4 Reasoning: Drawing Deductively Valid Conclusions

Contents

As far as Joan's opponent was concerned, the debate wasn't going well. It was clear from the sea of nodding heads and sounds of "uh huh" and "yeah" that Joan was scoring points and convincing the audience, whereas he seemed to be losing support every time he spoke. He wasn't surprised; he had been warned. Joan had studied reasoning and now knew how to make people believe anything. Soon, she would have everyone convinced that the war was justified and what was wrong was right. The way she was going, she could probably make people believe that day was night. It certainly wasn't fair, but what can you expect from someone who studied reasoning?

This fictional vignette was taken from a real-life incident. I was present at a debate where one debater accused the other of cheating by using reasoning. At the time, I thought that this was pretty funny, because I had come to think of reasoning as an important critical thinking skill—the sort of skill that you would use to make valid conclusions when dealing with information that is complex and emotional. To the losing side of this debate, it was a trick. Trick, skill, or strategy, reasoning is the best way to decide whom and what to believe.

LOGICAL AND PSYCHOLOGICAL

The trick, of course, is to reason well. It isn't easy and it isn't automatic.
—Kahane (1980, p.3)

Reasoning is often taken to be the hallmark of the human species. Colloquially, reasoning tells us "what follows what." When we reason, we use our knowledge about one or more related statements to determine if another statement, the conclusion, is correct. A **conclusion** is an inferential belief that is derived from other statements. The ability to reason well is a critical-thinking skill that is crucial in science, mathematics, law, forecasting, diagnosing, and just about every other context you can imagine. In fact, I can't think of an academic or "real world" context in which the ability to reason well is not of great importance.

When we reason logically, we are following a set of rules that specify how we "ought to" derive conclusions. **Logic** is the branch of philosophy that explicitly states the rules for deriving valid (correct) conclusions. A conclusion is **valid** if it necessarily follows from some statements called *premises*. Conclusions that are not in accord with the rules of logic are **illogical.** Although we maintain that the ability for rational, logical thought is unique to humans, all too often we reach invalid or illogical conclusions. This fact has led Hunt (1982) to award "A flunking grade in logic for the world's only logical animal" (p. 121).

Psychologists who study reasoning have been concerned with how people process information in reasoning tasks. The fact is that, in our everyday thinking, the psychological processes quite often are not logical. In a classic paper on the relation between logic and thinking, Henle (1962) noted that, although everyday thought does not generally follow the formal rules of logic, people use their own imperfect rules. If we were not logical, at least some of the time, we wouldn't be able to understand each other, "follow one another's thinking, reach common decisions, and work together" (p. 374). To demonstrate this point, stop now and work on one of the problems that Henle (1962) posed to her subjects in one of her studies:

> A group of women were discussing their household problems. Mrs. Shivers broke the ice by saying: "I'm so glad we're talking about these problems. It's so important to talk about things that are in our minds. We spend so much of our time in the kitchen that, of course, household problems are in our minds. So it is important to talk about them." (Does it follow that it is important to talk about them? Give your reasoning.) (p. 370)

Do not go on until you decide if it is valid to conclude that Mrs. Shivers is correct when she says that it is important to talk about household problems. Why did you answer as you did?

When Henle posed this problem to graduate students, she found that some arrived at the wrong answer (as defined by the rules of logic); whereas, others arrived at the right answer for the wrong reasons. Consider the following answer given by one of her subjects: "No. It is not important to talk about things that are in our minds unless they worry us, which is not the case" (p. 370). Where did this subject go wrong? Instead of deciding if the conclusion followed logically from the earlier statements, she added her own opinions about what sorts of things it is important to talk about. Thus, although the answer is incorrect as evaluated by the standard rules of logic, it is correct by the subject's own rules. Consider this answer: "Yes. It could be very important for the individual doing the talking and possibly to some of those listening, because it is important for people to 'get a load off their chest,' but not for any other reason, unless in the process one or the other learns something new and of value" (p. 370). This time, the subject gave the correct answer, but for the wrong reasons. This subject, like the first one, added her own beliefs to the problem instead of deriving her conclusions solely on the basis of the information presented. Henle has termed this the **failure to accept the logical task.** It seems that in everyday use of reasoning, we don't determine if a conclusion is valid solely on the basis of the statements we're given. Instead, we alter the statements we're given according to our beliefs and then decide if a conclusion follows from the altered statements. We function under a kind of "personal logic," in which we utilize our personal beliefs about the world to formulate conclusions about related issues.

