LAW SCHOOL ADMISSION TEST

LOGIC LAB

Tom Beatty & Jodi Gubernat

TABLE OF CONTENTS

FOREWORD

NOTE TO THE TEST TAKER ~

Congratulations on your decision to take the next step in pursuing a career in the legal profession. This text is designed to develop your skills for the analytical reasoning, or logic games, section of the Law School Admission Test (LSAT). As you probably know, satisfactory performance on this test is necessary for admission to law school programs approved by the American Bar Association. To do well on the overall exam requires that you make a reasonable score on the logic games part. While the logic games are only one of several sections in the overall exam, many people who have taken the LSAT regard it as the most challenging section.

Our immediate purpose is to give you practical instruction and experience in applying strategies for solving logic games problems, but our ultimate goal is to help you develop confidence in knowing what to expect from the exam and in applying your newly acquired knowledge so that you can do your very best.

Neither of us are attorneys, however our study manual has been developed with the assistance of two attorneys with decades of combined professional experience. We are mathematicians with substantial backgrounds in teaching all aspects of applied logic. We sincerely believe that this gives us a unique advantage in communicating quickly and efficiently the basic knowledge that is required for maximizing performance on the analytical reasoning component of the LSAT. We have taken many standardized tests in our careers, so we can appreciate any apprehension you may have about these tests, in general, and the LSAT, in particular. Our job is to help you rise above it.

There are several LSAT review courses available from national providers featuring various blends of self-study, distance learning, and traditional classroom instruction. Although they tend to be complete and informative, they also tend to be expensive, time intensive, and in some cases, rather inconvenient or impersonal. We have tried to identify and further develop some of the strengths of these courses so that they can be presented in a form suitable for group or self-study. We hope this little book is just what you need to succeed in taking that next step.

INTRODUCTION

OVERVIEW OF THE LSAT

HISTORY

The LSAT (Law School Admission Test) was originally developed by representatives from several elite law schools (Harvard, Yale, and Columbia included, of course) and first administered in 1948. There was a perception that the admissions exams in use at the time were not sufficiently correlated with first year grade performance. A committee was formed to draft an exam that would correct this, although some participating law schools were openly skeptical about the admission of applicants on the basis of "aptitude". In retrospect, this seems quaint.

Preparation and administration of the test is currently managed by the LSAC (Law School Admission Council), and there are four test dates every year: February, June, September/October, and December. Pending sufficient registration, the FGCU LSAT minicourse will be offered on Saturdays the month prior to each test date. Currently, about 150,000 examinees take the test in a given year, although it has peaked at over 170,000 in the past. Most examinees are from the United States, although the LSAT is being used increasingly in Canada and other nations in the Anglosphere.

The LSAT has evolved quite a bit since its early years. The "modern era" of the LSAT started with the June 1991 test, which was labeled "Prep Test 1". The basic form of the exam has remained relatively stable from that point on, and all subsequent tests have been numbered consecutively, so that the February 2010 test became "Prep Test 60". Unlike, for example, the testing bodies that administer exams for the engineering profession, the LSAC is quite cooperative about making prior exams available to the public, although some particular exams are no longer accessible. In fact, the LSAC recommends that examinees study the prior exams and it even makes available a practice exam at the LSAC website. The sample problems in this book and the worksheets distributed in our minicourse use these prior exams freely as a resource, as do the big test prep firms such as Kaplan and Power Score.

SCORES

The scoring system for the LSAT goes from 120 to 180. The LSAC takes raw scores (questions answered correctly) and adjusts them with a conversion formula to account for variability in the difficulty level of the exams from year to year. This ensures some degree of comparability of scores over time. Typically, the 50th percentile score is about 151, the 90th percentile about 163, and 99th percentile about 172. The "sooper genius" percentile (99.9[th]) requires a score of 178.

A study at the University of North Texas has focused on the distribution of average LSAT scores by academic major. The findings are intriguing: criminal justice majors average 146.0, pre-law majors 148.3, liberal arts majors 152.4, English majors 155.2, and (sorry) mathematics majors 160.0.

While the LSAT is currently required for admission to law schools accredited by the American Bar Association, there has been some discussion regarding making them optional. This parallels the current debate over making the SAT and ACT optional in order to promote diversity of the student body. Georgetown and the University of Michigan have waived LSAT scores for students with sufficiently high GPAs.

As far as the original purpose of the LSAT - to predict first year law school grades - the LSAC has studied the issue and reports that there is about a 40% correlation between LSAT score and first year GPA. The claim is that this is a better predictor than baccalaureate GPA. Evidently a combination of undergraduate GPA and LSAT score, called an admission index, is even better at predicting first year grades. There is some small variability in the correlation depending on the particular law school attended.

There is a rule concerning how many times you can take the LSAT - no more than three times in two years unless specifically granted an exemption. Also, unlike the SAT, the LSAC reports all the scores that you have gotten in the preceding five years to the schools you have chosen as score recipients. You can't "hide" a poor showing, although if you are absolutely sure you don't want the results recorded for a test you have just completed, there is a provision on the answer sheet to basically pretend it didn't happen. That particular score will not be part of any score report, and, in fact, LSAC will not even report it to you. This is the nuclear option, so you may want to consider this very carefully. Law schools have different policies regarding which score or scores to consider if they receive multiple scores.

