

## **A revised method for projecting two different movies to two groups of viewers without their noticing the duality**

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The MORI technique reported in Mori (2003) has evolved into its second generation after the appearance of a new type of video projector with two advantages over the first generation. The new MORI technique uses a pair of DLP projectors instead of the LCD type. The improved technique does not require sideways framing of the movie for presentation as required formerly. Therefore, any ready-made movie clip can be used. Second, it utilizes a pair of circular polarizing filters instead of linear polarizers. Linear polarizing filters may leak the to-be-blocked light wave when they are tilted. Circular polarizing filters are less susceptible to that weakness. The effectiveness of the revised technique has been proved by several studies carried out in two separate laboratories in which undergraduates and preschoolers participated as eyewitnesses to observe simulated criminal events presented using this technique.

Mori (2003) invented a projection procedure, the MORI (manipulation of rivalrous images by polarizing filters) Technique, that enables experimenters to project two different video movies on the same screen to be viewed separately by two groups of viewers without their noticing the duality. The technique has been utilized in experimental research on eyewitness testimony experiments (Gary, French, Kinzett, & Mori, in press; Hirokawa, Matsuno, Mori, & Ukita, 2006; Kanematsu, Mori, & Mori, 2003; Mori & Mori, 2006), in which participants/eyewitnesses observed two different versions of a simulated criminal event presented using this technique and discussed what they had seen afterward. There was also a symposium on the application of the MORI technique in eyewitness memory research (Mori, Itoh, Gabbert, & Loftus, 2005).

The MORI technique utilizes the polarization of light. Since the emitted light from LCD (liquid crystal display) projectors is polarized when it passes through the LCD panels, it can be blocked by a polarizing filter placed perpendicular to the polarized vibration direction of the light beam, while it can pass through another polarizing filter placed in the same vibration direction. When two LCD projectors project two different images, A and B, onto the same screen with one of them set sideways so that its light beam is polarized perpendicular to the other light beam, the images A and B are separately blocked by a polarizing filter placed in the appropriate direction. In experimental settings, the polarizing filters are mounted into a pair of sunglasses to be worn by the viewers, one type for Image A and the other for Image B. This is the principle of the MORI technique, reported in detail in Mori (2003).

The MORI technique is promising as an innovative presentation method for a variety of research areas, not only for experimental studies on eyewitness memory, but also for any psychological research that requires surreptitious introduction of some discrepancy among participants. For example, if it had been possible to present two different sets of lines to participants, the Asch experiments could have been done without using confederates. However, a crucial problem has arisen concerning the use of the MORI technique because the manufacturers of LCD video projectors have recently changed the alignment of the three LCD panels in their video projectors. An LCD projector houses three LCD panels for the three primary colors, red, green, and blue. In the old type of LCD projectors, on the market before around 2000, the three LCD panels were aligned in the same direction in terms of polarization. Therefore, the emitted beam, a combination of three different colors, was polarized in the same way, vibrating in the same direction. So, a single polarizing filter placed perpendicular to the polarization direction was able to block the light beam emitted from an LCD projector.

However, in the new type of LCD projectors, the two LCD panels for red and blue are aligned in the same way while the one for green is perpendicular to the other two. The reason for the change of alignment has not been disclosed because it is a trade secret. The three LCD panels being aligned differently, the light beam emitted from these new projectors cannot be blocked totally by one polarizing filter. Therefore, the new type of LCD projectors cannot be used for the MORI technique. Worse yet, the old type of LCD projector is not available any more. All the

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LCD projectors in stores are those with mixed alignment of the three LCD panels.

As briefly stated in Mori (2003), a different type of video projector has appeared: the DLP projector. These projectors use a fundamentally new light processing technique, called *Digital Light Processing*. (“DLP” and “Digital Light Processing” are trademarks of Texas Instruments). The basic principle of light processing used in DLP technology is digital manipulation of a matrix of micro-mirrors, with each micro-mirror corresponding to one pixel of a digital image (see the Web page of Texas Instruments for further details: [www.dlp.com/tech/what.aspx](http://www.dlp.com/tech/what.aspx)). The crucial point is that the light beam emitted through a DLP projector is *not* polarized. Therefore, it is possible to polarize the light by placing an additional polarizing filter in front of the projection lens, and to have the polarized light either pass through or be blocked by a second polarizing filter.

In the MORI technique, the polarized light is blocked by a polarizing filter placed perpendicular to the polarization direction. However, the blockage can easily be undermined by tilting the second polarizing filter about 10 degrees in either direction as stated in Mori (2003). Although this is one of the weak points of the technique, it is not likely to cause a serious problem as long as adult participants are involved. They usually obey the instruction to keep their heads as straight as possible during the presentation. However, when children are the participants, it is rather difficult to prevent them from tilting their heads. Young children are active and move their heads in all directions more than adults. This may cause a serious problem for presenting two different images without their noticing the duality.

