

Optical Illusions in Aikido

by Guillermo Paz-y-Miño C., Ph.D. and Avelina Espinosa, Ph.D.

Abstract

Optical illusions deceive the visual perception of aikido techniques, affecting various aspects of its learning and teaching. Just like a magic trick, illusions in aikido make us believe we are seeing something that is not there or is not happening, generating confusion in class and frustration in students and instructors. By dissecting the components of aikido routines, we can identify and understand the sources of illusions; this can help us improve the methods of communicating aiki principles.* Here we discuss how illusory visual stimuli distort our interpretation of rolling and falling, partnered techniques of neutralization, projections-throws, and weapons.

Does the rim along the edge of this tatami mat appear to you as a straight line? It looks curved to me. Is it not true that if you extend this line out indefinitely, it will circle the Earth and come back to itself? Then it must be curved.
~ Koichi Tohei (Reed, 1992: 296)

Introduction

Optical illusions are misleading images that deceive the visual perception of shape, size, color, or motion. Illusory visual stimuli make us believe we are seeing something that is not there or is not happening. The gentle and relaxed manner with which an aikido practitioner throws a partner creates the impression that no force has been involved in the technique. This is because the human eye tends to not see the entire sequence of the technique, but only its most conspicuous component (i.e., an opponent falling). Efficiency in causing imbalance, applying leverage, and using gravity (force) are the secrets of this “magic.”

Aikido (*aiki* = harmony, *do* = path, the way of) is rich in optical illusions. They interfere with our perception of a throw, causing confusion in class and frustration in students and instructors. Here we discuss how illusory visual stimuli distort our interpretation of a variety of aikido routines, including rolling and falling, partnered neutralization techniques, projections-throws, and weapons. By dissecting the components of aikido routines, we can identify and understand the sources of the illusions. This can help us improve the methods for teaching aiki principles.

* Note:

“Aiki principles” refers to the complete art of aikido, including techniques, biophysical principles (gravity acting upon the body, centripetal force, leverage), and mind-and-body coordination (mental intention matches physical action).

Photographs courtesy of A. Espinosa and G. Paz-y-Miño C.

In this article, we divide aikido's optical illusions in two broad categories, static and dynamic. To comprehend the complexity of aikido's most deceiving and common illusions, the dynamic ones, we must first discuss the static illusions. We recommend that students and instructors follow this approach.

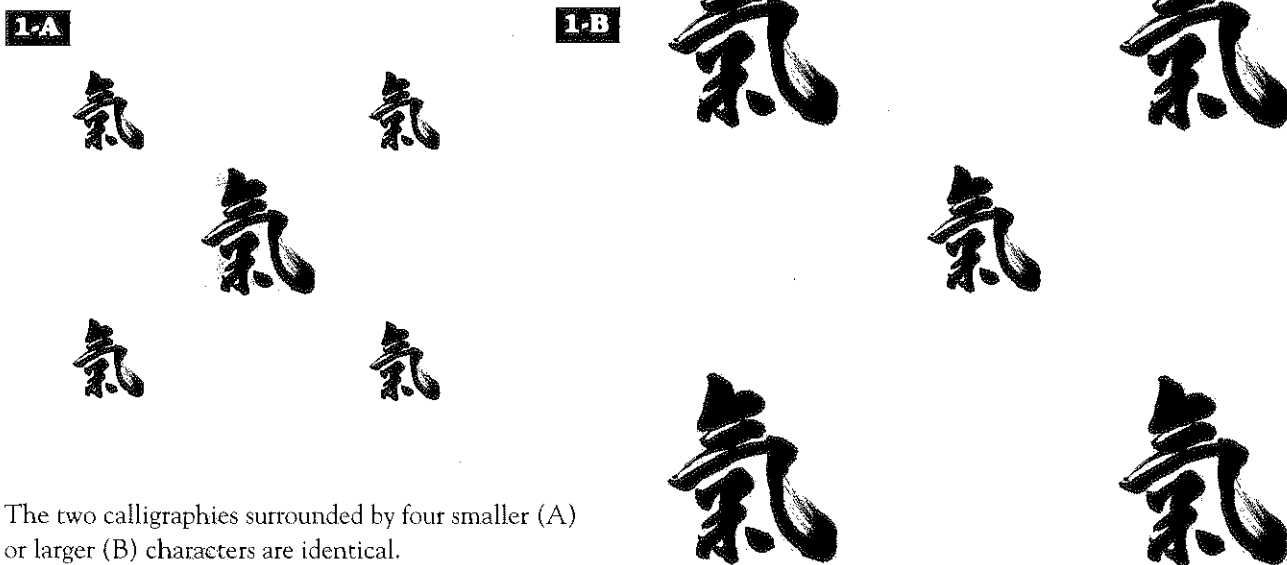
Static Illusions

Static illusions can be attributed to errors in perceiving contrast, size, orientation, or any combination of these variables. Below we provide three examples:

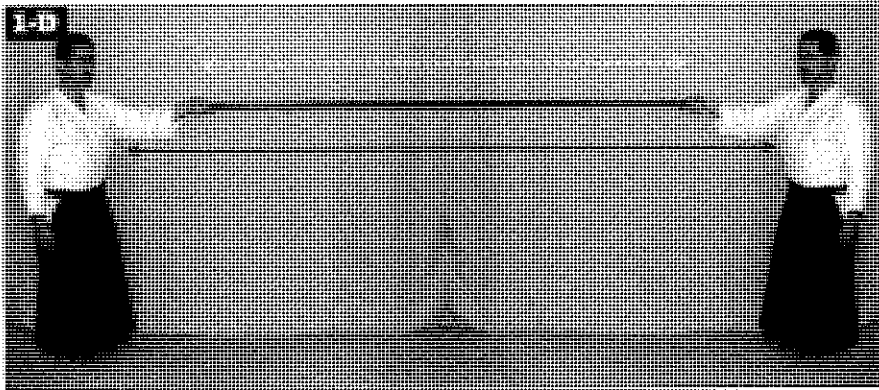
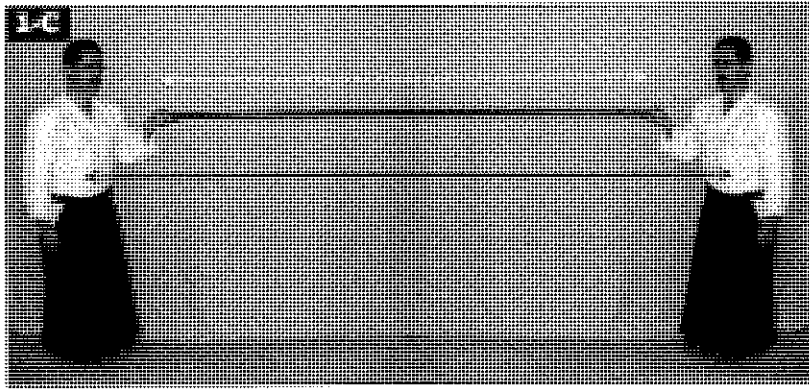
- 1) size-contrast
- 2) orientation-contrast, and
- 3) size-orientation-contrast illusions.

An example of *size-contrast illusion* is shown in Figure 1, where two identical calligraphies of the character *ki* (= life energy, spirit of harmony) are surrounded by four smaller (A) or larger (B) examples of the same character. For the observer, it appears that the calligraphy within the small symbols is larger than that within the large symbols. An even more impressive example of size-contrast illusion is depicted (C-D). When the human eye sees two mirror images of an aikido practitioner holding a wooden staff (*jo*), the attention is focused on the staff. If the practitioner keeps his arm bent (C), this creates the illusory effect of shortening the staff. In contrast, when his arm is extended (D), this has the effect of lengthening the staff. The illusion results from a misinterpretation of the staff's length (size) due to the position of the aikido practitioner in respect to the staff and the flexion or extension of his arm. An analogous example of this type of illusion is shown in Figures E-F.