FORM OF THE TEST

The LSAT has six parts: two sections of logical reasoning, one section of analytical reasoning, one section of reading comprehension, one section that can be any of the three preceding types, but which is not scored, and one section consisting of a writing sample, which always comes last. The order of the other sections may be shuffled to improve test security. The unscored section is considered experimental in the sense that responses to questions on it may guide the preparation of future test questions. Examinees are not told which section is the unscored one.

It may seem that logical reasoning and analytical reasoning should be one and the same, but that is definitely not the case. In the logical reasoning part of the exam , a short argument is stated and then the examinee is asked to identify assumptions, errors, and the effect on the strength of the argument if certain premises are added or removed. Common sense and a little practice with the format is excellent preparation.

In the analytical reasoning part of the exam, various puzzles known as "logic games" are presented. They are the subject of this book. Logic games are a bit like crossword puzzles, Sudoku™, or the word game Jumble™ in that they have partial information given in the form of clues which fit a predetermined game structure. The challenge is to fill in the blanks, so to speak, and answer various questions about that structure. The difficulty level of the games is determined by the exact nature and complexity of the game format, the quantity and helpfulness of the clues, and the depth of the questions that must be resolved. We will analyze these issues in complete detail shortly.

The reading comprehension section consists of four short (about 500 words max) articles on various academic subjects that would be reasonably familiar, for example, to a liberal arts or pre-law major. The questions center on determining the main theme of the article, correctly identifying facts that are presented, and making valid conclusions from the information given in the text. Obviously, the ability to read quickly and with decent comprehension is the key to handling these tasks in the time frame allowed. Skimming for critical information is a skill that can be learned.

The writing sample section asks you to take a pro or con position on a fairly benign subject and defend your choice as eloquently as you can manage after the grueling multiple choice part of the exam is over. The LSAC used to administer the writing sample part at the beginning of the overall exam. This section of the LSAT is actually not evaluated by the LSAC as part of your score report. An electronic image of your response is sent along with your score report to the various law schools you have designated. Those institutions are free to use or ignore your essay, but you should write *something*, since the LSAC may not report your scores if you don't attempt the writing sample. Schools that require other written material, such as a "statement of intent" or similar personalized essay expressing your interest in a law career, may typically be the ones to ignore your LSAT essay.

COST, SECURITY, & SCHEDULE

The current cost to take the LSAT is about $140. The testing center will want to take a thumbprint for positive identification, in addition to seeing some form of government issued photo identification, such as a driver's license, passport, or military ID.

The cycle for the four annual tests begins with the June exam, followed by the fall exam which may occur in September or October, then the December exam, and finally the February exam. The fall exam is the most popular with examinees intending to enter law school the following fall. December and February exam dates provide an opportunity to shore up scores that may need to be improved to allow a realistic chance at a top school.

The test itself consists of five 35 minute multiple choice sections totaling just about 100 questions plus a final 30 minute writing sample section. There is a short break given in the middle of the exam. There is no penalty for wrong guesses, so you should save a little time to fill in the answer sheet no matter what with your best guesses after you have made all the responses in which you have some confidence. Poker is as much about money management as card management, and tests of this nature are as much about time management as anything else. Using well the rather short amount of time allotted for the multiple choice sections is one of the key principles we will stress.

INTRODUCTION

OVERVIEW OF LOGIC GAMES

GENERAL

The analytical reasoning, or logic games (LG) section of the LSAT consists of four self-contained games with typically five to eight multiple choice questions about each game. The multiple choice format is five possible responses per question. The total number of questions is usually about 24. You have 35 minutes for these questions, so that is an average of about a minute and a half each to respond to everything. This includes the amount of time you need to read and understand the game scenario. We mention this not to alarm you, but to reinforce the point that time is very much of the essence. If you are not by nature a quick thinker, and most of us are not, you may take some comfort in considering that if you slow down to make sure that what you do is correct, even if you only answer half of the questions right on the test overall, your score would still be about 150.

The games themselves are logic puzzles of very specific configurations that the test authors use year after year. The common thread is that a puzzle presents a little story that defines various people or things which appear and the nature of the relationships among them. The little story is called a "scenario" and the people or things are called "variables". The variables are given to you in the scenario so there is no confusion, but in some cases you may have to decide how to symbolize them with single letters in order to work with them efficiently. Next after the scenario is a listing of various conditions, or "rules", which govern the allowed or possible relationships among the variables. These are generally fixed for the entire game and are called "global" rules. Finally, there is a list of five to seven (rarely eight) multiple choice questions which ask you to determine other facts or relationships that are consistent with the given rules. Typically the first few questions depend only on the global rules, but later questions may also introduce a new "local" rule just for that question, or suppress one of the global rules just for that question.

While one question for a given game may seem completely independent of another question, it is frequently the case that having the answer to one vastly simplifies the search for an answer to the other. Keep this in the back of your mind. The test

authors can be a little diabolical and they know, of course, that you are under severe time pressure. Often they plant a question toward the beginning that is not intrinsically difficult, but takes a little time to chase down and reject a number of incorrect answers. Learning how to recognize a "time-waster" will be something we want to practice.