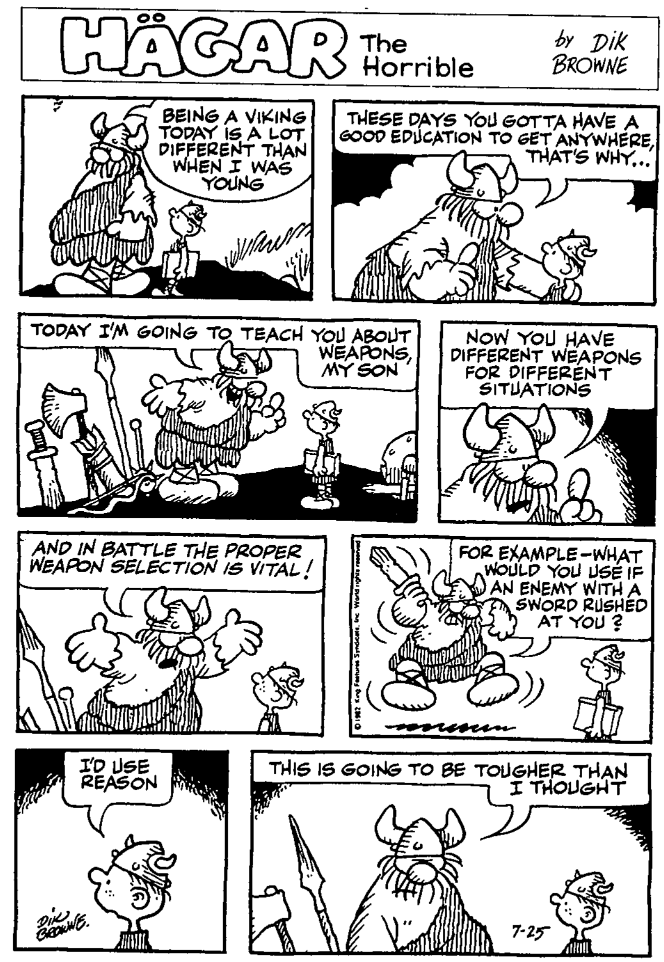
Inductive and Deductive Reasoning

Actual thinking has its own logic; it is orderly, reasonable, reflective.
—Dewey (1933)

A distinction is often made between inductive and deductive reasoning. (See chapter 6 for a related discussion of this topic.) In **inductive reasoning,** observations are collected that support or suggest a conclusion. For example, if every person you have ever seen has only one head, you would use this evidence to support the conclusion (or hypothesis) that everyone in the world has only one

head. Of course, you can't be absolutely certain of this fact. It's always possible that someone you've never met has two heads. If you met just one person with two heads, your conclusion must be wrong. Thus, with inductive reasoning, you can never *prove* that your conclusion or hypothesis is correct, but you can disprove it.

When we reason inductively, we collect facts and use them to provide support or disconfirmation for conclusions or hypotheses. It's how we discover what the world is like. Lopes (1982) described induction this way: "Scientists do it; lay people do it; even birds and beasts do it. But the process is mysterious and full of



paradox . . . induction cannot be justified on logical grounds'' (p. 626). We reason inductively, both informally in the course of everyday living, and formally in experimental research. For this reason, hypothesis testing is sometimes described as the process of inductive reasoning. When we reason inductively, we generalize from our experiences to create beliefs or expectations. Sometimes, inductive reasoning is described as reasoning ''up'' from particular instances or experiences in the world to a belief about the nature of the world.

In **deductive reasoning,** you would begin with statements known or believed to be true, like ''everyone has only one head,'' and then conclude or infer that Karen, a woman you've never met, will have only one head. This conclusion follows logically from the earlier statement. If we know that it is true that everyone has only one head, then it must also be true that any specific person will have only one head. This conclusion necessarily follows from the belief; if the belief is true, the conclusion *must* be true. Deductive reasoning is sometimes described as reasoning ''down'' from beliefs about the nature of the world to particular instances. Rips (1988) has argued that deduction is a general-purpose mechanism for cognitive tasks. According to Rips, deduction ''enables us to answer questions from information stored in memory, to plan actions according to goals, and to solve certain kinds of puzzles'' (p. 117).