This problem can be addressed by utilizing circular polarizers instead of linear ones. There are two types of circular polarizers; right-hand and left-hand ones. An ordinary light beam is right-hand polarized after passing through a right-hand circular polarizer. Thus, the right-hand polarized light can pass through another right-hand circular polarizer but cannot pass through a left-hand polarizer. Therefore, it is possible to create two invisible

separate channels in the same way as with linear polarizer as discussed above. It should be noted that the right- or left-handedness holds irrespective of the placement of the circular polarizer. This means that circular polarizer can block the other type of polarized light even if they are tilted in any direction to any degree.

Nothing is completely perfect. Circular polarizers have a weakness, too. There are small leakages of light waves as shown in Figure 1 (right panel). Linear polarizer can block totally all the wave range of light (from 450 to 700 nm, or from violet to red in our color vision) as long as two of them are crossed perpendicularly (Figure 1; left panel). However, a combination of left- and right-handed circular ones can block out only a certain wave range (from 500 to 600, roughly corresponding to green and yellow, respectively). Light waves in 450-nm wavelength range and ones in 700 nm cannot be blocked perfectly.

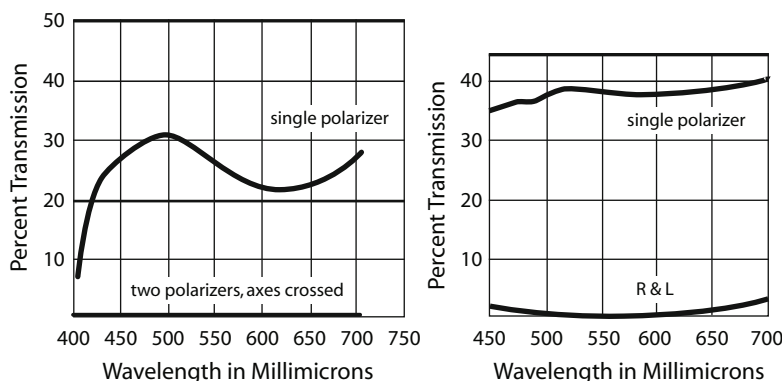
### THE MORI TECHNIQUE USING DLP PROJECTORS

#### Purpose

The purpose of the revision of Mori (2003) is to introduce a new way to use the MORI technique utilizing DLP projectors instead of LCD projectors. The new MORI technique, the second generation, in addition to overcoming the problem caused by the mixed alignment of LCD projectors, has two advantages over the original: (1) sideways framing is no longer necessary, therefore any type of preexisting movie clip can be used, and (2) circular polarizing filters can be used instead of linear polarizers that may fail to block the not-to-be-seen image if viewers tilt their heads.

#### Basic Principle

The basic principle for the new MORI technique is the same as the original one (Mori, 2003). It employs the polarization properties of light, which have been used in certain types of three-dimensional (3-D) displays. Physically speaking, light is a transverse wave, vibrating perpendicular to its direction. The polarization of light is the direction



**Figure 1. Percent transmission of light through polarizer in terms of wavelength. Left panel, linear polarizer; right panel, circular polarizer. Reproduced from the Web page of MeCan Imaging, Inc., [www.mecan.co.jp/original/polarizer/polarizer-shcase.html](http://www.mecan.co.jp/original/polarizer/polarizer-shcase.html), with permission.**

in which the wave is vibrating. Usually, light is composed of rays of all polarizations. A polarizing filter allows only the light of one polarization to pass through. Therefore, once light passes through one of these filters (then said to be “polarized”), it cannot pass through another polarizing filter that is a different type in terms of polarization. If two images are polarized differently to each other and are projected on the same screen, these two images look overlapped to the ordinary eye. However, if a viewer wears a pair of appropriate polarizing sunglasses, only one image can be seen while the other image is filtered out. The crucial point here is that polarized light, irrespective of whether it is polarized linearly or circularly, can be either blocked or allowed to pass through by means of an appropriate polarizing filter. It should also be noted that neither linear nor circular polarization affects ordinary vision. In other words, the naked eye cannot detect the polarization of light of any kind.

In the MORI technique, two different images presented on the same screen can be seen separately by two groups of viewers without their noticing that there are two different overlapping images. Two video projectors, hidden behind a half-transparent screen, project two images that are differently polarized to each other. Participants are asked to wear a pair of polarizing sunglasses which look similar to ordinary ones but can filter out one of the projected images. The simplicity of the experimental setting should help prevent the participants from becoming suspicious about the presentation trick. The point is that the participants should think they are observing the same event together when in fact that they are observing two different versions of it.