TYPES OF GAMES

Among the game configurations that have appeared during the last twenty years of the LSAT, four main ones and their variants account for substantially all of the problems used in the analytical reasoning section. These are: (1) linear games, (2) grouping games, (3) multilevel linear games, and (4) combination linear and grouping games. There are a few formats that have appeared very infrequently, such as games based on sequencing, and we will mention them briefly but spend the bulk of our time on the main four above.

The best way to understand what these game formats are is to look at some examples:

1) Linear Games

Linear games require you to arrange variables in a single sequence subject to all the constraints given.

This is a linear game from the December 1996 LSAT:

SCENARIO: During a 4 week period, each of 7 previously unadvertised products G, H, J, K, L, M and O, will be advertised. A different pair of these products will be advertised each week. Exactly one of these products will be advertised twice. The following constraints must be observed:

RULES:
1) J is not advertised during a given week unless H is advertised during the immediately preceding week.
2) The product advertised twice is advertised during week 4, but is not advertised during week 3.
3) G is not advertised during a given week unless either J or else O is advertised that week.
4) K is advertised during one of the first two weeks.
5) O is one of the products advertised during week 3.

The linear nature of this game is apparent from the string of four successive weeks. The problem consists in figuring out how to distribute the advertised products over the four weeks so that the constraints are satisfied. We are "lining up" four pairs of products in a sequence. Whenever there is an explicit or implied time sequence in a

scenario, you can be pretty sure you are dealing with a linear game.

Here is the first question asked in connection with this game:

Which of the following is a pair of products that CANNOT be advertised during the same week as each other?

a) H and K
b) H and M
c) J and O
d) K and L
e) L and M

To answer this question, you would have to try to configure the product pairs over the four weeks obeying all of the constraints. You may find in trying to do this that one of the five pairs above cannot appear without violating a constraint. That would be your answer. We will solve this game in detail later using our strategies for linear games.

2) Grouping Games

Grouping games (*pure* grouping games, not the linear/grouping combo games discussed subsequently) present a set of variables and ask you to assign them to subsets according to rules that link individual variables. There is no concern for any type of sequential order as with linear or multilevel linear games. Matching games fall into this category.

This is a grouping game from the October 1996 LSAT:

SCENARIO: A university library budget committee must reduce exactly five of eight areas of expenditure - G, L, M, N, P, R, S, and W - in accordance with the following conditions:

RULES:
1) If both G and S are reduced, W is also reduced.
2) If N is reduced, neither R nor S is reduced.
3) If P is reduced, L is not reduced.
4) Of the three areas, L, M, and R, exactly two are reduced.

The task presented by this game is to make an assignment of the eight variables to two groups: those reduced and those not reduced. Many assignments would be disallowed by the constraints. Although it may not seem like it, there are enough

constraints in this problem to whittle down the possible assignments so that we could identify a definite subset of five areas that would be reduced (and by implication three that would not).

Here is the third question asked for this game:

If P is reduced, which one of the following is a pair of areas of expenditure both of which must be reduced?

a) G and M
b) M and R
c) N and R
d) R and S
e) S and W

This question falls into the category of "game changer". In fact, five of the seven questions posed for this game are of this type, where new information in the form of a hypothetical (*"If P is reduced…"*) changes the basic rules of the game. This is a very common occurrence in the logic games.

3) Multilevel Linear Games

Multilevel linear games (some test prep authors call them stacked linear games) require you to arrange sets of variables in two or more sequences with all constraints satisfied. There is some interdependence among the variables in different sets established by the language of the constraints, so the sequences need to be coordinated.

This is a multilevel linear game from the September 1998 LSAT:

SCENARIO : Eight physics students - four majors: Frank, Gwen, Henry, and Joan; and four non-majors: Victor, Wanda, Xavier, and Yvette - are being assigned to four laboratory benches, numbered 1 through 4. Each student is assigned to exactly one bench, and exactly two students are assigned to each bench. Assignments of students to benches must conform to the following conditions:

RULES:
1) Exactly one major is assigned to each bench.
2) Frank and Joan are assigned to consecutively numbered benches, with Frank assigned to the lower numbered bench.
3) Frank is assigned to the same bench as Victor.
4) Gwen is not assigned to the same bench as Wanda.

Although a time sequence is not evident in this problem, it is clear that the sequence of numbered benches will do. The problem author gives us a big hint here. Note that there are two groups of variables that are separated by a condition...being a major or non-major. And note how thoughtful the test writer was to invent names that would allow us to assign variable letters F, G, H, and J versus V, W, X, and Y. We recognize this problem as a multilevel linear game, since we are tasked with arranging each set of variables separately with regard to the benches 1 through 4. The two sequences will not be independent...this is what makes the problem tough...because there are connections between them that have to be respected. Constraints (3) and (4) do precisely that by requiring the linking F and V and forbidding the linking of G and W.

Here is the second question asked for this game:

If Victor is assigned to bench 2 and Wanda is assigned to bench 4, which of the following must be true?

a) Frank is assigned to bench 1.
b) Gwen is assigned to bench 1.
c) Henry is assigned to bench 3.
d) Xavier is assigned to bench 1.
e) Yvette is assigned to bench 3.