Figure 1
Size-contrast illusions

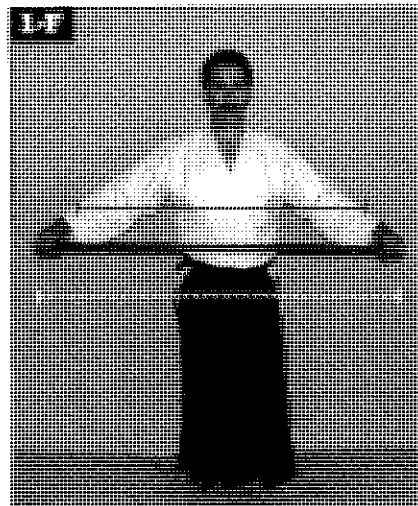
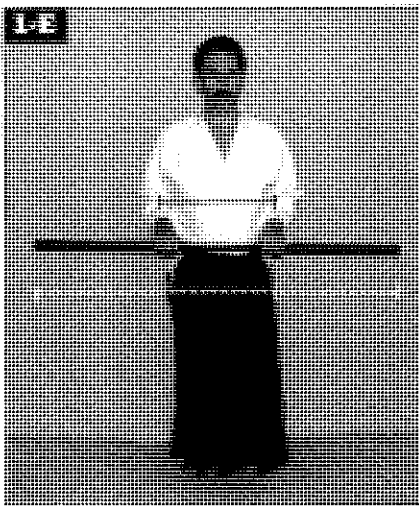


The two calligraphies surrounded by four smaller (A) or larger (B) characters are identical.



The length of the staff held by the aikido practitioner in the two mirror images (C-D) is the same (dashed line), but the position of the practitioner with respect to the staff differs (solid line) as a consequence of flexing or extending his arm.

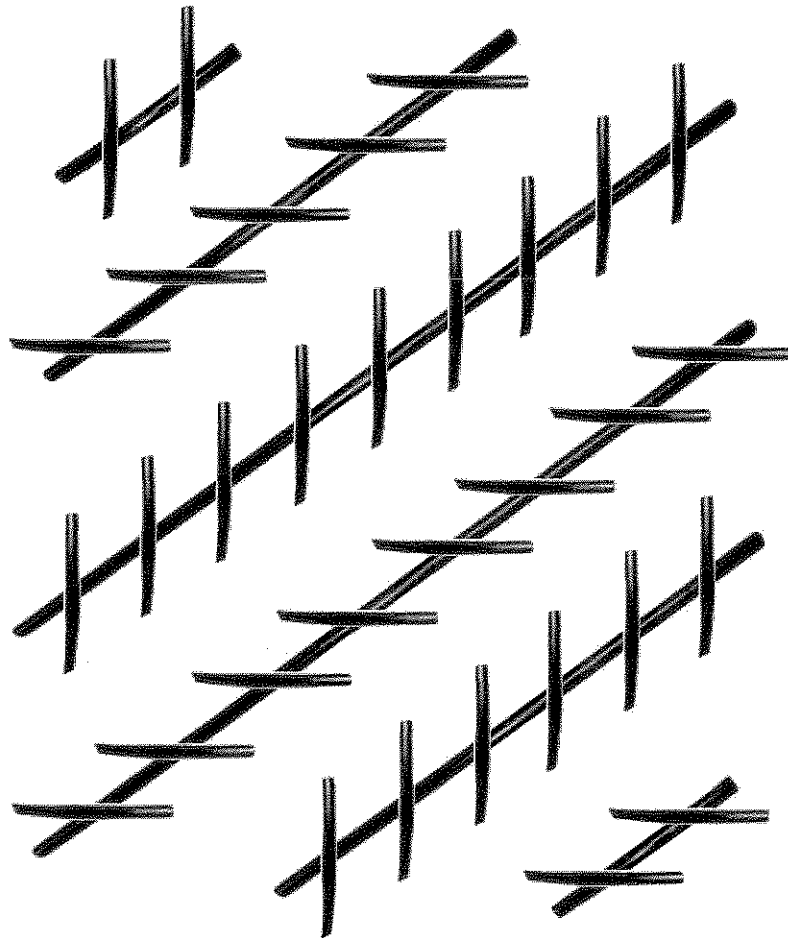
The demonstration is simple yet powerful (E-F): when the practitioner holds the staff with his arms close to the body, the staff looks shorter than when he keeps his arms wide open. Although the length of the staff never changes (dashed line), the position of his arms does (solid line). In all these cases, the scale and distribution of the elements in the surrounding environment interfere with the perception of size.



An example of *orientation-contrast illusion* is illustrated in Figure 2. In this case, various wooden staffs (*jo*) are arranged equidistant and parallel to each other, while wooden knives cross them in opposite directions. This contrasting orientation of lines creates the illusion that the staffs merge near their ends.

Examples of *size-orientation-contrast illusions* are presented in Figure 3. The two *suzu* bells (A) (used for vigorous aikido chanting) are identical. However, the orientation of the lines in the background makes the bell on the left look larger than the one on the right. The three photographs of an aikido practitioner standing and holding a staff (B) are also identical, but the background creates the illusion that the one furthest away is the biggest. Finally, the arrangement of two wooden swords (*bokkens*) within two diverging staffs gives the impression that the upper sword is longer than the lower one (C).

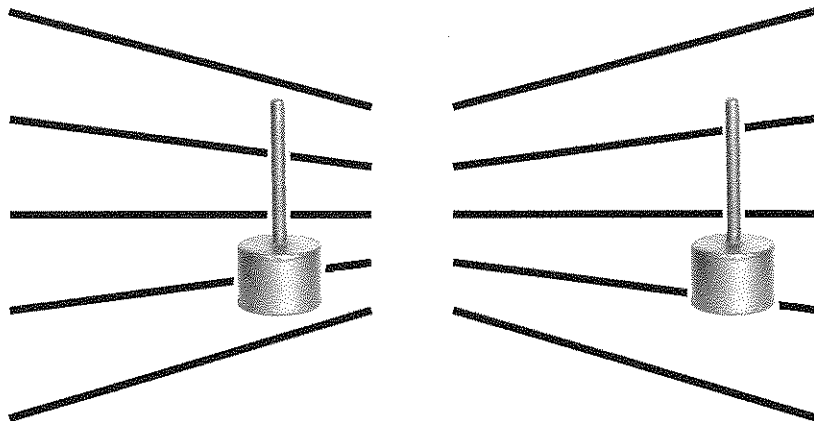
Figure 2
Orientation-contrast illusion



The opposite orientation of the wooden knives (*tanto*) in respect to the staffs creates the illusion that the staffs merge near their ends.