Although it is common to make a distinction between inductive and deductive reasoning, the distinction may not be a particularly useful description of how people reason in real life. In everyday context, we switch from inductive to deductive reasoning in the course of thinking. Our hypotheses and beliefs guide the observations we make, and our observations, in turn, modify our hypotheses and beliefs. Often, this process will involve a continuous interplay of inductive and deductive reasoning. Thinking in real-world contexts almost always involves the use of multiple types of thinking skills.

SYLLOGISTIC REASONING

Nothing intelligible ever puzzles me. Logic puzzles me.
—Lewis Carroll (1887)

Syllogistic reasoning is a form of reasoning that involves deciding whether or not a conclusion can properly be inferred from two or more statements. One type of syllogistic reasoning is categorical reasoning. **Categorical reasoning** involves **quantifiers,** or terms that tell us how many. Quantifiers are terms like ''all,'' ''some,'' ''none,'' and ''no.'' The quantifiers indicate how many items belong in specified categories.

A **syllogism** usually consists of two statements that are called **premises** and a third statement, called the **conclusion.** In categorical syllogisms, quantifiers are used in the premises and conclusion. The task is to determine if the conclusion follows logically from the premises.

The premises and conclusion of a syllogism are classified according to **mood.** There are four different moods, or combinations of positive and negative statements with the terms ''all'' or ''some.'' The four moods are:

Mood	*Abstract Example*	*Concrete Example*
Universal Affirmative	All A are B.	All students are smart.
Particular Affirmative	Some A are B.	Some video games are fun.
Universal Negative	No A are B.	No smurfs are pink.
Particular Negative	Some A are not B.	Some democrats are not liberals.

As you can see from this table, a statement is universal if it contains the terms ''all'' or ''no''; it is particular if it contains the term ''some''; it is negative if it contains ''no'' or ''not''; and it is affirmative if it is not negative. Thus, it should be easy to classify the mood of any statement by searching out the key terms.

Several syllogisms are presented here. Each consists of two premises and a conclusion. Work through each syllogism and decide if the conclusion is valid (V) or invalid (I). In order to be valid, the conclusion must *always* be correct, given its premises. If you can think of one way that the conclusion could be false when the premises are true, then it is invalid. Don't go on until you have worked through these syllogisms.

1.	Premise #1	All A are B.	
	Premise #2	All B are C.	
	Conclusion	All A are C.	V or I
2.	Premise #1	Some A are B.	
	Premise #2	Some B are C.	
	Conclusion	Some A are C.	V or I
3.	Premise #1	All A are B.	
	Premise #2	Some B are C.	
	Conclusion	Some A are C.	V or I
4.	Premise #1	No A are B.	
	Premise #2	All B are C.	
	Conclusion	No A are C.	V or I
5.	Premise #1	No A are B.	
	Premise #2	No B are C.	
	Conclusion	No A are C.	V or I
6.	Premise #1	All zaks are creb.	
	Premise #2	All creb are bips.	
	Conclusion	All zaks are bips.	V or I
7.	Premise #1	Some flubs are gluck.	
	Premise #2	Some gluck are chez.	
	Conclusion	Some flubs are chez.	V or I

8.	Premise #1	All vox are thed.	
	Premise #2	Some thed are hef.	
	Conclusion	Some vox are hef.	V or I
9.	Premise #1	No crim are bub.	
	Premise #2	All bub are glot.	
	Conclusion	No crim are glot.	V or I
10.	Premise #1	No zevs are hip.	
	Premise #2	No hip are crep.	
	Conclusion	No zevs are crep.	V or I
11.	Premise #1	All boys are athletes.	
	Premise #2	All athletes are muscular.	
	Conclusion	All boys are muscular.	V or I
12.	Premise #1	Some lawyers are honest.	
	Premise #2	Some honest people pay taxes.	
	Conclusion	Some lawyers pay taxes.	V or I
13.	Premise #1	All judges are wise.	
	Premise #2	Some wise people are liberals.	
	Conclusion	Some judges are liberals.	V or I
14.	Premise #1	No teenagers are happy.	
	Premise #2	All happy people are rich.	
	Conclusion	No teenagers are rich.	V or I
15.	Premise #1	No professors are cool.	
	Premise #2	No cool people are punk.	
	Conclusion	No professors are punk.	V or I

According to the rules of logic, it should not matter if the syllogisms are presented in abstract terms of *A*s and *B*s, nonsense terms like "zev" and "creb," or meaningful terms like "lawyers" and "cool." The logical rules for deciding if a conclusion can be validly inferred from the premises remain the same. We're really saying "All ______ are ______." It should make no difference how we fill in the blanks; any letters, nonsense or meaningful words, or even fancy pictures should be handled in the same way. However, from a psychological perspective, there are important content differences. Did Syllogisms #6 to #10 seem easier to you than #1 to #5? Did the last five syllogisms seem the easiest? Did you realize that the same five syllogisms were used in each set with only the content words changing? I return to the "problem" of content in a later section, when I discuss common errors.