To address this question you would need to lay out the skeleton of a sequence for majors and one for non-majors with the definite assignment of V to position 2 and W to position 4 in the non-major sequence. Then, coordinating the two sequences so that all of the given constraints are observed, one of the five answers must be unavoidable. You can be confident that a "which of the following must be true (or false)" type question will mercifully have only one answer.

4) Linear/Grouping Combo Games

Both ideas of linear and grouping games can be combined. In these games, variables are sorted into groups and then the variables within a group are arranged in a linear order which is compatible with the constraints of the problem. So the grouping part of the solution precedes the linear sequencing part of the solution. Although it may seem that a game with a complicated structure and many constraints would always be the most difficult, the silver lining is that more structure and rules often combine to reduce the number of possibilities for the variable configurations. The methods we will discuss for linear and grouping games carry over to analysis of combo games.

This is a combo game from the February 1994 LSAT:

SCENARIO: A soloist will play six different guitar concertos, exactly one each Sunday for six consecutive weeks. Two concertos will be selected from among three concertos by Giuliani - H, J, and K; two from among four concertos by Rodrigo - M, N, O, and P; and two from among three concertos by Vivaldi - X, Y, and Z. The following conditions apply without exception:

RULES:
1) If N is selected, then J is also selected.
2) If M is selected, then neither J nor O can be selected.
3) If X is selected, then neither Z nor P can be selected.
4) If both J and O are selected, then J is played at some time before O.
5) X cannot be played on the fifth Sunday unless one of Rodrigo's concertos is played on the first Sunday.

Here is the second question asked for this game:

If the six concertos to be played are J, K, N, O, Y, and Z and if N is to be played on the first Sunday, then which one of the following concertos cannot be played on the second Sunday?

a) J
b) K
c) O
d) Y
e) Z

This question requires that you have in mind tentative layouts of concerto selections for the six dates that satisfy the constraints plus the additional condition that N is played on the first date. You can see that the grouping process...picking the six concertos to be played out of the ten available...is aided considerably by the extra rule presented in the question itself. If N must be played, then by constraint (1) so must J, then by constraint (2) M must not, and so forth. Then as we attempt to arrange the concertos selected into a sequence, we will discover that one of the answers, if it is required to be played on the second date, is incompatible with all of the constraints. We will explore general methods to attack games like this shortly.

5) PATTERN GAMES

Pattern games are a variant of multilevel linear games where the constraints apply to the variables across the board rather than to one or perhaps several variables only. For example, you might be told that no variable can appear first in both sequences, rather than variable A must appear second in at least one sequence.

Here is a pattern game from the October 1997 LSAT:

SCENARIO : Five candidates for mayor - Q, R, S, T, and U - will each speak exactly once at each of three town hall meetings - meetings 1, 2, and 3. At each meeting, each candidate will speak in one of five consecutive time slots. No two candidates will speak in the same time slot as each other at any meeting. The order in which the candidates will speak will meet the following conditions:

RULES:
1) Each candidate must speak either first or second at at least one of the meetings.
2) Any candidate who speaks fifth at any of the meetings must speak first at at least one of the other meetings.
3) No candidate can speak fourth at more than one of the other meetings.

Here is the third question asked for this game:

If the order in which the candidates speak at meeting 1 is R, U, S, T, Q, and the order in which they speak at meeting 2 is Q, R, U, S, T, which one of the following could be true of meeting 3?

a) Q speaks first
b) R speaks third
c) S speaks first
d) T speaks second
e) U speaks fifth

We will use a modification of our strategy for multilevel linear games to deal with pattern games.

Occasionally, the LSAT presents circular linear games, sequencing games (distinct from linear games), or mapping games. We will cover these briefly in the text.

6) CIRCULAR LINEAR GAMES

These are just linear games with the beginning and end of the natural order connected. An example would be a game based on a seating arrangement for persons around a circular table. Apparently the LSAT has used this game format once in the last twenty years.

7) SEQUENCING GAMES

This game format has appeared much more frequently than the circular linear game. Sequencing games resemble ordinary linear games except that the positions of the

variables are relative only to one another and not to some fixed natural order such as days of the week or fixed rows of seats, for example.

8) MAPPING GAMES

Mapping games involve determining the complete picture of relationships among several variables based on incomplete information. They have been used more frequently in the past than recently. Often they can be reduced to a grouping game.

STRUCTURE OF LOGIC GAMES

GAME STATEMENTS

The vast majority of logic games that appear on the LSAT are puzzles based on two general ideas...order and association. Solving such a puzzle amounts to identifying a typically small collection of objects called *variables* and then arranging them in a certain way (order) or grouping them together in a certain pattern (association) so that all of the arbitrary *rules* that constrain possible solutions are obeyed. The introductory patter that defines the variables and describes the basic task of the game is called the scenario. The scenario and the rules make up the game statement.

