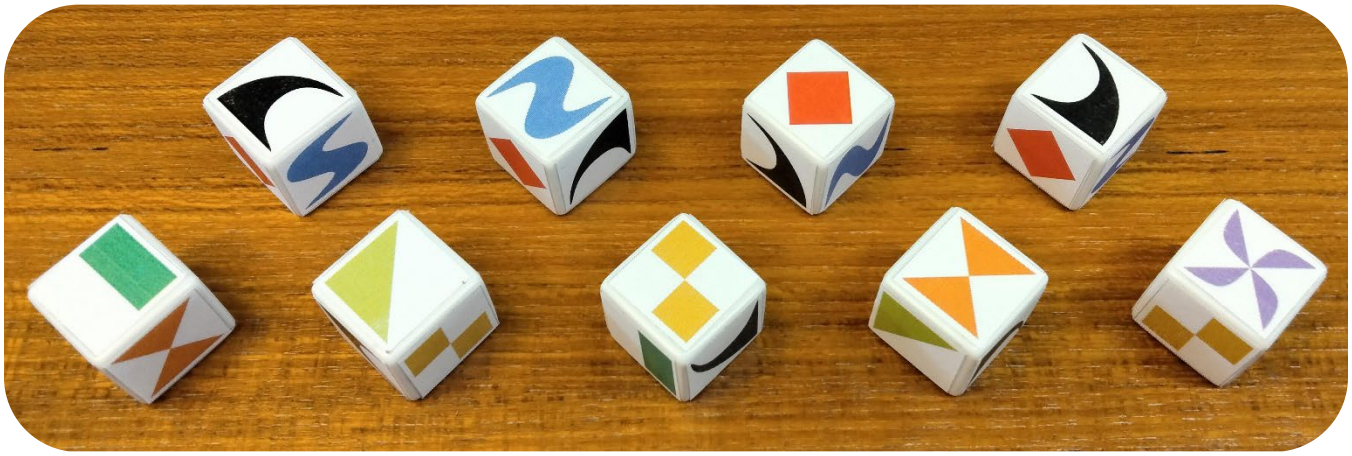
SymmDice

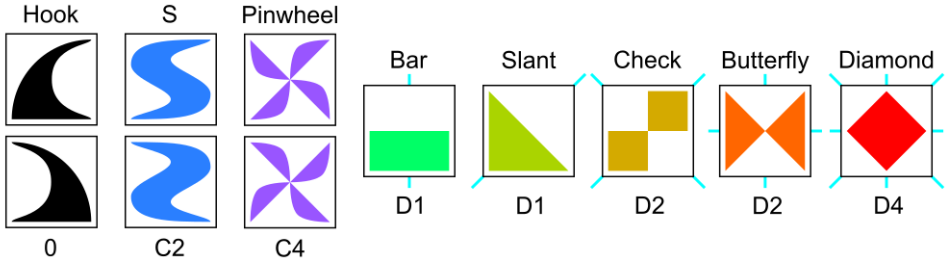
Dice Design Game
Art + Math



Standard SymmDice Set

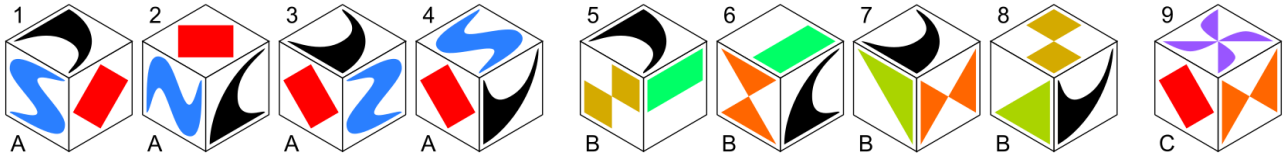
Number of sets. To play the game, you need at least one set of nine SymmDice. With just one set, players play their turns one at a time. With multiple sets, players may play their turns at the same time.

Face motifs. The square faces of the cubical dice are decorated with eight motifs: hook, S, pinwheel, bar, slant, check, butterfly, and diamond.