Determining If a Conclusion Is Valid

How did you go about deciding if the conclusions were valid? There are two different types of strategies that can be used with syllogisms to determine if a conclusion follows from its premises. If you've been reading the chapters in order, then you know that a common approach to improving thinking is the deliberate use of both spatial and verbal strategies. The same two approaches

apply here. First, I present a spatial method for testing conclusions, then I provide some verbal rules that can also be used. Either method will "work," but you'll probably find that you prefer one method over the other.

Circle Diagrams

One way of determining if a conclusion is true is with the use of circle diagrams that depict the relationships among the three terms (A, B, C, or whatever we used to fill in the blanks). The degree to which the circles overlap depicts the inclusion or exclusion of the categories. Look very carefully at Fig. 4.1.

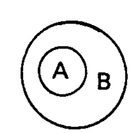
The four moods that statements in syllogisms can have are listed in the left-hand column of Fig. 4.1. Next to each statement are circle diagrams that are correct depictions of the relationships in the statement.

There are several different methods of drawing diagrams to depict the relationships among the terms in a syllogism. One of these methods is known as **Venn Diagrams,** named for the 19th-century English mathematician and logician who first introduced them. These are the same diagrams that you probably used in mathematics classes if you ever studied set theory. A second method of diagramming relationships is known as **Euler Diagrams.** According to popular lore, this method was devised by Leonard Euler, an 18th-century Swiss mathematician, who was given the task of teaching the laws of syllogistic reasoning to a German princess. Because the princess was having difficulty understanding the task, Euler created a simple procedure that could be used to understand the relationships among the terms and to check on the validity of inferences. A third method is called the "Ballantine method," because of its use of three overlapping circles. In all of these methods, circles are used to indicate category membership. The differences among these methods is not important here, and the general strategy of checking conclusions with circle drawings is referred to as **circle diagrams.** If you've learned a different method of circle diagrams in another context (e.g., a class on set theory or a logic class), then continue to use that method as long as it works well for you.

Let's draw circle diagrams to depict the relationships in Syllogisms #1, #6, and #11. The same diagram will work for these three syllogisms, because they are identical except for the content words.

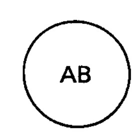
Premise #1 states that "All A are B." Look at Fig. 4.1. There are two different ways of drawing circles that are correct interpretations of this relationship.

Premise #1a



The A circle is in the B circle.

Premise #1b



A and B are the same circle.