### Apparatus

**Video projectors.** Instead of LCD projectors, a pair of DLP projectors should be used for the new MORI technique. As stated above, the LCD projectors now on the market are not suitable for the MORI technique because their LCD panels are aligned differently from the older type described in Mori (2003). Unlike the light beam of an LCD projector, that of a DLP projector is not polarized.

It is recommended that the two projectors be stacked vertically rather than set side by side, so that the two projection lenses are as close together as possible. It is also recommended that a frame be made to make it easier to mount the two projectors in an appropriate configuration.

**Polarizing filters.** Since the light beam emitted from the DLP projectors is not polarized, two pairs of polarizing filters are required: they are referred to as pA1, pA2, pB1, and pB2. Two of the polarizers, pA1 and pB1, are placed in front of the projector lenses to polarize the emitted light beams before they are projected onto a half-transparent screen. The other two polarizers, pA2 and pB2, will work as separators of the two polarized images. The latter polarizers, pA2 and pB2, are framed into pairs of sunglasses to be worn by the viewers. The polarizers pAs and pBs should be different in terms of their polarizing direction so that the light polarized by pAs would not pass through pBs, and vice versa. In this way, two invisible separate channels are created; from pA1 to pA2 and from pB1 to pB2.

**Polarizing sunglasses.** Polarizing sunglasses can be made using ordinary sunglass frames and cutouts from a sheet of polarizing filter. Plastic sheets of polarizing filter (linear and circular) are sold for use as school teaching materials. A sheet measuring 25 cm × 25 cm × 0.8 mm costs about ¥6,000, or US\$50.00. It can be cut easily using ordinary scissors.

**Special notes about utilizing circular polarizer.** In order to utilize circular polarizers instead of linear ones, two types of polarizing filters and sunglasses, right- and left-hand circular polarizers are needed. It should be noted that the function of circular polarizer is unilateral; the light beam passing through only from the appropriate surface to the other side is polarized circularly and the circular-polarized light can be blocked only by the back surface of the other circular polarizer. Therefore, right- and left-hand circular polarizers must be placed in front of each of the projectors, with the front surface facing the projection lenses. Two pairs of sunglasses suitable for viewing either of the two video images should be made with circular polarizing filters with the front surface facing the viewer's eyes.

**Half-transparent screen.** It is recommended that a half-transparent screen be used and that projection be done from the rear because of the following two reasons. First, ordinary screens tend to depolarize the polarized light beam at the point of reflection whereas half-transparent screens let the polarized beam pass through relatively unchanged. Second, rear projection can hide the two projectors from the viewers. A plain ground glass pane or a similar plastic half transparent sheet sold as desk mat material can be used as a half-transparent screen.

**Configuration of apparatus.** The apparatus described above are laid out as in Figure 2.

### SAMPLE APPLICATION STUDIES OF THE MORI TECHNIQUE

Several experiments have been conducted using the revised MORI technique that have confirmed its effectiveness (French, Mori, & Garry, 2006; Garry et al., in press; Mori & Takahashi, 2004). The results of those studies are not the focus of this paper and thus are not described in detail. Instead, some technical aspects of those experiments that are more relevant to the purpose of this paper are discussed below.

In the studies by French and colleagues, the new MORI technique was utilized with newly developed misinformation movie clips on DVD (Takarangi, Parker, & Garry, 2006). Takarangi et al. created two slightly different versions of the same event, about “Eric the Electrician” working in an unoccupied house. The two versions are identical except for eight critical items. The important point here is that the new MORI technique can utilize video materials developed by other researchers, as well as any ready-made movie clip.

Mori and Takahashi (2004) carried out experiments in which 13 preschooler pairs observed basically the same event with three nonconforming points secretly interjected using the MORI technique with circular polarizer. In the

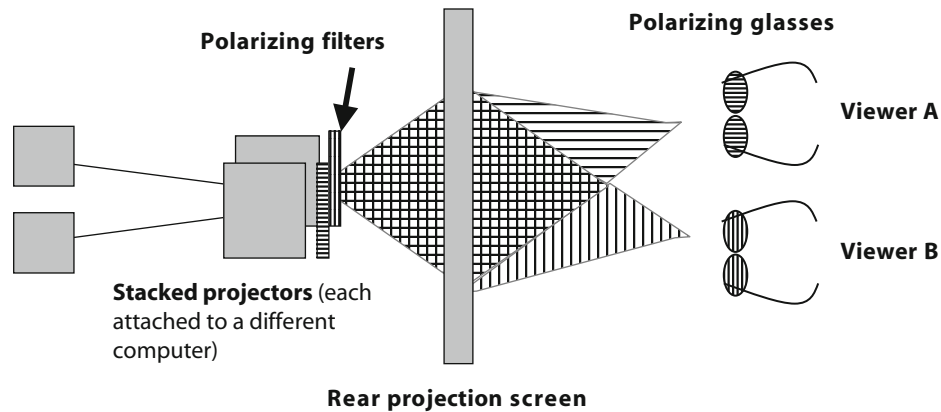


Figure 2. Layout of experimental equipment for the MORI technique.