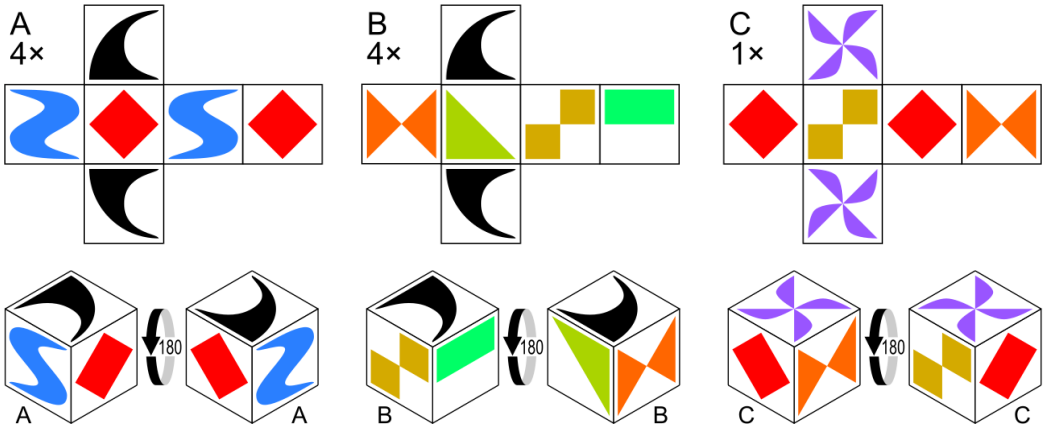


Each motif, including its square face, has rotational symmetry (C2, C4), mirror symmetry (D1, D2, D4), or no symmetry (0). (The symmetry types are described in the Symmetry section below.)

Dice set. A standard set has **nine dice**: **four A dice**, **four B dice**, and **one C die**. Each A die has S's, hooks, and diamonds. Each B die has hooks, a bar, a slant, a check, and a butterfly. Each C die has pinwheels, diamonds, a check, and a butterfly.



Arrangements. The motifs are arranged on the faces of the A, B, and C dice as shown in these folding patterns and isometric views.



Opposite faces have the same motif (diamonds), mirror-images of the same motif (hooks, S's, pinwheels), or motifs with the same type of symmetry (bar & slant, check & butterfly).

Distribution. A set of nine dice has 54 faces: 16 hooks, 10 diamonds, 8 S's, 5 checks, 5 butterflies, 4 bars, 4 slants, and 2 pinwheels.

Colors. Dice sets may be monochrome (for example, black and white) or multicolored. Within a set, all instances of a motif should have the same foreground color and the same background color (for example, all diamonds are red-on-white).

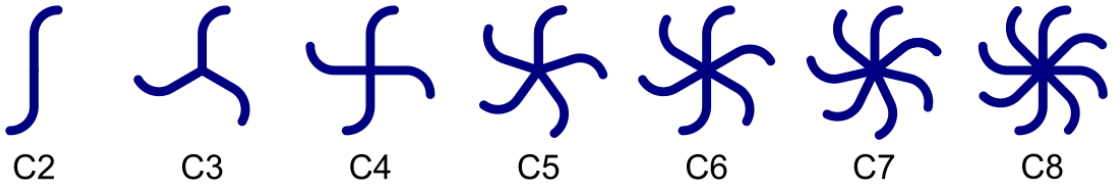
Symmetry

Definition. A figure has symmetry if some transformation results in a figure that is identical to the original. The symmetries in this game use two transformations: rotations and mirror reflections.


0

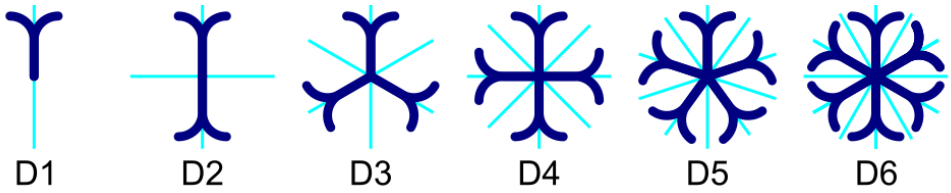
No symmetry. In this game, a figure has no symmetry if it has neither rotational nor mirror symmetry. For example, a single hook is not symmetrical. We say the symmetry number is zero (0) because it scores no points in this game. (We do not call it C1 in this game.)

