



# EXPERIMINTA

ScienceCenter FrankfurtRheinMain



## Materials on mirrors

Mirrors in the Science Center  
Mirrors at school and at home

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# Preface

The Hands-On Museum EXPERIMINTA offers a rich collection of experimental stations illuminating the topic of mirrors. The fascination mirrors exert on primary school children (as well as on others) presents the opportunity to delve into this topic in the Science Center as well as in the classroom.

Despite the complexity of the topic, many mirror phenomena lend themselves to theoretical as well as practical consideration even in primary school.

The mirror stations in EXPERIMINTA are concentrated in two areas on the ground floor:

- Right side
- Left side

This division facilitates working with the topic, since the children are not too distracted by all the other experimental stations.

To help primary school teachers, this brochure assembles the following materials for the study of mirrors:

1. Introduction to the **experimental stations** concerned with mirrors. Each station provides on-the-spot information, images and sometimes explanatory sketches, as well as a short description and exploration of the scientific background.
2. Brief **factual information** about the cultural-historical and developmental psychological background of mirrors. Here, you can also find remarks about the production of a mirror image.
3. Suggestions for **exploring the experimental stations** in EXPERIMINTA.
4. For **further study**, the stations offer ways to observe each phenomenon in everyday experience and in the school, as well as classroom experimentation and - if possible - reproducing an experiment. A few suggestions for pedagogical design are made, although no complete lesson units are presented.
5. In addition the brochure provides a selective representative bibliography of print and internet sources for further study. It should be mentioned that the literature on mirrors is very extensive.

# Mirror Book

Ground floor, left side



## Description

Two mirrors are bound together like the front and back covers of a book. They can be rotated (opened up). If you put a toy, geometric tile or three-dimensional figure (or even your own nose) between the mirrors, the objects are reflected in both right and left mirrors.

The mirror images are also reproduced repeatedly in a circular pattern. The closer together the mirrors are, the more mirror images result. The reflections alternate between "mirror image" and

"normal". Especially beautiful patterns result when the Mirror Book is opened at particular angles of aperture.

Through experimentation you can discover which angles of aperture yield especially appealing patterns.

Another option to use with the Mirror Book is to reproduce the images from the box beside it. In order to do this, you first have to pick out the desired figures, and then set the Mirror Book to the corresponding angle of aperture.



## Explanation

With a single mirror, every object has exactly one mirror image. But with a Mirror Book, the "pages" are reflected reciprocally, so that the entire image is comprised of multiple reflections in both mirrors. From these reciprocally multiplied reflections result axial as well as rotational symmetries. For instance, at a 45 degree angle of aperture one sees, in addition to the original object, 7 images in a circular pattern, of which 4 are reversed, or "mirror images".

# Hover Mirror

Ground floor, left side



## Description

On the opposite wall next to the window, a tall narrow mirror is placed. Perpendicular to this mirror, on the free-standing wall, is another large mirror.

Position yourself vis-a-vis the narrow side of the wall, so that only the right half of your body can be seen in the mirror opposite. When you position yourself in the right way, you can see your whole body. If you raise your right leg, for instance, in the mirror it looks as if you have also raised your other leg. Thus it looks as if you are hovering in mid air.

## Explanation

This seemingly complete figure is comprised of two different mirror images of the same non-occluded half of your body. In the mirror opposite, you see the right half of your body. This half is also reflected on the left side, onto the mirror on the wall.

Thus you see your right half twice—mirrored once toward the right side and once toward the left side. You see an apparently whole body that is actually composed only from the right half of the body.

You can test this easily by putting a handkerchief on your right shoe.



# Giant Spoon

Ground floor, right side

## Description

A giant freestanding spoon can be viewed from either side.



If you are relatively far away from the bowl of the spoon, your reflection appears smaller and upside-down. If you are very close, in the soup so to speak, your reflection appears right-side-up again. On the back side of the spoon, you see a right-side-up reflection, although somewhat distorted.



## Explanation

The giant spoon has a bowl (concave mirror) and a bulging side (convex mirror).

A concave mirror, like a convex lens, has a focal point; the distance of the focal point from the mirror is called the focal distance.

If an object is positioned within the focal distance of the concave mirror, a right-side-up and magnified reflection results.



If the object stands beyond the focal distance, a smaller, upside-down reflection results (see figure left).

On the back side of the spoon, your image appears right-side up, but smaller (see figure right).

