STRUCTURAL BALANCE, RECIPROCITY, AND POSITIVITY
AS SOURCES OF COGNITIVE BIAS

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Structural Balance, Reciprocity, and Positivity as Sources of Cognitive Bias

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The major contribution which derives from the theories of cognitive consistency—balance, dissonance, and congruity—is that they specify the nature and sources of various forms of cognitive bias (Zajonc, 1960). Thus, for instance, Heider (1946, 1958) assumes that if there exist cognitions that "P likes O" and that "P likes X", a bias will operate on the cognition about the feeling which O has for X. This cognitive bias will tend to represent the OX relationship as positive. The existence of cognitive biases in representing social relationships has been demonstrated directly by DeSoto and Kuethe (1958, 1959) and by Kogan and Tagiuri (1958). Kuethe labeled these biases "social schemata" (1962). Indirectly, the existence of cognitive biases in the representation of social relationships has been shown by DeSoto (1960). Hypothetical social structures were broken into their elementary links, each consisting of two individuals and a relation of one to the other. These links were taken by DeSoto to form the items of a paired-associates learning list in which the pairs of individuals constituted the stimulus terms and in which the relation between them the response terms. DeSoto found that some forms of social structures are learned more rapidly than others. Recently, Zajonc and Burnstein (1965) employed DeSoto's technique to demonstrate the
existence of a cognitive bias which derives from structural balance
effects. An additional source of cognitive bias, positivity, preva-
iously reported by Morrissette (1958), was also identified.

Among the hypothetical structures examined by DeSoto (1960) some
were symmetric and some asymmetric. A symmetric structure was one in
which each relation was reciprocated (e.g., if "BILL liked BOB" then
"BOB liked BILL"). One of DeSoto's major findings was that hypothetical
"liking" structures are learned more rapidly if they are characterized
by reciprocity than when they are characterized by its absence. The
presence of a reciprocity bias was also found by DeSoto and Kuethe
(1959) who asked Ss to guess the probability of various social
relationships.

Since reciprocity is a significant component of balance it is of
interest to inquire just what contribution is made by reciprocity, inde-
dependently of balance, to the sort of effects which balance theory
predicts. For a two-person situation, P and O, a state of balance
exists if P likes O and O likes P, or if P dislikes O and O dislikes P.
Thus, the structure is balanced when the relation is reciprocated and
unbalanced when it is not. For the dyad, therefore, balance and
reciprocity are equivalent. The problem raised in the present paper
deals with the role of reciprocity in more complex structures. By
definition, a three-entity situation in which all six relations are
negative is unbalanced, yet all the relations are reciprocated. A
similar three-entity structure in which these six relations are positive
is balanced and completely reciprocated, as well. The question which
we raise is whether reciprocity is an independent source of cognitive
bias. From the results of DeSoto and Kuethe (1959) it would appear that with respect to the liking relationship reciprocity may indeed constitute a source of cognitive bias. Subjects in their experiment estimated the probability of reciprocation of the liking relation to be .74. In a further experiment by DeSoto (1960) already noted, Ss took longer to learn an hypothetical social structure characterized by absence of reciprocity than one in which all relations were reciprocated. It was not clear from the results of either experiment, however, if these learning effects were due to reciprocity alone or to balance, since the structures employed by these researchers differed from one another not only in terms of reciprocity but in terms of structural balance as well.

Method

Subjects

Thirty Ss recruited from among male undergraduates at The University of Michigan were assigned at random to one of two experimental groups (HIGH BALANCE and LOW BALANCE) of fifteen Ss each. They were paid $1.50 for participation in the experiment.

Materials

Six structures varying in terms of reciprocity and balance were employed in the experiment. Each structure consisted of two hypothetical men (e.g., AL and ART), two issues (INTEGRATION and BIRTH CONTROL), and six relationships. The names in each structure began with the same letters (AL and ART, BILL and BOB, CHUCK and CARL). Subjects in the HIGH BALANCE group learned three structures with an average degree of balance equal to .66, and Ss in the LOW BALANCE group three
structures with an average degree of balance of .33. In computing balance Cartwright and Harary's (1956) formulation was applied, which defines the degree of balance as equal to the ratio of the number of positive semicycles to the total number of semicycles in the structure. Within each degree of balance three forms of reciprocity were examined: positive, negative, and non-reciprocity. The six structures are shown in Fig. 1, where P and O are the hypothetical men, and X and Y the two issues.

As in the previous experiment (Zajonc & Burnstein, 1965) the relationships between the two hypothetical men and between each of them and the issues constituted the items of the paired-associates learning list. Since each S learned three structures, either of high or low degree of balance, and since each structure involved six relationships, the paired-associates lists consisted of 18 items each.