Rotational symmetry. A figure has rotational symmetry if it looks the same after being rotated about its center. These symmetries are called Rotate 2, Rotate 3, ..., or C2, C3, ... (Math notation is C_2, C_3, ..., where C is for cyclic.)


C2 C3 C4 C5 C6 C7 C8

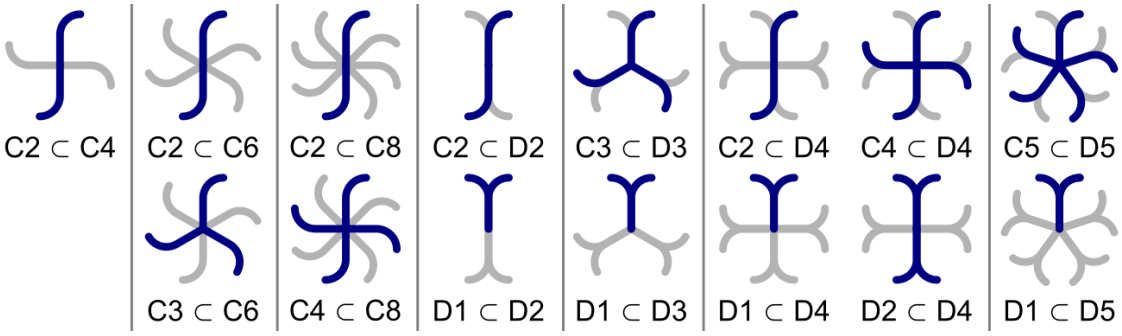
The symmetry number is the number of rotational positions that look the same as the original image. The turning angle is 360/n degrees. For example, a figure with C4 symmetry can be rotated to four positions, with a turning angle of 90°. The standard nine-dice set allows C2 to C8.

Mirror reflection symmetry. A figure has mirror symmetry if it looks the same after being reflected in a mirror. These symmetries are called Mirror 1, Mirror 2, ..., or Reflect 1, Reflect 2, ..., or D1, D2, ... (Math notation is D_1, D_2, ..., where D is for dihedral.)


D1 D2 D3 D4 D5 D6

The symmetry number is the number of mirror lines (and the number of rotational positions). Each mirror line divides a figure into two halves that are mirror images. For example, a figure with D2 symmetry has two mirror lines: the vertical mirror line shows that the left and right halves are mirror images; the horizontal mirror line shows that the top and bottom halves are mirror images. The standard nine-dice set allows D1 to D5.

Sub-symmetries. A figure may have more than one type of symmetry. For example, a figure with C4 symmetry also has C2 symmetry, a figure with D2 symmetry also has C2 and D1 symmetry, and a figure with D4 symmetry also has C2, C4, D1, and D2 symmetries. Larger symmetries contain smaller symmetries, as shown in this diagram. Here, the symbol "⊂" means "is contained in."


C2 ⊂ C4 C2 ⊂ C6 C2 ⊂ C8 C2 ⊂ D2 C3 ⊂ D3 C2 ⊂ D4 C4 ⊂ D4 C5 ⊂ D5
C3 ⊂ C6 C4 ⊂ C8 D1 ⊂ D2 D1 ⊂ D3 D1 ⊂ D4 D2 ⊂ D4 D1 ⊂ D5

Rules

Number of players. 2 to 8. **Ages:** 8 to adult.

Object. The object of the game is to score points by making symmetrical figures.

Set up. Assemble one or more dice sets. A set has nine dice: four A dice (with S's), four B dice (with bars & slants), and one C die (with pinwheels). Get a pencil and paper to keep score.

Selecting first player. Select the first player if you are playing consecutive turns rather than simultaneous turns. Each player rolls all nine dice. The player who rolls the most hooks wins. Reroll to break ties.