The test authors may create games based on simple orderings (linear games), unordered groupings (grouping games), simultaneous orderings (multilevel or stacked linear games), and ordered groupings (combination games). Once you gain some experience in handling problems based on the two main concepts of order and association, you will find that extending your problem-solving skills to games that are offshoots or combinations of these concepts will be easier. You will also be able to immediately classify a game as to its type, and this will save time...always a good thing...in organizing your approach to solving the game.

SCENARIOS

Logic games are introduced in the form of a scenario, or short paragraph that defines all the variables and the initial relationships that must be established among them. Scenario comes from the Italian "scaena" for scene or stage, and it is particularly apropos in this context. A logic puzzle could be correctly and completely given in terms of nothing but dry as dust mathematical symbols, but unless you are used to this sort of thing, this would stimulate no immediately useful imagery in your mind and would make the crucial details of the game less easy to remember and work with. The test authors recognize this and try to make the details of the game statement more memorable by inventing a little story and couching the game in more familiar and concrete terms. Allowing the game to come alive on stage in your imagination, if only for the few minutes you need to answer the game questions, is a skill that you will

want to cultivate.

Memory experts will tell you, the more links you can make between new material and your own experience, the better your retention will be. After all, the faster you can absorb the big picture, the sooner and more confidently you can move on to answering the questions. Another benefit of being able to quickly relate to the basic elements of a logic game is that the questions asked will not be, except in rare (but most welcome) instances, of the "look up" type. This is a question where a single look back to the scenario or rules nails down an answer. The majority of logic game questions require the construction of a solution template, or diagram, which incorporates both the given conditions of the scenario and the constraints embodied in the rules. Often there are subtleties in drawing an acceptable template that are apparent only if you have thoroughly digested the game statement.

VARIABLES

Identifying the variables in a logic game is usually cut-and-dried. Either the test authors just go ahead and give you symbolic variables...capital letters...or they give you a string of names that are conveniently chosen so that the initial letters are a successive string in the alphabet, in which case you simply use those. In doing problems, we have occasionally seen the case where one letter is skipped over in the variable list, and unless you catch it, you may jump in and construct a solution template that has a serious error.

Occasionally you may encounter a game which seems to have two sets of variables and it is not clear how to proceed. Typically, this happens with a linear game which has a scenario that presents both objects that are to be arranged in some order, and also the positions available (in time or space or some other order) for this to be done. You can resolve these cases easily by focusing on which apparent set of "variables" has a natural order...like days of the week, rows of seats, and that sort of thing. The objects with the natural order form the positions in the template into which the objects that have no natural order are to be arranged. For example, if a doctor was to see one patient per day among Al, Bob, and Charlie on Monday, Tuesday, and Wednesday, it is the people who are variables, not the days, which will be naturally ordered positions in the solution template. Another clue may be found in the rules. Generally, the variables appear as subjects in the sentences giving the contraints.

RULES

The difficulty of logic games is contained in the scope and subtlety of the rules which limit your freedom in constructing valid solution templates. It would be easy to seat five people on five chairs. Less so if we have to worry about seating them so that two particular people can't be adjacent and one specific person has to be in the middle. The number of feasible arrangements plummets as soon as we start imposing extra conditions. We could easily put so many conditions on the seating problem that there would be no solution. Obviously the LSAT test designers don't want to go that far, but there is a happy...for them...medium, where the solution to such a problem would exist (there could be several) but be far from obvious.

These limiting constraints or conditions which follow the scenario in a game statement constitute the rules. There are typically three to five such "global" rules which we must observe right from the outset in constructing a solution template. The questions posed for the game may introduce additional "local" rules, or even relax an existing global one. Pay careful attention to any modifications in the basic rules when addressing a specific question.

STRUCTURE OF LOGIC GAMES

QUESTIONS

GENERAL OBSERVATIONS

The Logic Games part of the LSAT typically presents twenty-four questions overall covering four separate games. Occasionally the total number of questions will vary slightly, but the number of games is always four. Individual games have between five and eight questions, with eight being very rare. A typical pattern is to have a five question game, two six question games, and a seven question game. Having the larger number of questions does not automatically mean that the game is the hardest. In fact, since there is some time overhead spent in absorbing and understanding the game statement, we may welcome a (simple) seven question game, since we can knock out more questions without having to stop and absorb a new game statement.

The questions posed after the game statement loosely follow a general pattern. The first couple of questions usually do not introduce any modification to the rules. This happens with the later questions. Often one of the initial questions is a so-called "acceptability" question", which is designed to fritter away your valuable minutes by requiring you to do a process of elimination. We have a suggestion later on how to handle these efficiently. The flip side of the time-waster is that it may reinforce the game statement in your mind so that you have a better perspective for the remaining questions.

Questions posed after the first few often introduce special local or ad hoc assumptions that change the rule environment. Generally you need to make secondary deductions from the rules in order to answer these confidently. Certain types of these secondary deductions are automatic, and we will discuss them later. Oddly or not, very often the last question for a game has a "silver bullet" answer, by which we mean it can be answered immediately without any lengthy process of elimination by appealing to a single insight gotten from the rules and secondary deductions.

Provided that all the rules, modifications included, are identical for two questions, a

correct answer for one may be an immense help in answering the other, so don't treat the questions in isolation....there are linkages. And the linkages work both forwards and backwards.