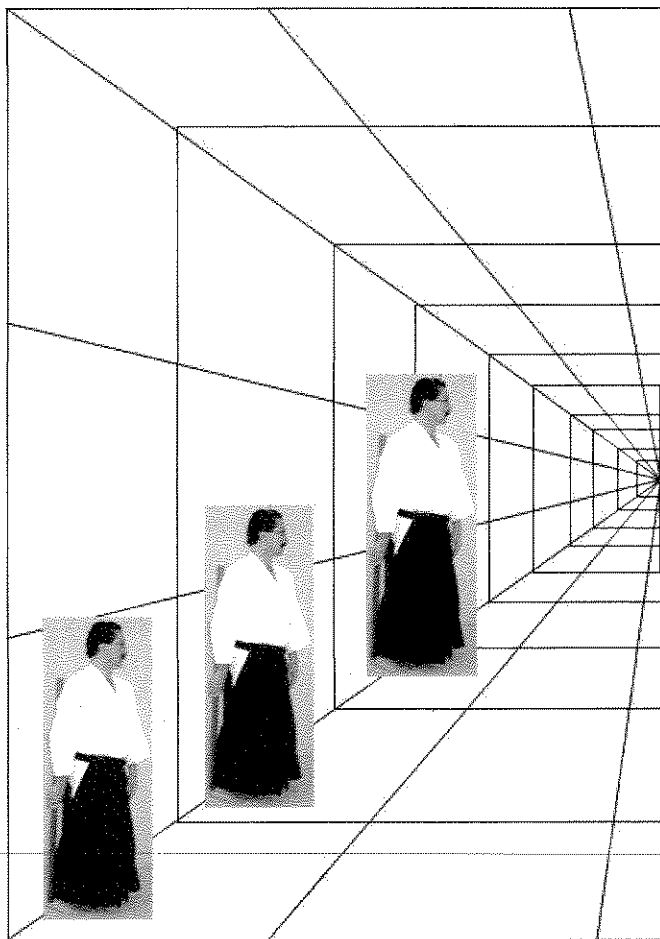
Figure 3
Size-orientation-contrast illusions

3-A

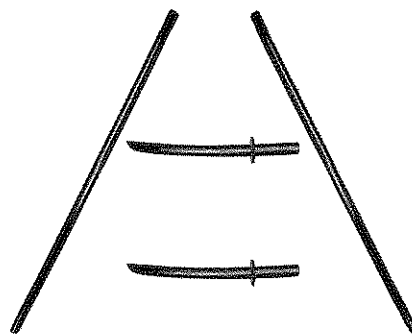


The orientation and arrangement of the lines in the background give the impression that the suzu bells (A) and the photographs of the aikido practitioner (B) differ in size.

3-B



3-C



A similar illusory effect emerges when two wooden swords are arranged within two diverging staffs (C).

Dynamic Illusions

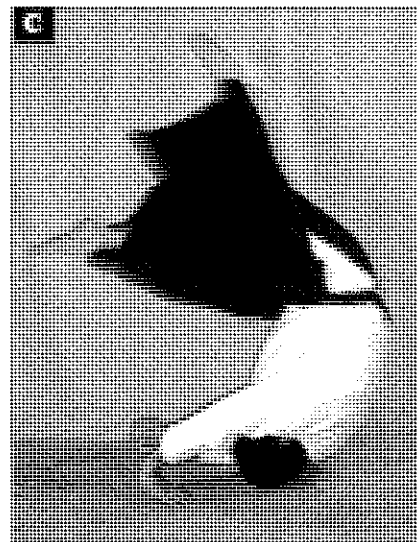
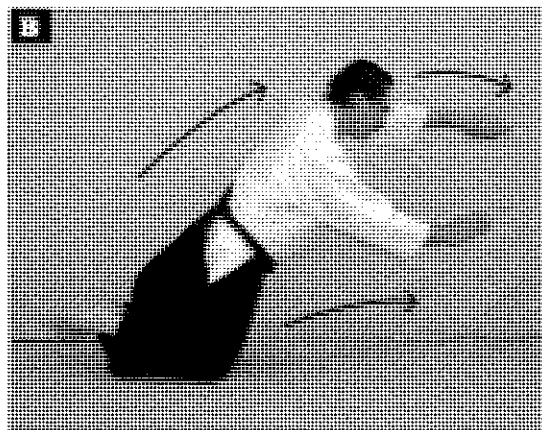
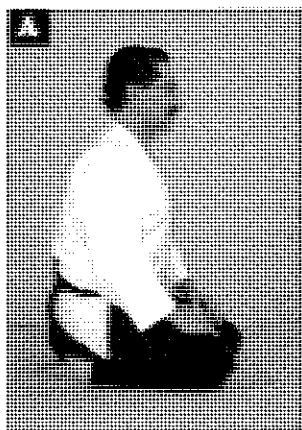
Dynamic optical illusions are also caused by errors in perceiving contrast, size or orientation, but these illusory visual stimuli emerge *only* when these variables interact in motion. Some illusions, for example, suggest movement of a stationary practitioner as a result of the motion of others around him. There are scenarios in which two or more practitioners move with similar velocities, however their speed can be perceived as different; moreover, if two practitioners move at the same speed, it may seem like the one performing the technique remains still while his partner is moving. Dynamic illusions arise from the interaction of the practitioners' kinetic patterns (unique to the human anatomy), with their relative speed of movement while executing a technique and the features of the environment (contrast, size, and orientation of objects; light, depth, and texture of the background; even sounds and/or noise can interfere with the perception of movement).

Aikido techniques include a complex combination of apparently independent movements in a three dimensional environment. The instructor usually performs all these "independent" components with accuracy and blends them into harmonious motions. Because the human eye captures the most conspicuous element of this blend, the student inadvertently disregards details. His visual perception of the instructor's performance is incomplete and illusory. Student and instructor are usually unaware of this phenomenon. Since the illusion is not conceptual but perceptual, knowing that the effect is illusory does not diminish the strength of the illusion. Shortly, student and instructor develop a negative feedback loop: the young practitioner continues to mimic only the most conspicuous element of the routine while the instructor struggles to communicate the important details within the entire technique. The illusion corrupts the correct understanding of those details because, in numerous cases, the student cannot even see them. At the end, student and instructor agree that only long-term training and arduous physical workout will take care of the problem.

We believe that this difficulty can be minimized, not by blindly fighting against the strength of the illusion (i.e., via long-term physical workout until the body, not the mind, finds the answer to the problem), but rather by consciously acknowledging its existence. Here are a few tips that can help you achieve this goal.

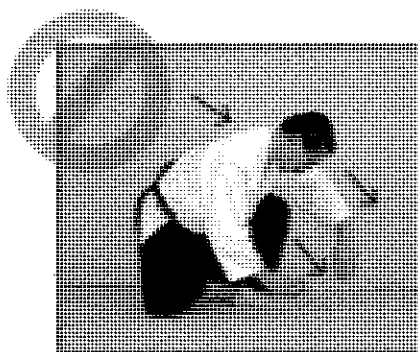
1. Assume that all aikido techniques include one or more optical illusions.
2. Acknowledge that when watching a technique the illusions emerge when the movements of the one-point (*hara*) "central point," or the body's center of equilibrium (located about two inches below the navel), interact with movements of the upper limbs (the "details," above). If the body moves up/down (by squatting), rotates (by turning), or shifts (by stepping), the arms will also move in these directions. In physical terms, this is true even if the practitioner never moves the joints of his arms. Why? Because the body cannot move without taking the limbs with it! In consequence, subtle motions of the arms, which are characteristic of aikido arts, will appear huge to the observer's eye given that they are enhanced by the motions of the one-point. The observer will tend to exaggerate and/or distort these or any other movement linked to the motions of the one-point.
3. Make sure you understand the movements of the one-point and the

Figure 4
Forward roll from a formal sitting posture (*seiza*)

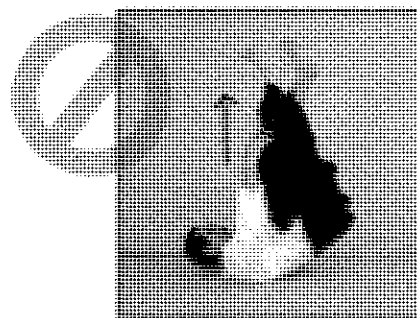


Starting position: formal sitting posture (A). Raise your body up and “throw” yourself into a forward roll (B). Continue rolling (C-D).