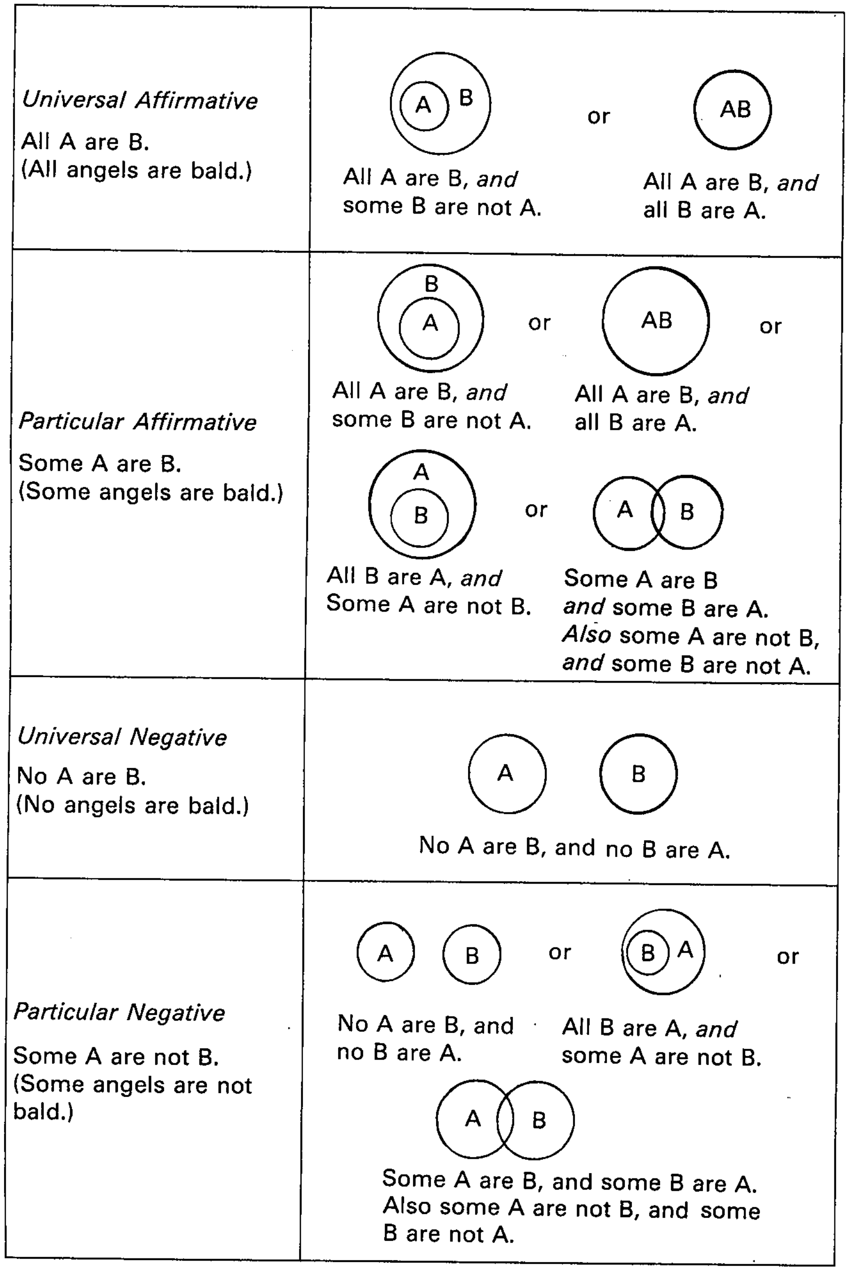
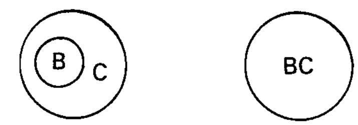


FIG. 4.1. Circle diagrams depicting correct interpretations of the premises used in syllogisms. Note that "all" can have two correct interpretations, "some" can have four correct interpretations, "no" has one correct interpretation, and "some–not" can have three correct interpretations.

In the diagram on the left, the circle that has the letter A inside of it stands for all things that are A. This circle is inside the B circle to indicate that everything that is A is B. This diagram shows a situation in which "All A are B, and some B are not A." Using the more concrete language of Syllogism #11, this diagram depicts the situation in which "All boys are athletes, but there are athletes who are not boys." The diagram on the right is also a correct interpretation of "All A are B," but it represents a different interpretation of the A–B relationship. In this figure, "All A are B, and all B are A." Using the language of Syllogism #11, this translates to "All boys are athletes, and all athletes are boys." According to this depiction, everyone who is an athlete must also be a boy. Either of these diagrams is correct, given the information that "All A are B." It is important to consider both interpretations of this relationship.

Let's go on and consider the second premise in Syllogism #1, which is identical to the second premise in Syllogisms #6 and #11. Again, this premise is the universal affirmative mood and will look the same as the preceding figures, except that we changed the letters.

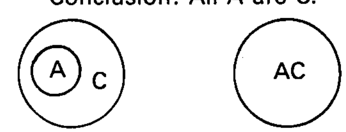
Premise #2a Premise #2b



The B circle is in the C circle. B and C are the same circle.

Given these four figures, two possible correct depictions of Premise #1 and two possible correct depictions of Premise #2, how do we use them to determine if the conclusion is valid? Start by drawing the relationships in the conclusion. This should be fairly easy because, in this example, the conclusion is also universal affirmative.

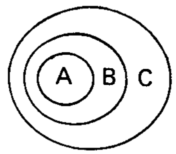
Conclusion: All A are C.



The A circle is in the C circle. A and C are the same circle.