The LSAT authors adhere to some conventions in framing questions, so we will explore them below. Also, we present a basic review of logic with particular emphasis on some of the logical fallacies that test writers rely on for temptation.

QUESTION STYLES

Most logic game questions, adjusted for specifics, are of three types:

1) Which of the following statements must be true?

> This is the most common type of question. To answer it you must be able to make an argument that a particular configuration of variables is forced to happen by the rules.

2) Which of the following statements could be true?

> This is a popular type of question. To answer it you need to identify a configuration of variables that satisfy all the rules. It need not be forced as with type 1), and in fact, there could be other configurations consistent with the rules. You may rest assured, however, that only one valid configuration will be presented as an answer choice. Very often, this type of question is posed in connection with verifying some complete configuration...all the variables assigned somewhere. Having a valid answer to this question is an immense help in dealing with other questions that ask if such and such a detail is possible. You will see it phrased as "Which of the following could be a complete and accurate list of the ..." or words to that effect. The acceptability question mentioned above is one of this type, and it is worth having a confident answer.

3) Which of the following statements CANNOT be true?

> This is the flip side of type 1). We are now looking for what cannot possibly happen. Don't make the mistake of interpreting it as "could be false"...it is definitely false. You could approach a question of this type by trying to eliminate the four incorrect responses that "could be true", but unless you have

some substantial information on this already, you are headed for wasting time with a process of elimination. One nice thing about so-called counterexample problems is that all it takes is for one thing to be out of place...one rule violated...and you have your answer.

You may see questions like these:

4) Which of the following statements must be false?

5) All of the following statements are true EXCEPT:

Question types 4) and 5) are clearly equivalent to 3). The test authors capitalize words like "cannot" and "except" as a courtesy to the test taker, so there is no doubt about the negation in the question.

Other frequently encountered generic questions include:

6) It is possible to determine the exact status (position in a sequence, membership in a group) of exactly how many variables?

7) Which of the following variables must come before a given variable (in a sequence)?

8) Which variables must be grouped with a given variable?

9) If A happens before B (A is grouped with B), then [a type 1, 2, or 3 question]?

Question types 1) and 3) are generally easier to answer than type 2) because they involve definite conditions. A solution template may rule out or rule in a particular outcome, and that is enough to decide questions of those types. A question of type 2) may require that we investigate each candidate statement and determine if it is not necessarily false. Sometimes there may not be enough information contained in the scenario and rules to reason your way to a definite answer for a type 2) question. In that case, a trial solution diagram that can be shown not to violate any of the rules, and therefore result in a "could be true" may be the only approach. This happens, so don't be discouraged by the apparent lack of definiteness.

For a type 1) or 3) question that does not yield easily to a direct interpretation, a process of elimination, like that for a type 2) question, may have to be used, but try

to avoid it if at all possible. To rule out an answer to a "must be true" or "CANNOT be true" question, it suffices to find a single respective counterexample. Don't forget that if you are reasonably sure that you have answered a type 1) or 3) question correctly, the content of your answer is as good as another rule in guiding your response to further questions based on the same rule set.

A type 6) question can be answered with the help of answers to type 1) questions. The latter establish what is forced to be true, and that is the point of type 6) questions. Type 7) and 8) questions also benefit from having as complete a picture as possible of what is necessarily true. A type 9) question introduces a local rule...good just for that question or maybe the one right after it, too. Local rules can turn "could be trues" into "must be trues" by eliminating all but one rule-consistent variable configuration. So having a confident answer to a "could be true" might lead to a quick answer for a type 9).

It is always a good idea to "pick the low hanging fruit"...by which we mean writing down for easy reference the obvious implications of the scenario and rules. Let us call these derived rules. As you parse the game statement, it may be immediately obvious that a potentially useful derived rule can be inferred from the stated rules. Write this down on speculation even before you approach the task of building a solution diagram. You may need it...maybe not...but very often the low fruit leads to an easier time with the questions. If nothing occurs to you, don't try to force it...concentrate on the questions.

Generally, using a process of elimination is more time consuming than appealing to a direct interpretation of the rules...the silver bullet, so to speak. Questions of type 2) usually require the process of elimination. For type 1) or 3) questions that involve a particular variable, look for rules that place restrictions on that variable...the more numerous and confining the rules the better, as this limits the possibilities. Often a question with this feature can be cracked by an application of basic logic to the rules, either explicitly stated or derived.

BASIC LOGIC

A conditional statement is one where we say "If A happens, then B happens". It is conditional because A might not happen. B can happen on its own without forcing A to either happen or not. The only thing this statement really says is that should A somehow happen, it is unavoidable that B will happen as well. Logicians would call the "if" part the antecedent, and the "then" part the consequent. There is an implied before/after order here...whoever or whatever can cause event B is somehow aware of the status of possible event A, and should A ever happen, then the trigger for event B must inevitably be pulled.

We can characterize the two events in the following way. A is a **sufficient condition** for B, since whenever we have A, we then have B. Not only do we just have B, we *must* have B, and that means B is a **necessary condition** for A. You can't have A without B. Logicians call a conditional statement like this a **material implication**. It is a weaker assertion than it may first appear to be. The only thing that is being ruled out is that you can't simultaneously have A and not B.

