

# “Physics in Kindergarten (nursery schools) and elementary schools” – Why not?

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**Where does she drive?**

Newsweek,  
Aug./Sept. 2003 S. 69

- **Generally, many youngsters are highly interested in physics – especially up to puberty. This interest must be preserved otherwise the subject will be ignored on secondary level: *contents connected closely with the world of young people, age-specific context, new trials and experiments with their practical use in every-day-life are essentials to attract pupils.***
- **But there is another problem, which is not only a German one: *Many educators or teachers had just 2 physics lessons per week during 8 to 10th grade at secondary school. And often those lessons were taught quite academically. Help is needed!***
- **Students in class 10 attempt, under my guidance, to answer physics questions, in the area of Kindergarten, respectively, to integrate with elementary school. Besides this we have developed a total of 10 trial groups so far. Regarding our long term goal – e.g. prevention of hearing damage, danger from the socket / plug -, the available knowledge can bring in new ideas to guide the physics knowledge in this age group. We could enlighten nursery school and elementary school teachers, as they only have limited access to physics in their training.**

**Aim of the project:**

- to motivate children and make them curious about physics,
- to establish a relationship to the everyday life of the children,
- to integrate the background knowledge of 5 to 6 year old children,
- not to strive for pure actions but for a long-lasting effect,
- to appeal to several senses at the same time:
  - ❖ listening
    - seeing
      - doing it yourself
        - learning in real situations,
- support of educators / teachers,
- in elementary school: to complete General Knowledge.

• **Experiments:**

➤ **Ear drum attack**

**Object:** Prevention of damages to hearing – turn down your Disc man

<i>Problem</i>	<i>Experiment</i>
<ul style="list-style-type: none"> <li>• test your hearing</li> <li>• sound moves air</li> <li>• sound hammers</li> <li>• what happens to the auditory channel?</li> <li>• “joghurt-cup”-phone</li> </ul>	determining hearing frequency distort flame / blow – dancing gum bears on a speaker sound waves in a tube with sand  primitive self-made rope telefon

➤ **How does lightning originate?**

**Object:** Understanding of nature

<i>Problem</i>	<i>Experiment</i>
<ul style="list-style-type: none"> <li>• production of charge</li> <li>• „Struwelpeter“</li> <li>• Van der Graaff Generator</li> <li>• lightning stroke</li> </ul>	rubbing a PVC comb / rob with fur, flash-bulb rubbing a comb/ rob, hairs wad of cotton wool fly between 2 conductive spheres like a rain-drop between clouds, paper strips on a conductive sphere, kids with long hairs on a insulating chair (board) flash of lightning between two conductive spheres, set a piece of cotton on fire

➤ **Electricity.**

**Object: Danger from the socket / plug**

- *Experiment:* sizzling sausage as a part of a circuit

**Object:** experimental work

- „little electrician“ illuminate a self made house (Fig.1)
- „raising one’s finger – electrically



Fig. 1:

➤ **We “play” power station**

**Object: Conservation of energy**

- *Experiment:*  
illumination of a dark room by self-induced electrical energy, mini generator  
- you get tired

➤ **“Hot wire”**

**Object: Patience and coordination exercise**

- “Hot Wire: (Fig. 2)  
are you clever with your hands?
- a self made „Hot Wire”



Fig. 2:

➤ **“Why do ice bears never freeze?”**

**Object: Learning from nature**

➤ **“Why does an astronaut wear protective clothes“?**

**Object:** Distant view. Erde als einmaliger und zu schützender Planet!  
Science-Fiction and reality.

➤ **Road safty.**

**Object:** Obligatory wearing of seat belts! Wearing a bicycle helmet! „Blind spot“!

➤ **Separation of Refuse.**

**Object:** Environmental protection.

➤ .....

- **Experiences and perspectives**  
“Is the lesson already over? Are we not going to do anything more? When are we allowed to come again?” these are comments of the enthusiastic children. Their first homework was to draw a picture of their favourite project.  
The enhancement of natural sciences as mere entertainment to a more valuable sphere of interaction made it necessary that topics of preschool (kindergarten) and elementary school had to be discussed with educators and teachers. In cooperation with elementary school, we emphasized the experimental character of General Knowledge in order to illustrate it more vividly to the children. As a result of our agreements with these teachers and the experience we have had with the children you can find detailed plans in the annex.  
We think that the concept we presented makes it possible to motivate juveniles more intensively for physical questions, at least more than in former projects with this group of children. Physical knowledge is no longer boring for children because it gives explanations and solutions to everyday problems.
- ..... and more experiences  
In this case the group consisted only of female pupils who have had experience with physics for three years. Our aim was to get rid of the prejudice that girls don't know anything about physics. In addition to that, the kindergarten children quickly trusted their older partners who learned to speak freely, to argue convincingly, to organize their group work independently and to make experiments at the same time.  
As a side effect, they were trained in social learning and cooperation without being consistently supervised and judged by their teacher as in the classroom situation which might be helpful for their future careers.