Slow down and prepare yourself to “knee walk” (E-F). The optical illusion makes the observer believe the practitioner quickly curls the body to execute the roll (incorrect B) and tries to stand up as soon as the back touches the mat (incorrect C).

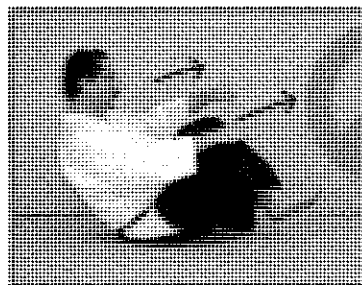


Incorrect-B

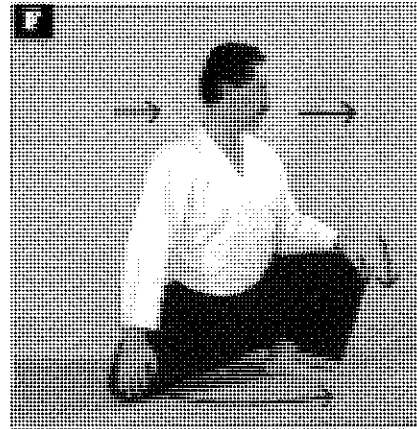
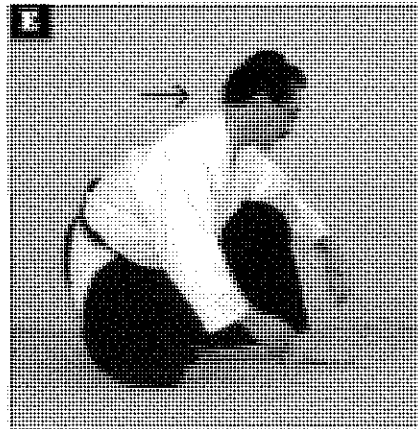
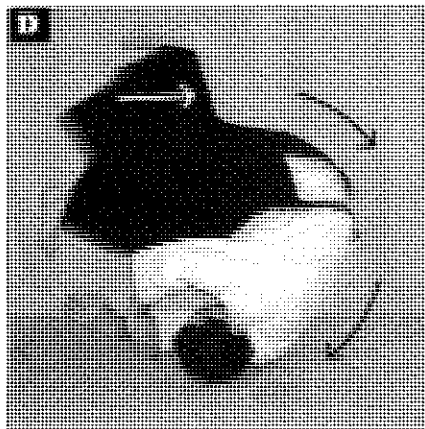


Incorrect-C

The early curling of the body compromises the entire technique preventing the practitioner from finishing the roll (incorrect E). The roll should be big, long, and forward, however, the student sees it as small, short, and compressed.



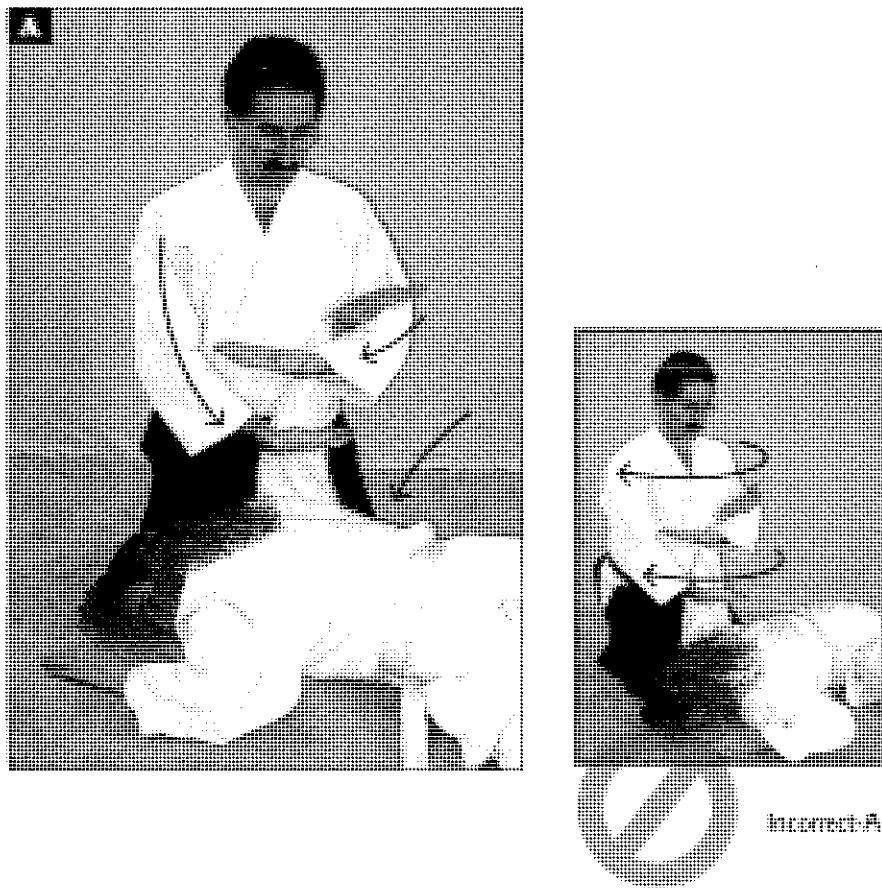
Incorrect-E



- movements of the upper limbs separately before attempting to blend them.
4. Be critical about yourself and allow others to correct you. They should also be aware of the potential existence of illusions.
 5. Be sensitive with yourself and others. Remember that, like viewing a magic trick repeated numerous times, knowing that a visual effect is illusory does not diminish the strength of the illusion.

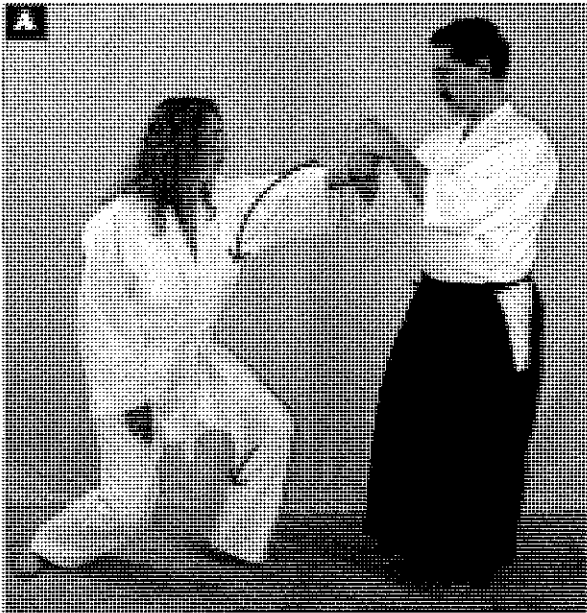
Below we provide examples of how dynamic illusions distort our interpretation of a variety of aikido arts. Each figure includes a detailed description of how to perform the routines. "Incorrect" execution of a technique or parts of a technique is indicated.

Figure 5 .
Three-palms-up lock



This lock relies on complex angular trajectories applied to the arm: one in the direction of each of the practitioner's hands (down and in), and another in the direction of the attacker's shoulder (see three arrows). These trajectories converge into a major center – the attacker's shoulder. The optical illusion misleads the interpretation of the technique, making the observer believe that the practitioner is turning his torso to his right (incorrect A), which actually frees the attacker or, even worse, injures her shoulder rather than simply restricting her movement.