In everyday contexts you see convex mirrors that produce enlarged visual fields. These are used, for example, to increase traffic safety when there is limited visibility for crossing or merging traffic.



# Factual Information

Mirrors belong to the world of objects we experience and use every day. However familiar they seem to us, they are nevertheless full of peculiarities and surprises.

First, the mirror represents an objective, impartial perspective on things. In the first place it is an instrument of self-recognition that directly shows a person his or her own complete image as the only thing. (Without a mirror, a person can see him/herself only in the front and approximately from the chest to the toes.)

Second, and paradoxically, it is also an instrument of "transformation": with certain curved mirror surfaces reality is not imitated, but fragmented and reassembled in a different way, so that deceptive and fantastic images result. Even simple reflections, for instance in a window or on the surface of an automobile, can generate bewildering perspectives that transcend everyday experience.

Nor is the symbolism of the mirror straightforward. On the one hand, the mirror embodies vanity and desire, and on the other hand self-knowledge, intelligence, and erudition. Through the centuries, art and literature have given the most varied expression to these phenomena.

## Making of a Mirror

From the beginning of time, human beings have been drawn to gaze at their own faces. Therefore water was probably the first mirror surface for humans.

Mirrors made from polished silver, copper, and bronze were commonly in use among the Egyptians, Greeks, Etruscans, and Romans. Crystal ball mirrors have been known since about the fourteenth century. In the nineteenth century mirrors were made by precipitating a layer of silver onto glass, while today aluminum and glass are generally used.

## Observations on Developmental Psychology

*Jacques Lacan* (French psychoanalyst and theorist), in his theory of the developmental stages of the child, designates the period from six to eighteen months as the "mirror stage".

In this phase children discover their own image in the mirror. According to Lacan, this gaze upon the self as a whole constitutes the psychic function of the ego. Through the self-image seen in the mirror, the child first develops a sense of self.\*

Naturally, the theory of the Lacanian "mirror stage" as "creator of the ego-function" is not uncontroversial in psychoanalytic theory.

The significance of the mirror in the development of children also figures in *Reggio pedagogy*, a concept developed in Italy that has also gained a following in international early childhood pedagogical theory.\*\*

In facilities devoted to Reggio pedagogy, mirrors may be found in a great variety of places and in various arrangements, for instance as mirror tents, funhouse mirrors, and mirror prisms. They induce children to try things out, to be amazed, and to ask questions, and can help the child to create a self-image, including in interaction with others.

\* From <http://de.wikipedia.org/wiki/Spiegelstadium>

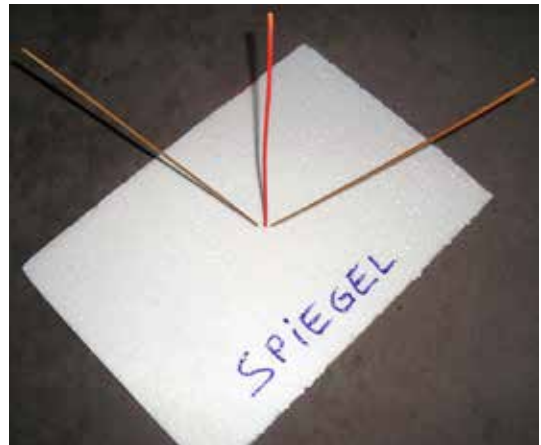
\*\* See [www.kindergartenpaedagogik.de/1595.html](http://www.kindergartenpaedagogik.de/1595.html)

## On the Reflection of Light

When light falls on the surface of an object, it is radiated back with greater or lesser intensity. It is the quality of a mirror to reflect the light as efficiently as possible.

When you shine a flashlight perpendicular to a mirror, the reflected light returns perpendicularly. But what happens when you shine it obliquely on the mirror?

These reflections can be clarified on a piece of Styrofoam. Stick a shish-kebab skewer into the piece of Styrofoam to represent the incoming light beam, and consider where and how the beam is reflected (which you can represent by sticking a second skewer into the foam piece).



After many unsuccessful attempts, it becomes obvious that a so-called plumb line is necessary. This plumb line can be represented by a third skewer (perhaps colour-coded) stuck into the foam at a right angle to the mirror. After doing so, one can stick the second skewer into the foam at the same angle relative to the plumb line as the first skewer. Finally, one must make sure that all three skewers are aligned in the same plane.