*Information and contact:*

<http://www.Donnertsberg.de/WEG/>

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# Ear drum attack

## Object: Prevention of damages to hearing!

Today many young people have first symptoms of a defective hearing. One of the reasons for such defects are headphones which are adjusted to the full volume. It is predominant aim of education to prevent hearing defects at young age.

### ➤ Auditory walking tour

- with
  - without earplugs
- in the playground or in the kindergarten / school

People who are totally deaf have lost their basic means of communication; in a silent world it is difficult to learn, to speak and language itself is a risk.

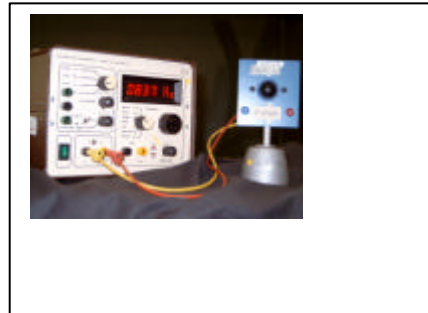
### ➤ Do you really hear everything?

Die Bestimmung des individuellen Hörfrequenzbereiches gibt einen Aufschluss über den Zustand des Gehörs. Das unterschiedlich ausgeprägte Hörvermögen bei Lebewesen (Mensch, Tier – Hund, Fledermaus) sollte zusätzlich problematisiert werden.

#### • Experiment(s): Hearing in an individual ability!

##### Materials:

- Whistle
- Dog-Whistle ( $f > 20$  kHz)
- Signal Generator with Amplifier
- Loudspeaker



The frequency of an signal generator with amplifier and loudspeaker is tuned down slowly from about 50 kHz onwards.

Preveously the volume has been adjusted to a medium level. The cild who can first hear something is asked to describe the sound.

#### • Additional experiment : Are there favourite sounds for our ear? – individual hearing diagrams.

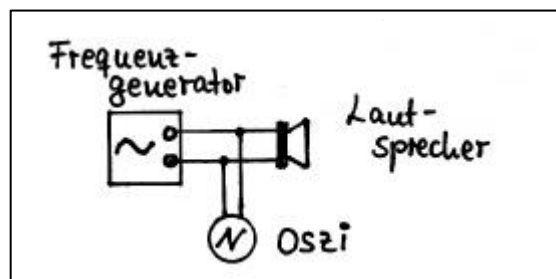
Sounds are generated with the signal generator with given frequencies. A diagram shows the hearing impression.

##### Material: additional

- Oscilloscope

##### Hinweis:

Alle Töne müssen auf dem Oszilloskop eine gleich hohe Wellenlinie ergeben.



Individual hearing impression:

		Ton 1	Ton 2	Ton3	Ton 4	Ton 5	Ton 6	Ton7
		250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	16000 Hz
very loud	<b>10</b>	○	○	○	○	○	○	○
loud	<b>8</b>	○	○	○	○	○	○	○
mittel	<b>5</b>	○	○	○	○	○	○	○
quiet	<b>3</b>	○	○	○	○	○	○	○
very quiet	<b>1</b>	○	○	○	○	○	○	○

### ➤ How does sound reach the ear?

Sound moves air. Sound is passed on by air pressure variation.

#### • Experiment(e): „swinging candle“

##### Materials:

- CD-Player Bass-Loudspeaker
- Candle
- Signal Generator with Amplifier
- Loudspeaker - high pressure-
- Wires