Rounds. Play proceeds in rounds. In each round, each player gets a turn, and possibly one or more extra turns (a run). If you have only one dice set, players will play their turns consecutively (one at a time). If you have multiple dice sets, players may play their turns simultaneously (at the same time) during each round.

Turns. A turn consists of rolling, making a figure, declaring, challenging (possibly), and scoring. Turns are not intended to be timed, but you may set a time limit (say, three minutes) from first roll to declaration.

Rolling. You may roll the dice once, twice, or three times. Begin by rolling all nine dice. Choose which dice you want to let stand and reroll the other dice. You may reroll any, all, or none of the dice. The same rules apply to the third roll. You may reroll any dice, even those that were previously left standing.

Making a figure. Arrange at least two of the dice into a figure with rotational symmetry and/or mirror reflection symmetry. See "SymmDice Figures" (below). All dice lie flat on the table, not stacked, and the top faces are the figure. The dice should be near each other but need not touch. The dice may be placed at any positions or angles, if they are placed symmetrically. You will enjoy the game more if you make creative and artistic designs, rather than merely lining up the dice in a single row.

Declaring. Declare the symmetry type of your figure. For example: Say "Rotate 2" or "C2" for a figure with C2 symmetry. Say "Mirror 1" or "Reflect 1" or "D1" for a figure with D1 symmetry. See "SymmDice Figures" (below) for examples of all symmetry types.

Challenging. After a player declares, any player may challenge the validity of the declared symmetry by saying "Challenge." The first player to say "Challenge" is the challenger. All players decide together by consensus whether the figure has the declared symmetry. There are three possible outcomes. **(1)** If the figure has the declared symmetry: The figure maker scores as usual. The challenger is penalized 10 points. **(2)** If the figure does NOT have the declared symmetry: The figure maker scores zero for the current turn but keeps any points from previous turns in the same run. The player is not allowed to take an extra turn. The challenger gets 10 points. **(3)** If it cannot be decided: The figure maker replays the turn.

> *Note: The declared symmetry is valid if the figure has the declared symmetry, even if the figure also has other symmetries. For example, a declaration of C2 or D1 is valid for a figure with D2 symmetry. See "Sub-symmetries" (above).*

Scoring. Your score for the turn (if not successfully challenged) is your declared symmetry number times the number of dice in your figure. If you use all nine dice in your figure, add 10 bonus points. See "SymmDice Figures" (below) for examples of scoring.

Extra turns. If you use all nine dice in a figure and you only rolled the dice once, you earn an extra turn to be played immediately after scoring your current turn. A sequence of one or more consecutive turns is called a run. There is no limit to the number of turns in a run.

End of game. The suggested goal is 100 points. When any player reaches the goal, that round becomes the last round. The round is played out, so every player in the round gets a turn. The player with the most points wins. Ties are possible.

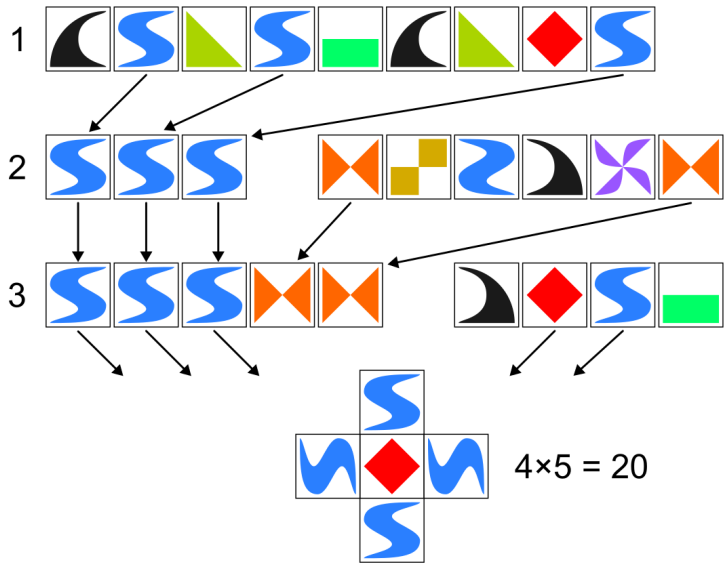
Playing a Turn

Example turn:

Roll 1. Roll all nine dice.