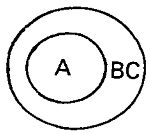
Now, to check the validity of the conclusion, draw *all* combinations of diagrams for Premise #1 and diagrams for Premise #2. Let's do this systematically, first putting together Premise #1a with Premise #2a, then Premise #1a with Premise #2b, then Premise #1b with Premise #2a, and finally Premise #1b with Premise #2b.

Premise #1a
+ Premise #2a



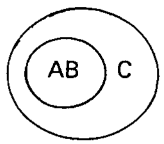
1a. The A circle is in the B circle.
2a. The B circle is in the C circle.

Premise #1a
+ Premise #2b



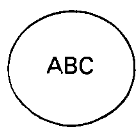
1a. The A circle is in the B circle.
2b. B and C are the same circle.

Premise #1b
+ Premise #2a



1b. A and B are the same circle.
2a. The B circle is in the C circle.

Premise #1b
+ Premise #2b



1b. A and B are the same circle.
2b. B and C are the same circle.

Look at the four correct circle diagrams that result from combining all possible interpretations of the two premises. Check each one. Is it always true that "All A are C?" I hope that you can see that the answer is "yes." In all four diagrams, the circle with A is either inside the circle with C or it is the same circle as the C circle.

Suppose that the conclusion had been, "All C are A." Is this a valid conclusion, given the premises? To answer this question, look at the diagrams that resulted from all combinations of the premises. If you can find one diagram in which this is false, then the conclusion in invalid. Can you find any? The first three conclusion diagrams depict relationships in which there are some C that are not A, thus this conclusion would be invalid.

The problem with using circle diagrams comes in drawing all possible combinations of the premises in order to check the validity of the conclusion (Guyote & Sternberg, 1981). Sometimes, there are as many as 33 different possible combinations. Fortunately, we really don't always have to draw all of them. As soon as you draw one combination in which the conclusion is false, you can stop there because you've already shown that the conclusion does not necessarily follow from the premises.

A list of steps for checking the validity of conclusions with circle diagrams is

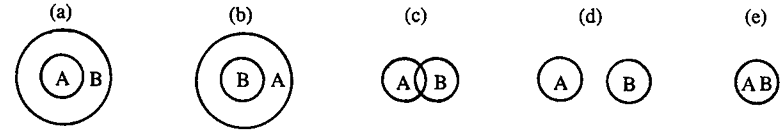
shown in Table 4.1. Stop now and look over the steps. Refer back to them as we work through the rest of the syllogisms.

TABLE 4.1
Steps for Determining the Validity of Conclusions Using Circle Diagrams

1. Write out each premise and the conclusion of the syllogism.
2. Next to each statement, draw all correct diagrams, using the diagrams shown in Fig. 4.1.
3. Systematically combine all diagrams for Premise #1 with all diagrams for Premise #2. Try Premise #1a (the first diagram for Premise #1) with Premise #2a (the first diagram for Premise #2). Continue combining Premise #1a with all Premise #2 diagrams, then go on and combine all Premise #1b with all Premise #2 diagrams. Continue in this manner (Premise #1c with all Premise #2 diagrams, then Premise #1d with all Premise #2 diagrams) until
4. You find *one* diagram in which the conclusion is invalid or
5. You have tried all combinations of Premise #1 and Premise #2 diagrams.

Note: Sometimes, there will be more than one way to combine diagrams from the two premises. Be sure to try all combinations. When trying out all combinations, remember that there are five possible ways to combine two circles: (a) A inside B; (b) B inside A; (c) A and B overlapping partially; (d) A and B with no overlap (two separate circles); and (e) A and B represented by one circle (A and B are the same circle). These five possibilities are shown thus:

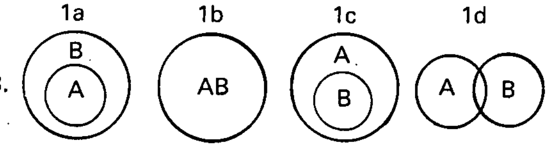
(a) (b) (c) (d) (e)



Let's try this method with Syllogisms #2, #7, and #12. I've drawn below the possible correct interpretations of each premise and the conclusion.

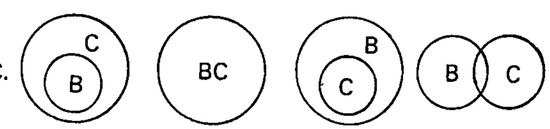
1a 1b 1c 1d

Premise #1. Some A are B.



2a 2b 2c 2d

Premise #2. Some B are C.



Conclusion. Some A are C.