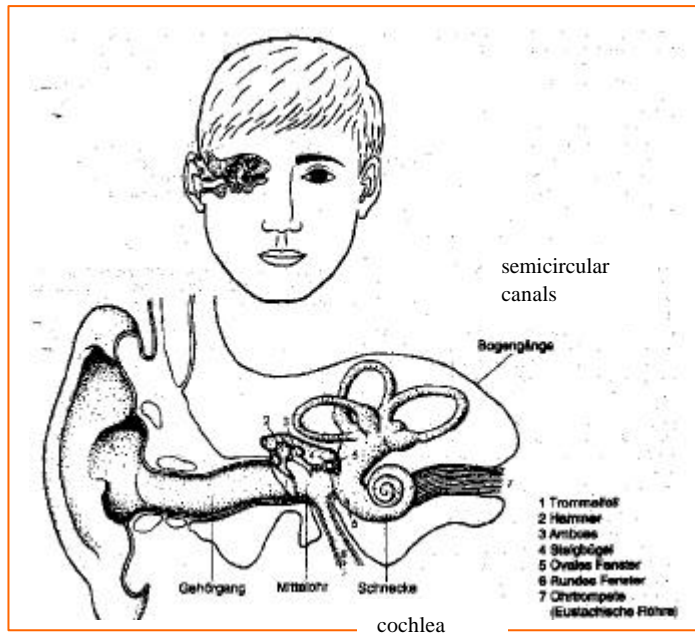


- Sound distorts a flame  
ideal: „bumm-bumm-Musik“
- Sound – low frequency - blows out a flame

### ➤ How does the ear function?

What is going inside the ear?





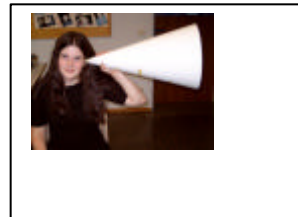
- 1 ear drum
- 2 hammer
- 3 anvil
- 4 stapes
- 5 oval window
- 6 round window
- 7 Eustachian tube
- 8 auditory nerve

aus<sup>1</sup>

❖ **auricle**

It collects the sound like a funnel.

- **Experiment: Hearing can be improved by using an ear trumpet**



speak  
quiet

**Material:** paperfunnel

❖ **Ear-Drum**

The outer ear acts as an organ pipe closed at one end, so that the air in it can vibrate. This vibration is passed to a membrane – it behaves like a drum - and then to a mechanical linkage of three bones.

<sup>1</sup> BzgA (Hrsg.): Lärm und Gesundheit - Materialien für die Grundschule, 51101 Köln Best.Nr. 933191

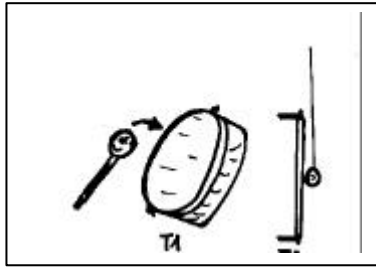
- **Experiment(s): Sound hammers to ear drum – various models**



“dancing gum bears”  
on a speaker show  
the vibration of a  
membrane

**Materials:**

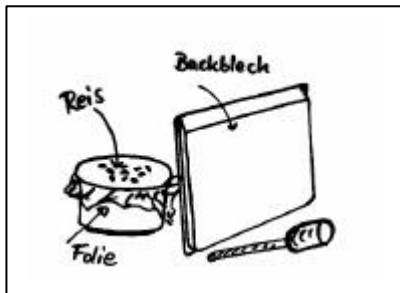
- Signal Generator with Amplifier
- Bass-Loudspeaker
- Gum Bears
- Wires



- Tamburin 1:  
soundsource
- Tamburin 2:  
„ear drum“
- table-tennis ball:  
„bones“

**Materials:**

- 2 Tamburin
- Klöppel
- Tischtennisball am Faden



- sound moves the  
graines of rice

**Materialien:**

- Baking sheet
- Holzstößel
- Dish
- Plastic wrap
- Grains of Rice or Sugar

❖ **Cochlea**

There are auditory nerves in the hair cells of the cochlea. Sound pressure makes them move. When noise level is too high, the hair cells are damaged.

A glass tube is a model for an uncoiled cochlea. The sand inside the tube represents the hair cells.

- **Experiment: We annoy hair cells and basilar membrane – unpleasant sound!**

Materials:

- Glass Tube, Sand
- Signal Generator
- Loudspeaker
- Wires
- 

Versuch: Kundtsche-Röhre  
typ. Frequenzbereich  
500 – 3000 Hz

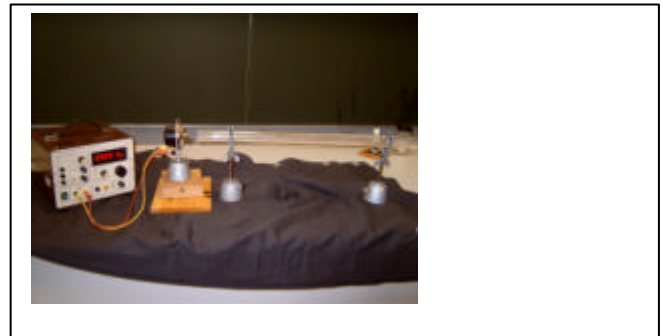




Fig.: damaged hair cells<sup>2</sup>

## Some more experiments::

### ➤ Walkers in the night

Why do we turn our head to the left when there is a crack on our left?