Roll 2. Let three dice stand and reroll six dice.

Roll 3. Let five dice stand and reroll four dice.



Make a figure. The figure has Rotate 4 (C4) symmetry.

Declare. Say "Rotate 4."

Challenges. Nobody challenges.

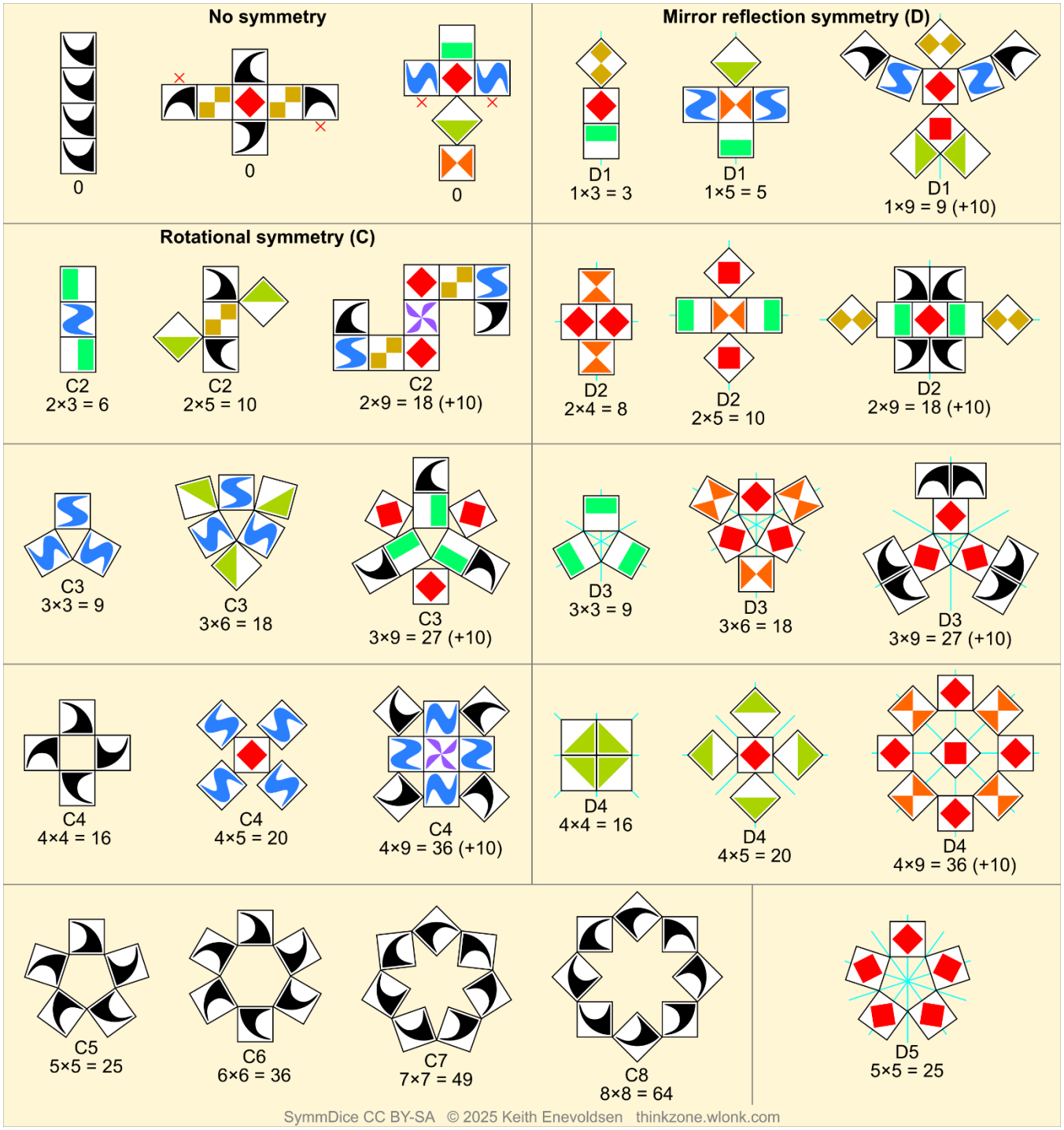
Score. The declared symmetry number is 4 and the figure has 5 dice, so the score is 4×5 = 20.

