Phantom Phlame

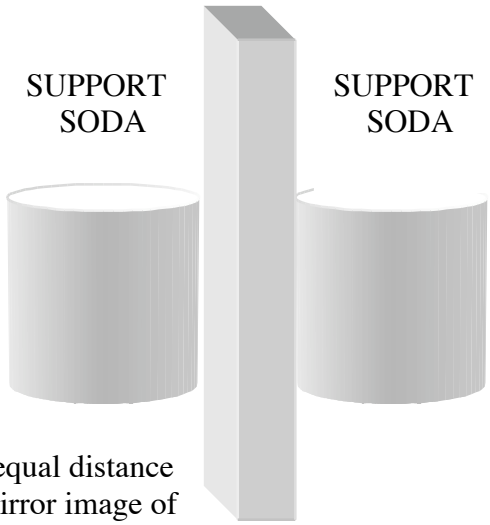
Optical Pain

Introduction:

Hold your hand over a burning and candle and not get burned. This is done by reflecting and transmitting the light of two candles.

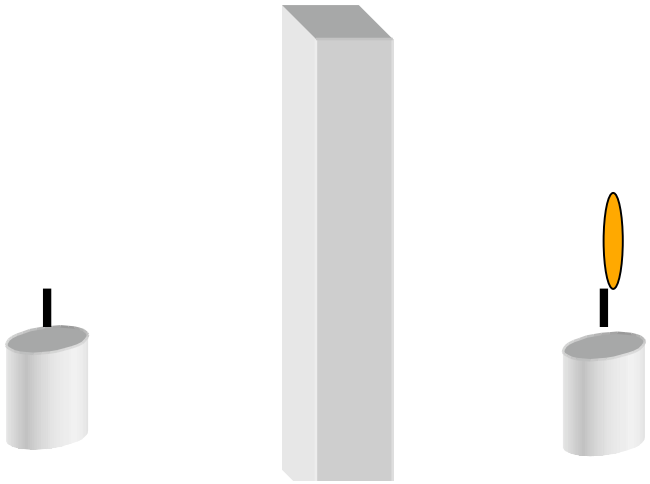
Materials:

- Plastic sheet – roughly 12” by 8”
  - Note: This activity can be scaled-up.
  - Note: Glass can also be used, but there is a higher chance of breakage.
- 2 full cans of soda
  - Note: anything that keeps the plastic sheet perpendicular will work.
- 2- identical candles
  - Note: both need to be the exact same height.
  - Note: both wicks need to be burned
- Matches or lighter
- Dimly lit room



Assembly:

1. Place the plastic sheet between the 2 soda cans so that the sheet is perpendicular to the table. The cans should be at the edge of the sheet so that the majority of the sheet is not blocked.
2. Place one candle on each side of the plastic sheet.
3. Position the candles so that they are perpendicular and equal distance from the plastic sheet (the candles are positioned in a mirror image of each other on each side of the mirror.



Support Sodas omitted in this image

4. Final adjustments:
   a. Dim the lights in the room
   b. Look at one candle from one side of the plastic sheet.
   c. Light this candle.

Eric Muller - draft
Exploratorium 2004

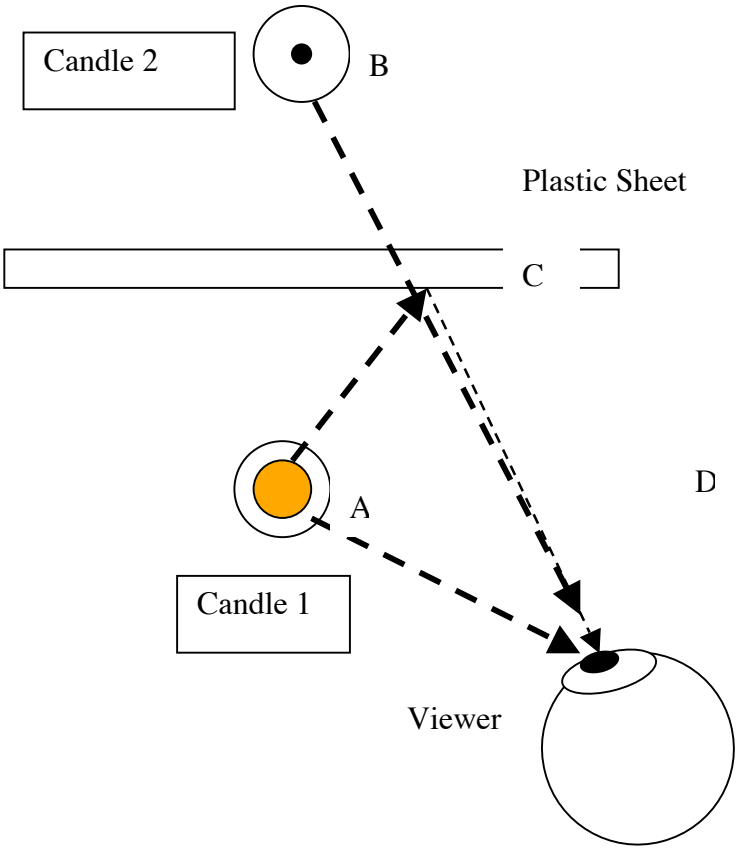
d. You should see a reflection of the candle you just lit in the plastic sheet. Align this reflected image so that it overlaps your view of the candle on the opposite side of the plastic sheet. Make sure the wicks are also aligned.

To do and notice:

1. Assemble a crowd of people (or students) on one side of your apparatus.
2. Light the candle closest to the crowd.
3. **Here's the trick** - Pretend to the light the candle on the opposite side.
4. After a brief discussion about how you've been trained to tolerate pain, hold your hand over the unlit candle. From the crowd's perspective, it will appear as though your hand is over a lit candle.

What's going on?:

It looked like your hand was over a lit candle, but it wasn't.
Using the diagram below, the viewers saw both candle 1 and candle 2 (Rays AD and BD).
Some rays from Candle 1 also bounce off the plastic sheet (AC and CD).
There is no flame from candle 2 (BD), but rays from the candle 1 flame bounced off of the plastic sheet and they appeared as though they are coming from candle 2 (BD).



This activity was originally shown to me by Brad Katuna