- **Experiment(s): Direction of sound / noise**

**I: “Who is knocking?”**

A blindfolded child is sitting in the middle must tell who is knocking and point in his direction.

**II: “Where was the knocking?”**

**Materials:**

- 2 Funnels
- ca. 1m Tube
- Pencil or Ruler for knocking



### ➤ „Joghurt-cup-phone“

Besides air other materials conduct sound!

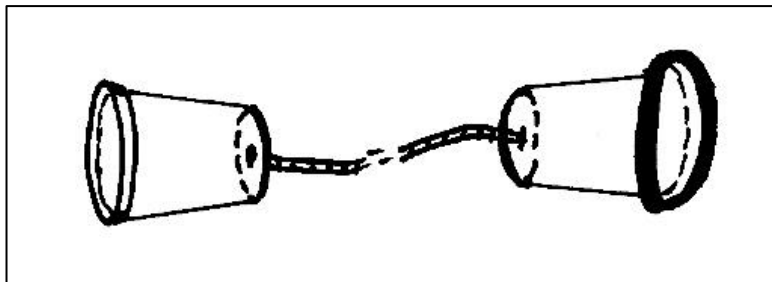
- **Experiment:**

**Materials:**

- 2 Joghurt-Becher
- Silberfolie (evtl.)
- ca. 2m Bindfaden
- 2 Streichhölzer ohne Zündkopf zum Befestigen des Fadens
- Nagel um Loch zu bohren

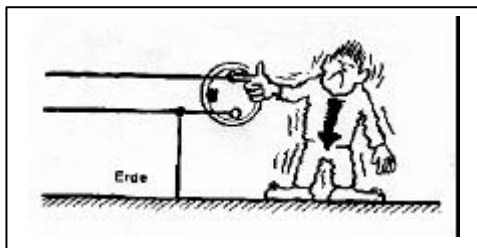


<sup>2</sup> Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (HRSG.): Gesundheitsschutz 4, München 1996, S. 29



## Electricity I:

### Object: Dangerous Plugs!



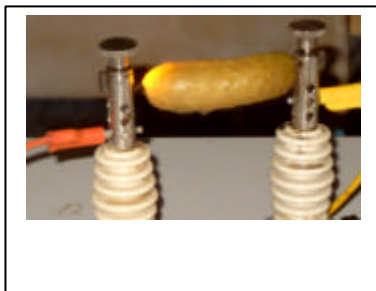
“Keep off the plug!” – Who didn’t instruct their children to keep off the plug? Instead of giving an explanation, however, adults preferred to drive this warning home by instilling fear into children. The actual danger was never explicitly explained. *What will happen, if ....?*

aus<sup>3</sup>

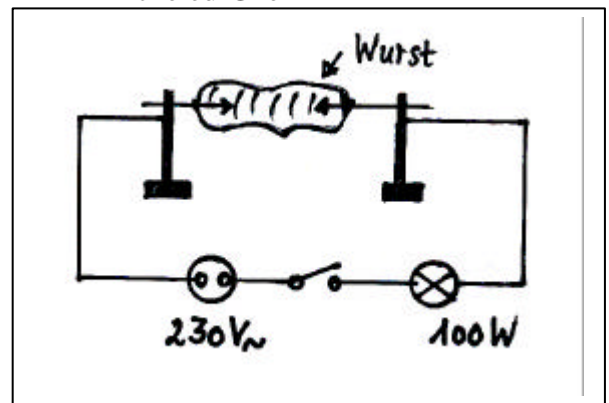
- **Experiment:**

**Materials:**

- Plug , Extension Lead and Switch 230 V
- 2 isolated Holders
- 2 Nails -big-
- Bulb 100W with Socket
- Wires
- Emery Paper
- Sausage
- Pickled Gherkin



“pickled gherkin” or sizzling sausage as a part of a circuit



**Versuchsaufbau:** Weißwurst als Teil des elektrischen Stromkreises

**Tipps:**

- beim endgültigen Versuch Birne entfernen, so dass Bratwurst allein den Stromkreis schließt
- aus Sicherheitsgründen sollte beim Umbau ein Kind den Stecker für alle sichtbar hochhalten
- bringt man anstelle der Weißwurst eine Gurke in den Stromkreis, so leuchtet diese für ca. 1 min auf - ein Super-Spaß!