Score Table

The score for a turn is the symmetry number times the number of dice in the figure, plus a ten-point bonus if you use all nine dice. This table shows all possible scores for a turn, using the standard set of dice.

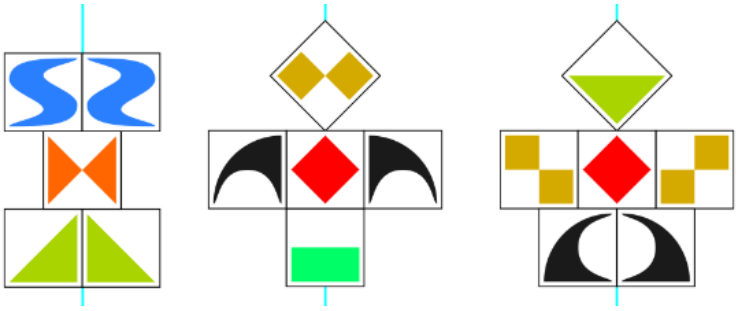
Score		Number of dice							
		2	3	4	5	6	7	8	9
Symmetry number	1	2	3	4	5	6	7	8	9 + 10
	2	4	6	8	10	12	14	16	18 + 10
	3	-	9	-	-	18	-	-	27 + 10
	4	-	-	16	20	-	-	32	36 + 10
	5	-	-	-	25	-	-	-	-
	6	-	-	-	-	36	-	-	-
	7	-	-	-	-	-	49	-	-
	8	-	-	-	-	-	-	64	-

SymmDice Figures



Some examples of SymmDice figures. Symmetry types and scores are shown.

Little Kids' Variation



This variation uses only simple mirror symmetry (Mirror 1). This is intended for families or school groups with younger children (plus the guidance of an adult or older child).

Number of players: 2 to 6. **Ages:** 6 to adult.

Object. The object of the game is to score points by making mirror-symmetrical figures.

Set up. Standard dice sets.

Selecting first player. The youngest player goes first.

Rounds and turns. Standard rules.

Rolling. Standard rules.

Making a figure. Arrange at least two of the dice into a figure with simple mirror symmetry (Mirror 1). Otherwise, use the standard rules.

> *Note: Additional symmetries or higher-numbered symmetries are ignored. Additional mirror lines will not increase your score. Rotational symmetries do not count.*

Declaring. Say "Done" when you have finished making a figure with mirror symmetry.

Challenging. After a player declares "Done", any other player may challenge whether the figure has mirror symmetry by saying "Challenge." All players decide together by consensus whether the figure has mirror symmetry. If there is no consensus, an adult or older child may be the judge. There are three possible outcomes: **(1)** If the figure has mirror symmetry: The figure maker scores as usual. The challenger gets no penalty. **(2)** If the figure does NOT have mirror symmetry: The figure maker scores zero for the current turn. The challenger gets no bonus. **(3)** If it cannot be decided: The figure maker replays the turn.

> *Note: You can check a figure for mirror symmetry with a hand-held mirror.*

Scoring. Your score for the turn (if not successfully challenged) is simply the number of dice in your figure. If you use all nine dice in your figure, add 10 bonus points.

Extra turns. Standard rules.

End of game. The suggested goal is 50 points. Otherwise, use the standard rules.

One-Player Variations

Self-competitive solitaire. Use the standard rules, except that the goal is to beat your personal best score for 10 turns (more precisely, 10 runs of one or more turns).

Meditative solitaire. Use the standard rules, except that the goal is to make the most pleasing symmetrical figures. Do not keep score.

Playing Without Rules

Forget the rules! Break free of symmetry! Just arrange the dice into designs that you like. Make abstract designs or pictures of animals, people, or things.