We have squeezed all the juice out of the conditional statement "If A, then B". A is sufficient for B and B is necessary for A. A common mistake is to think that if B has happened, that must mean A has happened, or that B is sufficient for A. It often seems like this is a superficially reasonable conclusion, especially if the most probable way for B to happen is to be preceded by A, but it does not follow from the rules of logic. "If you stay out too long in the sun, then you will have reddened skin." Our common experience suggests that reddened skin is often caused by too much sun, but there could be other reasons...allergies, chemicals, or tanning beds, for example. "If B, then A" does not follow from "If A, then B".

Given the statement "If A, then B", the **converse** statement is "If B, then A", the **inverse** statement is " If A, then not B", and the **contrapositive** statement is "If not B, then not A". We have just noted that the truth of the converse statement is independent of the truth of the original conditional statement. The inverse statement is the denial of the original, so when the original is true, the inverse is false, and vice versa. The contrapositive statement is true or false precisely whenever the original conditional statement is true or false. We say that they are logically equivalent. Note that in the original A is sufficient for B and B is necessary for A. So if we deny B, that is sufficient to conclude that we cannot have A...but this is the contrapositive.

In the context of logic games, we are often given a rule such as "If A is in position 2, then B is in position 5". We may not conclude that if B is in position 5, then A must be in position 2. This is the converse. But we may conclude that if B is not in position 5, then A is not in position 2. Again, this is the contrapositive. Get into the habit of writing down the contrapositive for every "if-then" statement you see in a logic game.

The English language is very expressive, and there are many ways to make a conditional statement. Some samples are presented below. We recommend converting all conditionals to the model "if...then" form, which will be the most familiar to us.

If the furnace isn't working, then the guest bedroom will be cold.
Unless the furnace works, the guest bedroom will be cold.
If the guest bedroom is not cold, then the furnace must be working.
Unless the guest bedroom is not cold, the furnace must not be working.
Should the furnace not be working, the guest bedroom will be cold.
In the event that the guest bedroom is not cold, then the furnace must be working.
Either the furnace is working or the guest room is cold.
Except when the furnace is working, the guest room is cold.
Whenever the guest room is not cold, the furnace must be working.

Every one of these statements is logically equivalent to the first, and hence to each other. We will want to practice parsing conditional statements and reducing them to the more familiar "if-then" form.

Two logical fallacies to avoid are these:

If A then B, and subsequently if also not A, then not B. This is called the fallacy of denying the consequent. A happening definitely causes B to happen, but just because A does not happen, B may still happen for some other reason.

If Johnson pitches, then we will win. Johnson didn't pitch. We won anyhow.

If A then B, and subsequently if also B, then A. This is called the fallacy of affirming the antecedent. Again, A happening forces B to happen, but if B happens spontaneously, that doesn't mean A had to happen.

If it rains, the street will be wet. The street is wet, therefore it must be raining. Could have been a fire hose!

MODELING LOGIC GAMES

NOTATION

A good diagram or template that faithfully models the scenario and rules of a game statement is priceless. That is because it summarizes visually all of the quirks of a game and allows you to see subtleties and relationships that might not be apparent from simply reading the words of a game statement. A good diagram may answer some questions all by itself. Several observations can be made about "optimal notation":

1) You have to be comfortable using it...it has to be natural for you and effortlessly recalled. Some of the national prep courses have complicated systems where learning the notational system is a project in itself. You will be under constant time pressure taking the exam, and mentally fumbling for the niceties of some notational system is not what you want to be doing in the middle of the exam. Recall the story of the medical student who had studied a mnemonic phrase (little ditty that spurs the memory) to remember the Latin names for the craniofacial nerves. He took his exam and got so confused with the ditty that he completely botched the list of nerves.

2) It has to be sketched quickly. Given enough time, we could probably create a game diagram that flawlessly and completely summarized anything we might ever want to know about the game. But we don't have unlimited time, and the important thing is to get something written quickly and accurately that will give us the insights we need.

3) It has to fit legibly in the space we have to write it. Learn to write small. Scratch work has to be done on the examination pages and there is not a lot of room. Questions that introduce new or modify old rules may require a re-do of the template. Or you may get off on the wrong foot and have to start over on a diagram. Space is at a premium as well as time. We recommend committing to a horizontal format for whatever diagram you develop. The text on the pages is horizontal, and you will be able to scale and position your scratchwork better.

4) It has to be expressive enough to model the features of every game you might encounter.

The following chart presents a notational system that we have found satisfies the above desirable properties. This is admittedly subjective, so we present our system as a starting point for you.