<sup>3</sup> IPN Curriculum Physik: Der elektrische Stromkreis, Ernst Klett Verlag, Stuttgart 1986, S. 34

### *Sicherheitshinweise für Stromunfälle:*

- Verunfallten nicht berühren: Warum?!!!
- Not-Aus , falls vorhanden
- Hilfe holen

## Electricity II: “Little Electrician“

### Object: Experimental Skills!

- **Experiment: Installing light in a model house!**

#### Materialien:

- selbstgebasteltes Modellhaus aus Pappe mit bunten Fenstern
- Glühlämpchen ca. 3,7V/0,3A mit Schraubfassung E10 und Kabelklemmschrauben
- Flachbatterie 4,5V
- 2 Metall-Büroklammern als Batterieklemmen
- Fahrraddynamo (evtl.)
- Kabelmaterial : isolierter Draht
- Schalter :
  - Holzklötzchen ca. 6x4x1,5 cm
  - Büroklammer (Metall)
  - Reißbrettstift (Metall)
  - Holzschraube
  - Unterlegscheibe(alternativ: 2 Büroklammern aus Metall)

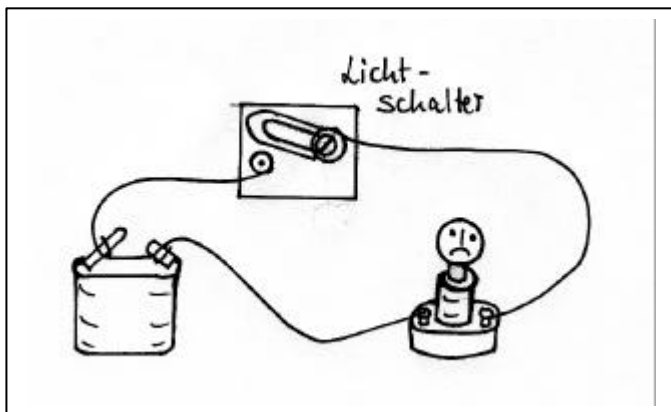


Fig: open / closed circuit

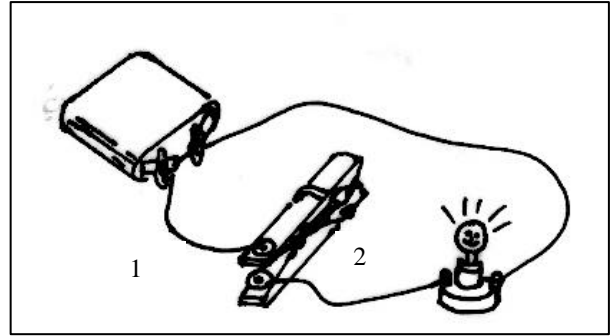
Electricity only flows when the circuit is closed. This experiment demonstrates how it works. Each “little scientist” will understand both the function of a light switch and the set-up of an cable with wire and insulating. In the construction process children will also learn how to skillfully remove the insulation.

- **Experiment: “Raising one’s finger” – electrically!**

#### Materialien:

- Glühlämpchen ca. 3,7V/0,3A mit Schraubfassung E10 und Kabelklemmschrauben
- Flachbatterie 4,5V
- 2 Metallbüroklammern als Batterieklemmen
- Wäscheklammer aus Holz
- 2 Metall-Reißbrettstifte
- Kabelmaterial: isolierter Draht

- Tipp:** - Kabel (1) wird direkt mit dem ersten Reißbrettstift an der Klammer befestigt
- der zweite Reißbrettstift wird an der Klammer so befestigt, dass die Spitze des ersten Reißbrettstiftes den Kopf des zweiten Stiftes berührt, wenn man die Klammer zusammendrückt
  - Kabel (2) kann ebenfalls direkt unter dem zweiten Reißbrettstift befestigt werden

