emphasis on the medical and biological aspects.

### 3.5 Epistemic dimension: science as method and research

It is important to stress that children do not only express magical connotations of science, nor just imagine science as linked to biology or medicine. They also depict quite a complex image of science as an epistemic social activity based on methods, experiments, theories, and researches. Scientist is not only a sorcerer, a wizard or a magician. Science is also a method of knowledge production:

C.: "Potion is also for witches… But we must explain this, because other children could get confused…"

C.: "The doctor is different from scientists, because he cuts the guts. Doctor heals, while scientist makes projects, he studies the things of the world… Docs make analyses to see if everything is ok"

C.: "Scientist also studies things that do not exists any more, like dinosaurs, isn't it?"

The typical moment in which children make the portrait of scientists is that of action: the experiment. The keywords used are "to study", "to understand" "to search". The experimental dimension of science, even though often mixed with the magical one denoted by potions, is always present in children's discourse, as well as the space of the laboratory and the idea of science as research:

C: "He looks for potions that are ok, tries and tries again until they are ok"

C: "He has his breakfast always with two donuts, goes in the lab, enters the code and makes experiments…"

Mod.: "What does it mean to make research?"

C: "Studying, understanding… Studying an element you want to understand…looking for…"

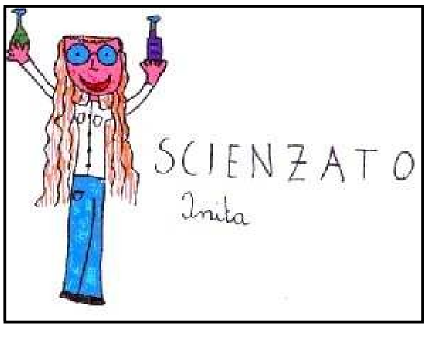


Figure 7 Women in science

Among the goals (and components of fascination) of science, there is the discovery of "new things" and to understand "what the things are made of":

F: "The scientist becomes famous because she discovers a new thing, a whole dinosaur"

M: "His goal is to discover what the blood of dragon is made of…"

M: "He won the medal of 'Best Scientist of All the Earth' for having understood what Mars is made of"

Experiment become almost, in children's discourse, a definition of the status of scientist:

M1: "Scientist is someone who makes experiments… by making a lot of experiments he became a scientist"

M2: "He is someone who search, and by studying and making research for several years he manages to understand the things he wants to understand"

M3: "If I was a scientist, I go out in the morning and if I see some phenomenon, that is a strange thing, I analyze it and try to take a small piece of that thing, I put it in a machine I invent and I see how it is formed, hoping that I can then find the solution"

While during the moment of the tale and story-telling, fantastic, almost oneiric elements prevail, it is especially in the phase of letter writing that children express quite surprising levels of awareness of part of the methods and practices of modern science. They use, either implicitly or explicitly, key concepts such as observation, hypothesis, analysis, and deduction:

Mod.: "…And how does he make these experiments?"

C1: "He threw a stone and said: 'let's see if it sinks'"

C2: "…He tries to put water on his head to see where he is, because in that way all water deviates and he can find where he is" [Talking about an invisible character]

C3: "He makes hypotheses, too"

Mod.: "What are they?"

C3: "It means thinking the world" / "How was the world created?" / "What is there to eat?"

C1: "They observe very carefully, then they make questions and then experiments and if it is right they go on… If it is wrong they go back to the beginning and make other experiments"

C2: "To analyze means you take a hair of some animals, with a proper machine, without harming them"

C4: "If you have money, before having money you make projects about what to buy with that money. Scientist does it, but not with money, with something else… For example, if he wants to build a mechanical arm, he takes a sheet of paper and makes the project…"

## 4. Conclusions

Several studies were conducted in last years on perceptions and attitudes toward S&T in children and teenagers. However, most of them were focused on pedagogical issues and problems: what do children do not know/understand/accept about S&T? Why? How to "improve" their knowledge and attitudes? If the kind of questions is such, it is not surprising that emphasis was on deficits, defects and stereotypes that affect young people's perception of science and scientists. We were interested also in other aspects, such as the active construction, performed by children, of cultural representations and images about science, technology and scientists. Adapting a classical test (the DAST) and integrating it with a technique less used with young persons (the focus group), we showed the children's perceptions and attitudes toward science, technology and scientists are complex and structured, and definitely not only based on stereotypes. While children, in order to identify scientists and describe part of their practices, do definitely use, as a "skeleton", ancient stereotypes and mythical images on scientists, and while they do put on it the "flesh" of recent images (taken out mainly from the media), at the same time their drawings and tales do not express only children's vision. On the one side, they show some major aspects of the cultural representation of S&T, while revealing, on the other side, quite surprising levels of awareness of the social, ethical and political aspects of scientific activity and of the methods and practices of scientists. Gender differences were also very interesting. While girls were drawing several women scientists, they felt the need to ask "permission" to do this (and often linked the biographical origin of their female character to some male scientist, usually a relative). Besides this, girls' image of women scientists was basically linked to biology and medicine, while boys seemed more focused on the technological aspects of their male scientists' practices. These issues will deserve further research.

## 5. References

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