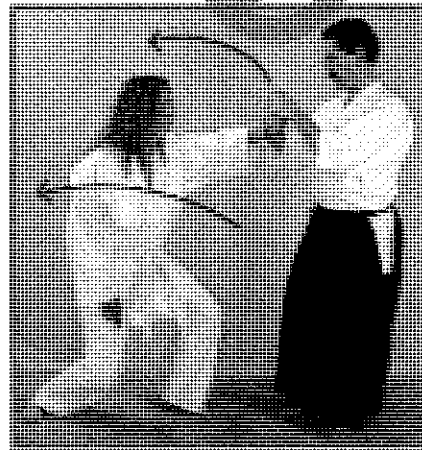
Figure 6
Wrist lock



Incorrect-A



Keep the attacker's fingers pointing up and bend the attacker's wrist toward the one-point (A-B). The trajectory of the technique, which connects the wrist with the elbow, shoulder and one-point, forces the attacker to kneel. To the observer, it appears as if the practitioner is lifting the attacker's arm and projecting it over her head (incorrect A), which leads to a loss of control of the lock (incorrect B) and of the entire technique.



Incorrect-B

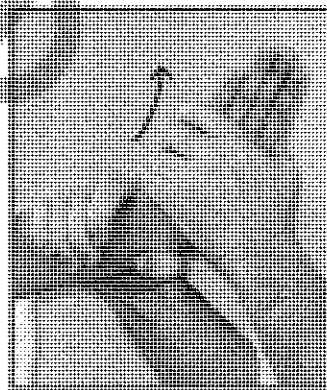
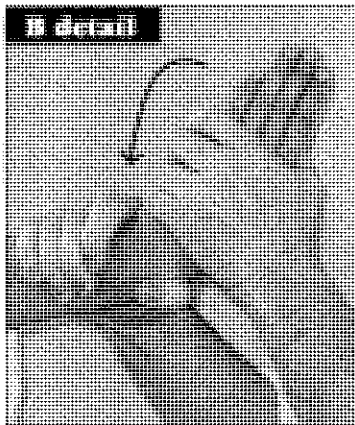
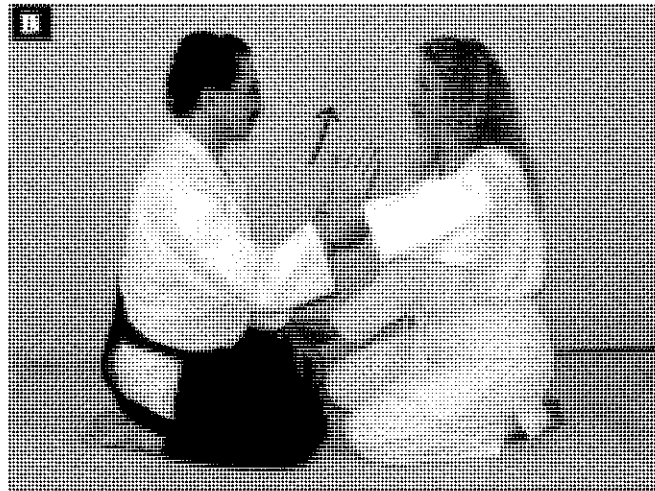
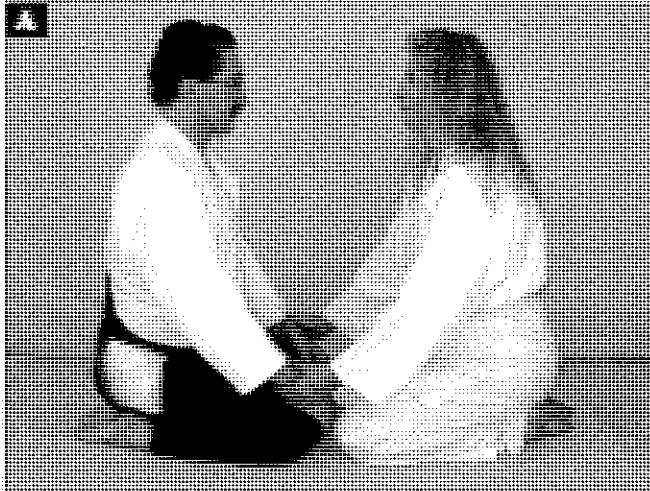
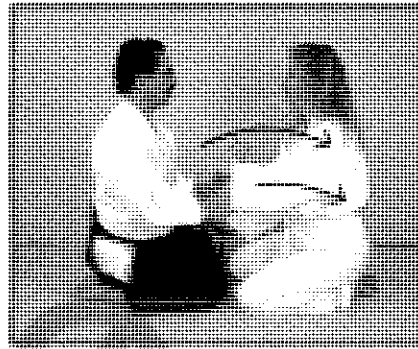


Figure 7
Lateral projection from a formal sitting posture



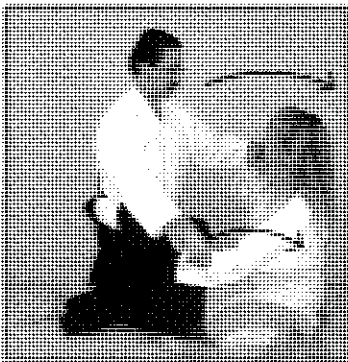
Attacker (right) performs a two-handed wrists grab (A). Defender (left) moves his right hand upwards, fingertips pointing to the sky (B). Defender's left hand mirrors the initial motion of the right hand and then he leads the attacker out and hack down to her rear diagonal side (C). The defender's right knee rises up and he twists the attacker's wrist with his right hand at the same time that the left hand addresses the direction of her movement. Attacker turns completely over her hip and does a break fall (C).



The optical illusion in this technique is strong. It looks as if the defender pushes the attacker backwards (incorrect B) and attempts to walk over her (incorrect C). The successful execution of this throw relies on the rotation of the attacker's body, which is centered down and very close to the defender's right knee.



Incorrect-B



Incorrect-C

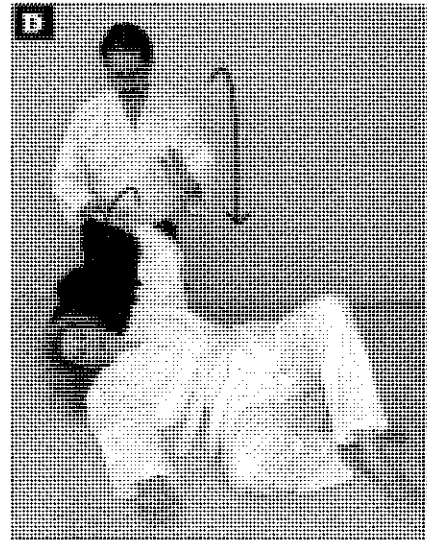
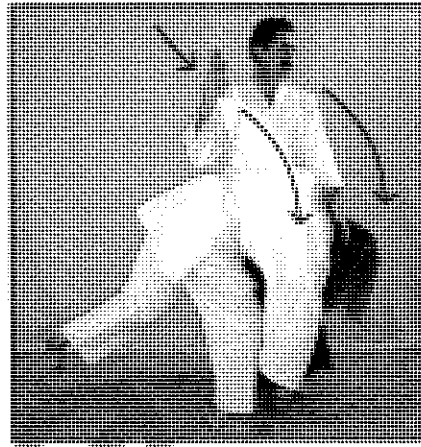
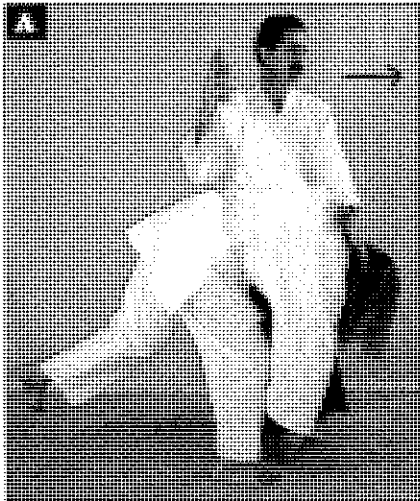
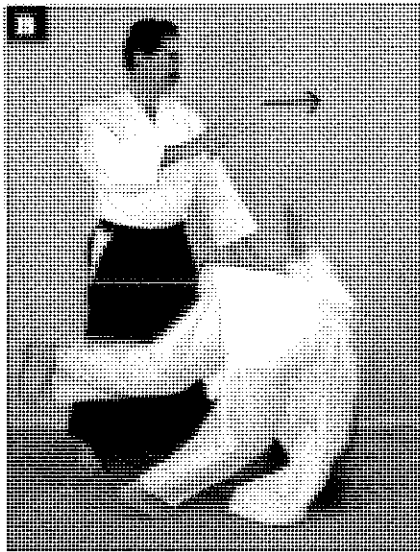