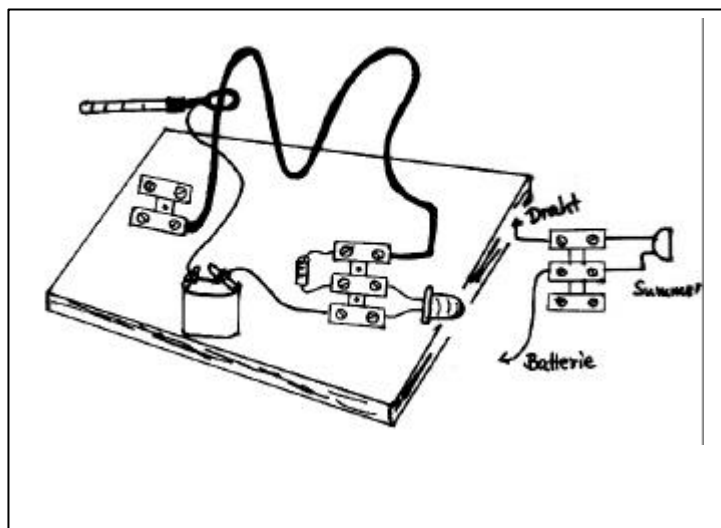


**If you press the wooden clothes-peg clip, your teacher will know that you are ready to give an answer.**

- **Experiment: „Hot Wire“ – selfmade!**

**Materialien:**

- Glühlämpchen ca. 3,7V/0,3A mit Schraubfassung E10 und Kabelklemmschrauben
- Flachbatterie 4,5V
- Lüsterklemmenleiste
- ca. 30 cm starrer Kupferdraht aus Stromkabel – teilweise abisoliert  
Tipp: gibt's beim Elektriker
- ca. 15 cm starrer Kupferdraht für Ring
- alternativ:
  - Leuchtdiode mit Schutzwiderstand 220  $\Omega$  in Lüsterklemme
  - Summer
- 2 Metall-Büroklammern als Batterieklemmen
- Kabelmaterial für Zuleitung - isoliert und flexibel
- Holzbrettchen ca. 20cm x 15 cm x 2 cm
- Holzstäbchen oder Bleistift ohne Mine
- 2 kleine Holzschrauben oder Nägel zur Befestigung der Lüsterklemme



*... have fun!!!*

Strom fließt nur, wenn der Stromkreis geschlossen ist. Auch dieses Spiel zeigt, wie das funktioniert. Die Metallöse am Holzstab ist der Schalter; sobald diese den Draht berührt, ist der Stromkreis geschlossen und die Leuchtdiode (Glühlämpchen) leuchtet auf bzw. der Summer summt.

**Tipp:** - Wird eine Leuchtdiode benutzt und leuchtet diese bei Berührung des „heißen Drahtes“ nicht auf, so hilft in fast allen Fällen ein Tausch der Batterieanschlussklemmen.

*Für alle die wissen wollen warum?: Eine Diode wirkt wie ein Ventil – sie lässt den Strom nur in eine Richtung durch; in der anderen sperrt sie. Ein Glühlämpchen hingegen lässt den Strom in beide Richtungen gleich fließen.*

# Electricity III: „Hot Wire“

## Object: Exercising your patience and coordination!

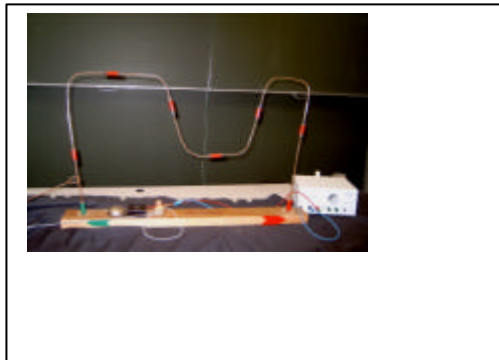
Concentration and patience can be enhanced by this playful stimulus. Besides it's a good exercise to practice coordination and manual skills.



- **Experiment:**

**Materialien:**

- Netzanschlussgerät typ. 0 – 6 V<sub>~</sub>
- Glühlämpchen ca. 3,7V/0,3A mit Schraubfassung E10 und Kabelklemmschrauben alternativ: Klingel
- Holzbrett ca. 60x15x3 cm
- Überklemmenleiste
- Befestigungsschraubchen
- Kochlöffelstiel aus Holz alternativ: Rundholzstab  
Ø 1,5cm
- ca. 1 m Kupferdraht starr größtenteils abisoliert
- ca. 15 cm starrer Kupferdraht für Drahtöse
- ca. 1m Kupferkabel flexibel
- 2 Krokodilklemmen
- Kabelmaterial
- Isolierband



**Tipp:**

Drahtenden des „heißen Drahtes“ zu Ösen umbiegen und mit Holzschrauben und Unterscheiben befestigen.

Fig: „Hot Wire“ with lamp and / or buzzer