Mori and Takahashi (2004) experiment, they introduced two technical innovations for eyewitness experiments with young child participants: utilizing circular polarizers instead of linear ones and an animated cartoon movie clip (Yamazaki, 2001).

Yamazaki (2001) converted the two versions of the Kanematsu et al. (1996/2003) movie into an animation cartoon strip of about one minute in length. The two versions were framed side-by-side so that the two versions were perfectly synchronized frame by frame (see Figure 3). The two-frame animated movie was played on a laptop computer (iBook) and the same video image was sent through an analogue RGB distributor (I.O.Data MSD-4A) to the two DLP projectors that projected the image onto the rear screen. The projector on the left side projected only the left frame of the animation while the right-side projector projected only the right frame onto the rear screen window. In this way, two different frames were overlapped on the rear screen in perfect synchrony and only one of them could be seen through the window screen by viewers wearing the appropriate sunglasses (Figure 4).

### CONCLUSION

The MORI technique (Mori, 2003) has been recognized as a useful new presentation technique and utilized in sev-

eral research laboratories other than the inventor's own (Garry et al., in press; Hirokawa et al., 2006; Itoh, Umeda, & Kawaguchi, 2005). All of them have verified its effectiveness. No participant noticed the duality during any of the experiments. The new MORI technique described in this paper inherits all these merits, and adds two improvements: It can use any ready-made movie clip and it can use circular polarizers which are less susceptible to possible lack of deception.

Both linear and circular polarizers have weak points: linear ones may leak the blockage of light when they are tilted, and circular ones have the flaw of blocking in certain wavelength ranges. However, experiments which have already been carried out have proved that these weaknesses can be ameliorated by means of other experimental contrivances such as synchrony of the two movies. If two images happen to be seen due to accidental leakage of the other polarized light wave, participants will never notice the duality as long as these two images are identical. In the experiments described above, the viewers watched the two versions of identical movies for most of the presentation period, and discrepancies were introduced only from time to time. When we see a 3-D movie at the theatre, we never notice the duality of images because the two versions are quite similar to each other and, most importantly, they are perfectly synchronized. The new MORI technique can be used with either linear or cir-



Figure 3. Sample frame from the Yamazaki (2001) cartoon (original was in full color).

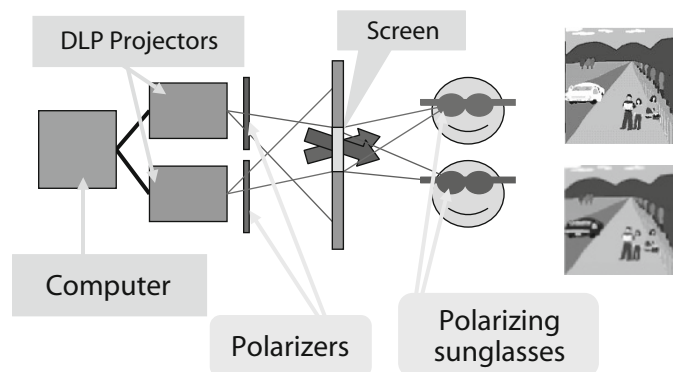


Figure 4. Diagram of the Mori and Takahashi (2004) experiment.

cular polarizer. Therefore, the experimenter should choose the most suitable ones depending on the experimental conditions, such as visual materials, participants, etc.

Thanks to competition among projector manufacturers, a DLP projector is available for as low as ¥60,000, or \$500 US. A DVD player can cost as little as ¥4,000, or \$35 US. Altogether, the minimum equipment for implementing the MORI technique, consisting of two DLP projectors, two DVD players, two polarizing filters, and two pairs of sunglasses (the latter two can be made from a sheet of  $25 \times 25$  cm polarizing filter), and a rear screen, can be obtained for as little as ¥140,000, or \$1,200 US.

The MORI technique can be applied to a variety of psychological research with a wider participant age range than those in the examples reported. It is expected that it will become a useful new tool for experimental research in psychology.

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