Figure 8
Harpoon throw

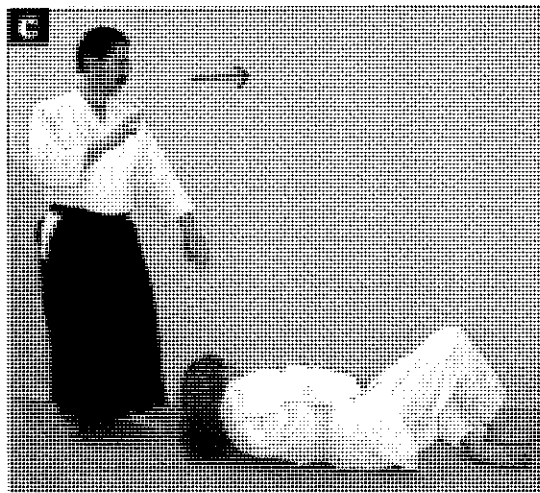


incorrect A.



The practitioner (standing) leads the attacker into a stooped position (A) before projecting her into a forward roll (B) and a break fall (C).

The projection is gentle and parallel to the ground. However, the optical illusion makes it appear as a rough downward throw against the mat, mostly energized by the practitioner pushing the attacker with his arm (incorrect A).

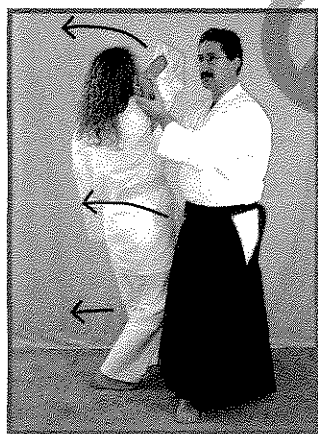


The impressive power of this technique is generated by the movement of the practitioner's entire body (not his arm!) since he steps forward while leading the student in the same direction.

Figure 9
Wrist-bent-toward-shoulder throw



Incorrect-A



The practitioner (right) bends the attacker's wrist toward her shoulder (A-B), leading her to sit (C) or projecting her backward down onto the mat (D). To the observer, it appears as if the practitioner is walking forward (incorrect A), projecting the attacker's wrist over her head, and throwing her far away from him. The technique, however, takes place within the practitioner's individual space, with no significant walking, but with subtle squatting.

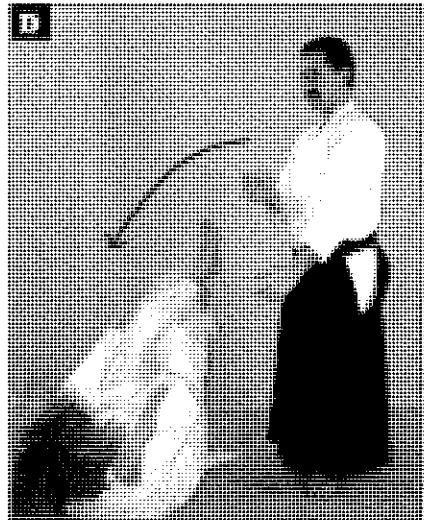
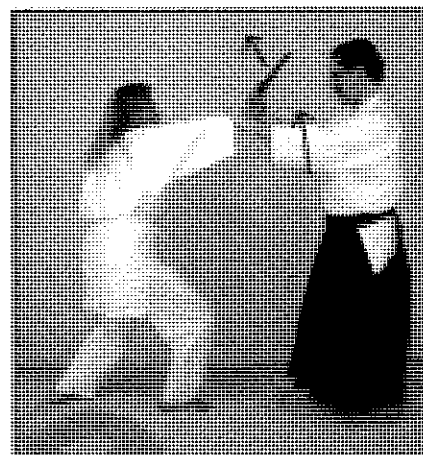
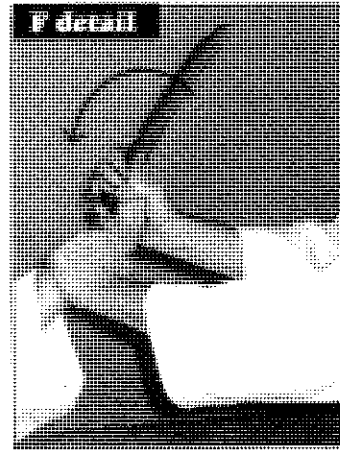
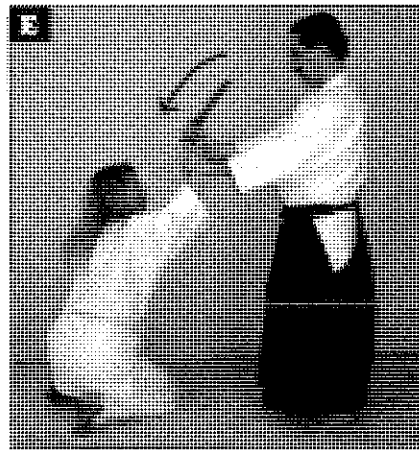
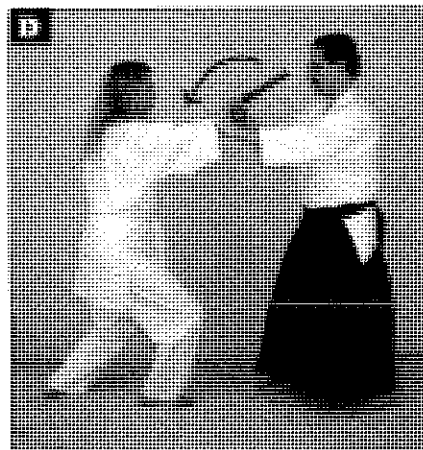
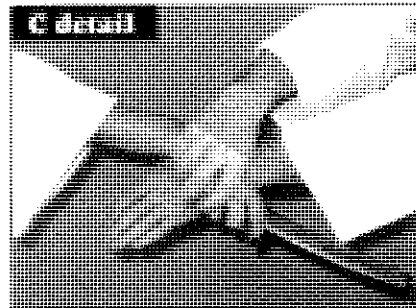
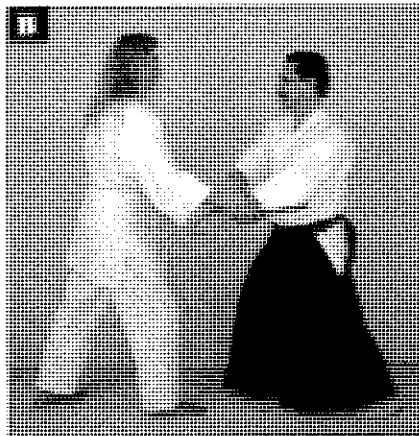
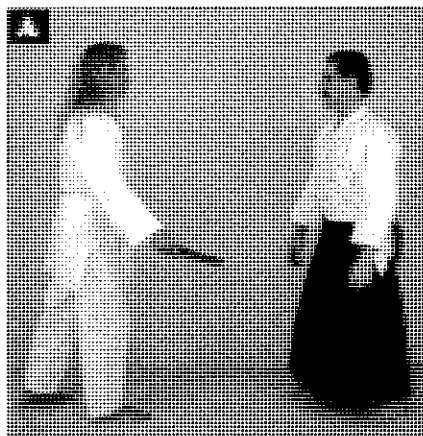
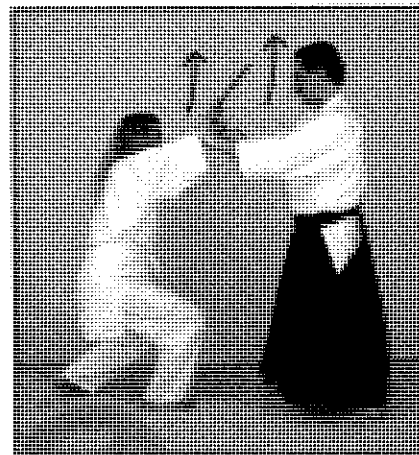