CHART OF SUGGESTED NOTATION

Notation	Meaning
S'	S is a variable which does not appear in any game rule
xS	S is a variable which cannot occupy a given position
$\boxed{ST}$	S immediately precedes T
$x\boxed{ST}$	S does not immediately precede T
$\boxed{S\_T}$	S is two positions before T
$\boxed{S\_..\_T}$	S is n positions before T
S/T	Either S or T occupy a given position
S,T	Both S and T can occupy a given position
$S < T$	S is positioned before T
$S,T < U$	S and T are positioned before U
$..\underline{S}.._n$	S must be at position n

...<u>S</u>/...   S could be at position n
   n

(ST...Z)   ST...Z appear somewhere in that order

$\boxed{\begin{array}{l} S \\ T \end{array}}$ S is bound to base variable T

$\boxed{\begin{array}{l} S \\ TU \end{array}}$ S is bound to T and T immediately precedes U

nS   S occurs n times

$S_A \text{---}> T_B$ If S has property A then T has property B

[STU]   S,T, and U are grouped together

LINEAR GAMES

STRATEGY

GENERAL OBSERVATION

Linear games have historically, along with grouping games, been the bread-and- butter puzzles for the LSAT. Rarely during the last twenty years has the LSAT not contained at least one straight linear game per test date. Linear games are easy to understand, if perhaps difficult at times to solve, so they lend themselves to the kind of instructional approach we are trying to provide here. Certain principles of game construction are used over and over again, so if we study these diligently, we will have both a sense of familiarity with the type of game and enough confidence in our ability to solve it that we may actually do so with a reasonable proportion of success.

RECOGNITION KEYS

The first task with linear games, as with any type of game, is to recognize them correctly. The game principle is, of course, putting things in order or sequencing them, so we should be on the lookout for clues that suggest this purpose in a game statement. Words that indicate some variables are before or after others in time, importance, or with respect to some other measure that reflects an intrinsic order are the key.

The test makers may try to de-emphasize the nature of a linear game, but it is always visible to the trained eye. The basic components are variables...objects that will be placed in positions...and the positions available. A linear game statement will introduce some kind of sequence of positions...days of the week, hours in a day, seats in a row, rows in a stadium...that sort of thing. It may be far from time-related, and, in fact, the sequence of positions could be based on something abstract, like consumer preferences, or some other non-physical scale. But the defining feature is that somehow the available positions will be ranked from first to last, lowest to highest, worst to best, or by a similar type of order.

Sometimes the line between variables and positions is a little murky, and under the battle conditions of an exam, there may be an opportunity for momentary confusion.

One way to avoid this is to note that in the rules for a linear game, almost always the variables appear as subjects in the rule statements, and the positions available are described in the predicates. Occasionally the test authors are completely transparent about the nature of a linear game, and almost draw the game diagram for you.

After we have identified a sequencing feature in a game statement, we need to assure ourselves of two things: (1) we haven't hooked a hybrid or combo game, and (2) we are not looking at a multiple level sequencing game. If there is any grouping or non-sequencing type of rule present, we have a combo game. If there are different levels of available positions (mornings vs. afternoons of days of the week, for example) we may have a multilevel linear game. Now sequences inside of sequences don't take us out of the realm of linear games, but two independent sequences with tie-ins between variables in one to variables in the other do qualify as a multilevel linear game.

Now that we are sure we have a straight linear game, there are some features that appear frequently.

GAME FEATURES

It is always clear how many positions are available for placing variables in order. Sometimes a rule explicitly tells you that a particular variable must go in a particular position. This is valuable, as it takes that variable off the table, so to speak. Use that variable as an anchor to roughly locate other variables. For example, if A is in position three out of five available, and B is later than A, then B must be in position four or five.

A common rule in linear games is that either one variable immediately precedes another, or it just precedes it, but we don't know by how much. This immediately precludes certain configurations of these variables. The variable that is "earliest" cannot be last, as there would be no place for the "later" variable. Likewise, the later variable cannot be first, as there would be no place for the earlier. If we know how many positions separate two variables with this type of rule in effect, it may even be enough to completely specify their positions in the overall sequence. For example, if A must be two positions before B (there is one skipped position between them) and there are only three positions available in this game, it is unavoidable that A will come first and B last. Even if there were five positions available in this game, we could still conclude that A would be restricted to the first, second, or third position, and

likewise B would only have access to the third, fourth, or fifth position. So a seemingly simple relative relationship between two variables may have substantial implications regarding their absolute placement.

Another trick the game authors use is to give a rule which pastes several variables together into a block. Then they create an obstacle in a sequence that forces the block, or something else that has to fit beside the block, into a definite absolute position. For example, say we are to sequence A thru E in five positions. If A immediately precedes B and B immediately precedes C, then somewhere the block ABC must appear. If we now ask, if E must precede C, but D must follow A, the only game in town is to put the block square in the center of the available positions, E first, and D last. We go from seemingly innocent relative position rules to a hard and fast unique final position of all variables. This is a gimmick that crops up often.

The preceding block trick can be expanded on by creating blocks of different sizes. Then depending on the placement of the obstacle...a variable that by assumption goes in a particular place...it may very well be that the remaining multiple-variable blocks only fit into the grand scheme one way. Imagine a block of three and a block of two variables to be placed in a sequence with six available positions. If the obstacle is placed in the first or last position, there are two ways each to position the blocks. But if the obstacle sits on the fourth position, there is a unique way to assign the blocks to the sequence. If the obstacle were in the fifth position, there would be no legitimate placement for the blocks available!

These are the main principles the game authors use to limit the options available in a linear game without appearing to do so in the statement of the rules.