## On the Position of the Reflection

The reflection appears to be the same distance "behind" the mirror as the object is in front of it. A small experiment will demonstrate this easily.



Place a lighted tea-light in front of a thin pane of glass or plexiglass. Place another tea-light behind the pane, this one unlighted and slightly offset.



In the first photo to the left, one sees the configuration from above, where the tea-light behind the pane is out of alignment.

In the second photo to the left, one sees the configuration from the front. In front one sees the lighted tea-light, the reflection in the mirror, and next to the reflection the unlighted tea-light behind the pane.

Now move the unlighted tea-light into alignment with the reflection.



In the third photo to the left, one sees the configuration from the front. The unlighted tea-light behind the pane now "burns" in the mirror. The connecting line between the tea-light and the reflection is perpendicular to the glass pane, and the distance between the lighted tea-light and the glass pane is equal to the distance between the glass pane and the reflection.



# Guidelines for Exploring the Stations in EXPERIMINTA

How can one integrate an extramural field trip into an instructional unit?

When working on the topic of mirrors, it is recommended to visit the mirror stations at the very beginning of your stay. Here the children will be confronted with a range of mirror phenomena that will astonish them and awaken their curiosity.

The pupils, alone or in small groups, engage themselves with the stations. They try things out, think about them, ask questions, and perhaps even already arrive at explanations. It makes a big impression on all of them to investigate something themselves and to be able to decipher or solve it. This experience can provide the motivation for further work in school.

The large mirror (part of the Hover Mirror, found on the left side on the ground floor) is especially suited to provide a playful introduction to the topic of mirrors. Many things that can be tried out only in part at school, and generally not at all at home, can easily be done here. Good prompts might be:

- Do I see myself in the mirror as I actually am?
- I wink with my left eye, raise my right arm, raise my left leg, etc. What does my reflection do?
- What do the letters **R** and **L**, which hang in front of the mirror, mean in this context?
- What colours are **R** and **L** in front of the mirror, and in the reflection? Can you explain this?
- Observe your friend closely, and then observe him/her just as closely in the mirror.

Do you notice anything?

- Go up close to the mirror, and then step back a little. What changes?
- Lie down with your legs in front of you in front of the mirror.

What does the mirror show now?

- What do I see when I put a large dice in front of the mirror?

A group photo of the class in front of the mirror is also fun! The Hover Mirror provides many more possibilities to explore.

For further exploration, the children should then be divided into pairs or small groups to engage themselves with the rest of the mirror stations. They should choose their favorite station in order to explore it more thoroughly.

Possible tasks might be:

- Write down the name of your favorite hands-on station.
- Describe or draw it.
- What can you do there, and what do you observe?
- Write down your observations. You can find help in using the rotating displays.



# Suggestions for Designing Lessons

Fully, as already been explained, no worked out instructional unit is furnished with the previously laid out material. Nevertheless, some suggestions that have proven to be motivating and helpful may prompt ideas for designing lessons.

The subject area is primarily science, but the stations can also engage language, mathematics, and art very well.

It is important to have *basic materials* that are relatively easy to acquire, for instance:

- A collection of various kinds of mirrors that the children can bring from home.
- A thin pane of glass or plexiglas.
- Mirror tiles or silver foil, which are available in a size of (for instance) 50 x 150 cm. Both are available at home improvement stores.
- In order to mount the mirror tiles, it is a good idea to get the supplier or a carpenter to saw small wooden blocks so that they have a groove in the middle. Each mirror tile is mounted on two grooved blocks.
- Tinted plastic panes as semi-transparent mirrors. These mirrors can also be purchased under the name of magic mirrors or MIRA-mirrors.
- Glue, fabric tape, or packing tape.
- Various small objects, like toy figurines, candles, tea-lights, dice, etc., to be reflected.
- Additional necessary materials are specified in the construction directions for several mirror exhibits (pp. 23-25).

## Possible Points of Access

- A good starting point is provided by the experiences and observations that the children make in connection with mirrors in EXPERIMINTA. The notes about their favorite experimental stations can be presented, discussed, and perhaps also revised and posted in the classroom.
- Unanswered questions can be collected.
- For further study, the children can look for mirrors and reflections in the school or around their homes and take notes about them. A short instructional walk can prompt astounding insights on the part of the children as they discover reflections everywhere in their environment.
- In this regard one can also explore how people observed their reflections even when there were yet no mirrors.