Figure 10
Neutralization of a thrust attack with a knife (*tanto*)



Incorrect-D

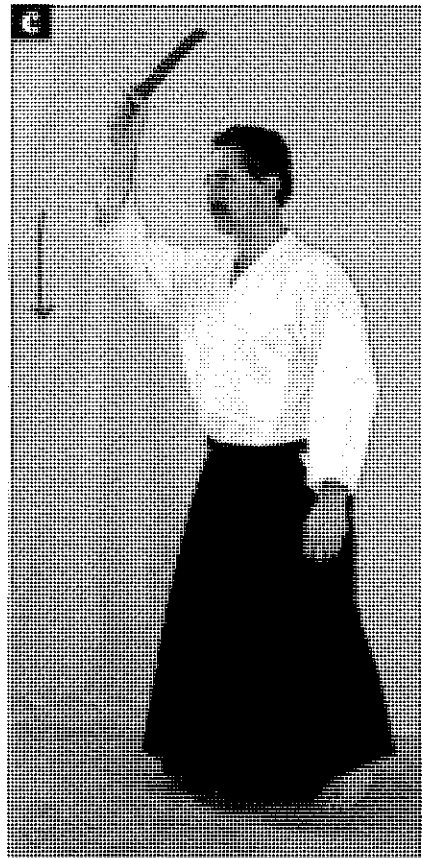
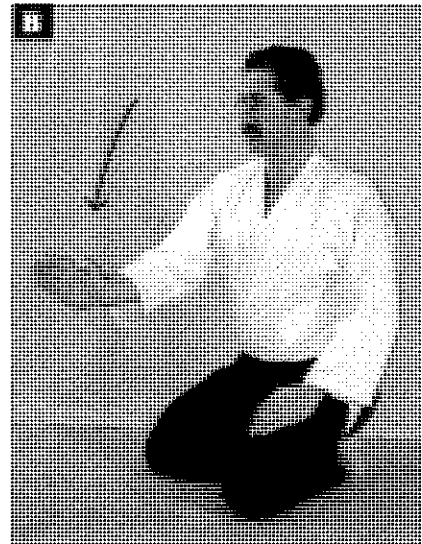


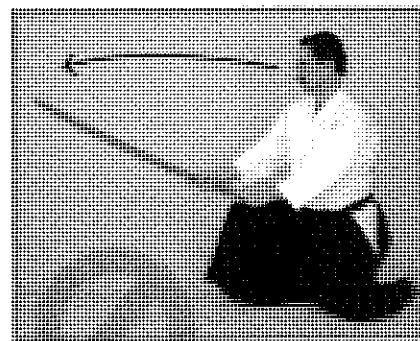
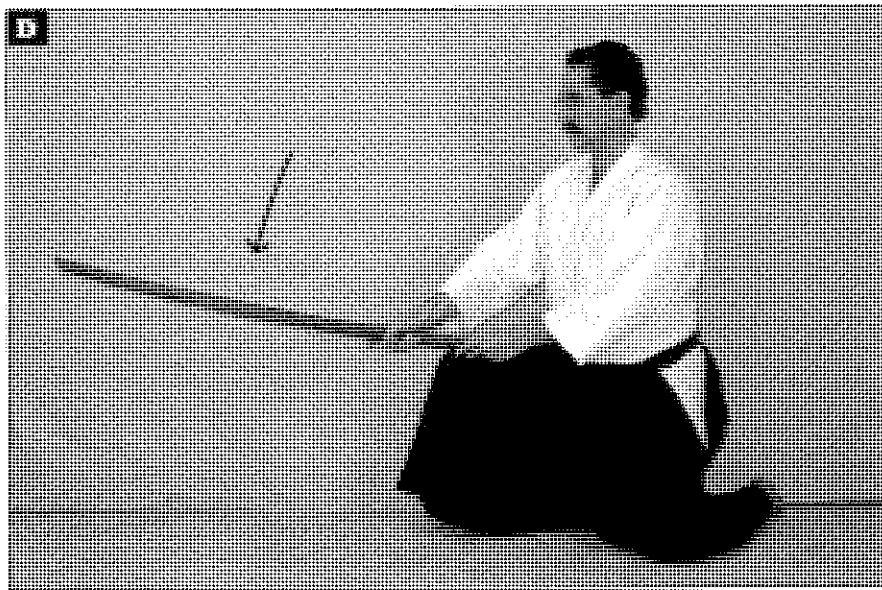
Incorrect-E

Attacker (left) thrusts the knife toward the defender's abdomen (A-B). Defender redirects the attack slightly down and out at the same time that he secures the attacker's wrist (C detail). Defender bends the attacker's wrist toward her shoulder (D), which takes her down on her knees (E; knife points upwards, see detail F). Because the attacker kneels leaving her hand up, it appears to the observer as if the defender lifts the knife and projects it over the attacker's head (incorrect D-E). The lock is secure only if the attacker's wrist is firmly redirected down and toward her one-point.

Figure 11
Cut with knife (*tanto*), sword (*bokken*) and staff (*jo*)

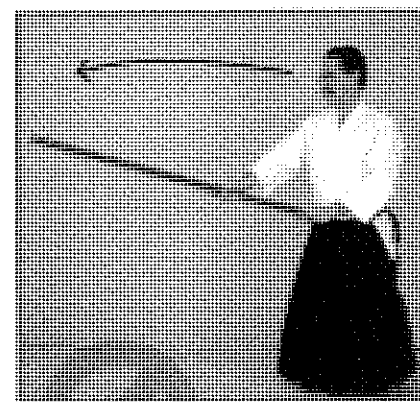
The vertical cut with an open hand is identical to the cut with a knife, sword or staff (A-B-C). Since the weapon is an extension of the body, the adjustments to the length of it are important, but should not compromise the correct motion.



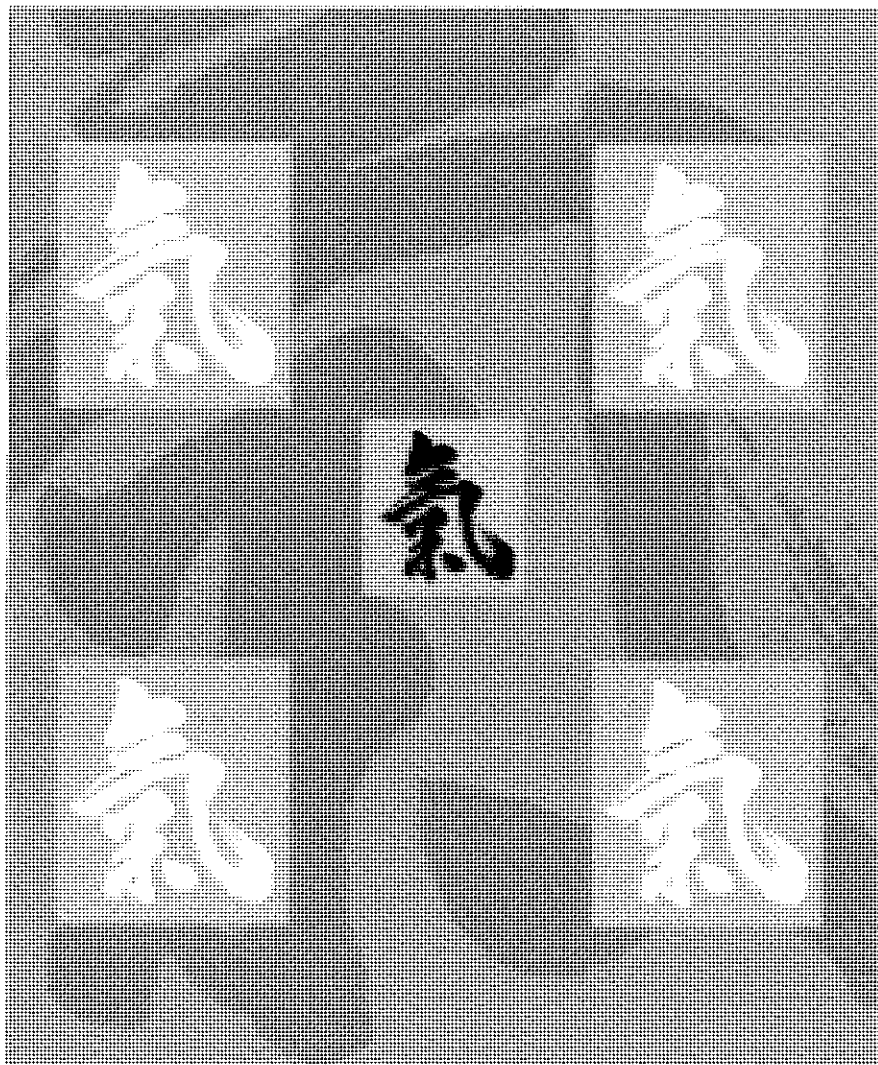


incorrect-D

Because the aikido practitioner focuses his sight on the horizon while cutting with a weapon (D-E), it appears to the observer as if he is throwing the weapon forward trying to reach a distant target (incorrect D-E). In reality, the cut is close to the practitioner's body and directed to the ground even though his eye vector and intention converge on the horizon.



incorrect-E



Concluding Remarks

To expedite the learning process, aikido's magic should be revealed to all students. In this way, students will understand critically and analytically the logic of aikido. They will also become efficient and independent in their development. Since errors in visual perception are universal to the eye, optical illusions might not be exclusive to aiki arts. Like aikido, other martial disciplines that rely on throws and projections can hide optical illusions in their forms. Throws and projections are based on equiangular (spiral) trajectories, with continuous wide rotations of the one-point. Combined with arm movements, these can create illusions. Striking arts, in contrast, emphasize on rotations of the one-point and linear blows, which communicate less confusing information to the eye (linear, of course, in relative terms). With this article, we hope that we have generated an awareness of some intrinsic difficulties in learning and teaching aikido principles, and we have suggested strategies to deal with them.



Bibliography

- Carlson, T., Schrater, P. & He, S. (2006). Floating square illusion: perceptual uncoupling of static and dynamic objects in motion. *Journal of Vision* 6, 132-144.
- Curtis, C. (2001). *Ki-Aikido on Maui*, 3rd Ed. Maui, Hawaii: MAKS Publications.
- Gillam, B. (1980). Geometrical illusions, pp. 87-94. In *Scientific American The Mind's Eye*. New York: W. H. Freeman and Company.
- Goodale, M. & Humphrey, G. (1998). The objects of action and perception. *Cognition*, 67, 181-207.
- Gregory, R. (1997). Knowledge in perception and illusion. *Philosophical Transactions of the Royal Society London B*, 352, 1121-1128.
- Maruyama, K. (1984). *Aikido with ki*. Tokyo: Ki No Kenkyukai Headquarters.
- Paz-y-Miño C., G. & Espinosa, A. (2002). Dichotomous keys to fundamental attacks and defenses in aikido. *Journal of Asian Martial Arts*, 11(1), 8-27.
- Paz-y-Miño C., G. & Espinosa, A. (2002). Aikido: the art of the dynamic equiangular spiral. *Journal of Asian Martial Arts*, 11(4), 8-29.
- Paz-y-Miño C., G. & Espinosa, A. (2004). The rhythm of aikido: Part I. *Journal of Asian Martial Arts*, 13(2), 44-63.
- Paz-y-Miño C., G. & Espinosa, A. (2004). Music principles applied to aikido techniques: Part II. *Journal of Asian Martial Arts*, 13(3), 64-81.
- Plodowski, A. & Jackson, S. (2001). Getting to grips with the Ebbinghaus illusion. *Current Biology* 11(8), R304-R306.
- Reed, W. (1992). *Ki: A road that anyone can walk*, 2nd Ed. Tokyo: Japan Publications.
- Reed, W. (1999). *Ki: A practical guide for westerners*, 6th Ed. Tokyo: Japan Publications.
- Schlag, J. & Schlag-Rey, M. (2002). Through the eye, slowly: Delays and localization errors in the visual system. *Nature Reviews Neuroscience* 3, 191-200.
- Shifflett, C. (1998). *Ki in aikido: A sampler of ki exercises*. Merrifield, Virginia: Round Earth Publishing.
- Shifflett, C. (1999). *Aikido: Exercises for teaching and training*. Merrifield Virginia: Round Earth Publishing.
- Smeets, J., Brenner, E., De Grave, D. & Cuijpers, R. (2002). Illusions in action: Consequences of inconsistent processing of spatial attributes. *Experimental Brain Research* 147, 135-144.
- Tohei, K. (1962). *What is aikido*. Tokyo: Rikugei Publishing House.
- Tohei, K. (1974). *This is aikido*. Tokyo: Japan Publications.
- Tohei, K. (2001). *Ki in daily life*. Tokyo: Ki No Kenkyukai Headquarters.
- Tohei, K. (2001). *The way to union with ki: Aikido with mind and body coordination*, 1st Ed. Tochigi: Ki No Kenkyukai Headquarters.

Acknowledgements

We dedicate this article to Mark Rubbert, William Reed, Koichi Kashiwaya, and Andrew Tsubaki who have inspired us to explore the fascinating complexity of *Shin Shin Toitsu Aikido* (founder Koichi Tohei). The material discussed in this article is not necessarily endorsed by Ki-Society or any of its affiliates.