It will be noted from Fig. 1 that among the LOW BALANCE structures the degree of balance is uniform. However, in the HIGH BALANCE condition two structures had a degree of balance equal to .5, and one equal to 1.0. The number of positive relationships was the same in HIGH and LOW BALANCE structures, however. Since we found previously that positivity is an independent source of cognitive bias, and since it is impossible to construct a set of structures which differ orthogonally in balance and reciprocity, and in which, at the same time, the number of positive relations is held constant, the above compromise was made.

Procedure

The items were typed on 3 x 5 in. cards, with the stimulus terms on one side, and with a plus or a minus sign on the other. Stimulus
terms consisted either of a pair of names or of a name with an issue. The plus and minus signs constituted the response terms. The plus and minus signs were explained to Ss as meaning "likes" or "dislikes" in the case of a relationship between two people, and "approves of" and "disapproves of" in the case of a person's attitude toward an issue. The task, as in the standard paired-associates procedure, was to anticipate the plus or the minus sign upon the presentation of the stimulus term.

The items were shown for approximately 2 sec. each, with a 2-sec. interval provided for the anticipation of the response. A five-second interval was given between items, and a thirty-second interval between the repetitions of the list. Twelve trials were given, each having a different sequence of the 18 items. The position of each of the 18 items of each list was determined by a random process for each trial. All Ss received the same sequence of trials. Furthermore, each pair of names was used with a different structure for different Ss in at least one complete replication. The issues (INTEGRATION and BIRTH CONTROL) were counterbalanced in a similar fashion.

Following the experiment each S was asked to indicate on a seven-point scale his own attitude toward INTEGRATION and BIRTH CONTROL, and on a six-point scale how important these issues were for him personally.

Results

Balance, positivity, and reciprocity

The major results of the experiment are reported in terms of errors per line. They are summarized in Fig. 1 and in Table 1. We note from the table that, as in the previous study (Zajonc & Burnstein, 1965),
two major sources of cognitive bias emerge.

First, subjects make fewer errors on relationships embedded in structures with a high degree of balance than on relationships in structures with a low degree of balance. The mean number of errors for the former was 2.41, and for the latter 3.30, a difference significant at the .05 level ($F = 7.14; \text{df} = 1, 28$). Secondly, as in the previous study, positive relationships seem to be easier to learn than negative relationships, the two mean error scores being 2.54 and 3.12 respectively. The difference between these two means was significant at the .01 level ($F = 9.90; \text{df} = 1, 140$). The effects of balance and positivity seem to be independent of one another. The interaction between these two sources of variance was negligible.

The effects upon learning which derive from reciprocity are more complex. It appears that reciprocity has an effect on learning, but only when the structure is characterized by a high degree of balance. The smallest number of errors per line is found in the HIGH BALANCE group on structures with negative reciprocity (1.91). Somewhat more errors are made by these Ss on the structure with positive reciprocity (2.40), and the greatest number of errors for this group is found in the structure with no reciprocity (2.94). The LOW BALANCE group, however, shows no differences in errors as a function of reciprocity (3.27, 3.41, and 3.23, respectively, for the above three types of reciprocity). Accordingly,
FIG. 1. AVERAGE NUMBER OF ERRORS MADE ON THE INDIVIDUAL COMPONENTS OF EACH STRUCTURE.
the interaction between the effects of balance and reciprocity was found to be significant ($F = 3.22; \text{df} = 2,140; p < .05$). While this result may be due in part to the exceptionally large difference in the degree of balance between the two negatively reciprocated structures (.33 and 1.00), the interaction between balance and reciprocity is still present when we consider only the structures with positive reciprocity and no reciprocity. Thus, reciprocity seems to constitute a source of cognitive bias, though perhaps not an entirely independent one.

The combined effects of reciprocity and positivity are of interest as well. In non-reciprocated structures and in structures with positive reciprocity positive relationships are easier to learn than negative ones (2.49 vs 3.52 and 2.27 vs 3.80). In the structure with negative reciprocity, however, it is the negative relations on which fewer errors are made. These results are obtained independently of balance, as both, the HIGH and LOW BALANCE groups show similar patterns of these differences. The interaction between the effects of reciprocity and positivity was significant at the .001 level ($F = 11.58; \text{df} = 2,140$). These interactions and others will be examined later.

Components of balance as sources of cognitive bias

The Cartwright-Harary (1956) definition of balance considers the semicycle as its basic component. Briefly, a semicycle of a directed graph is an ordered set of distinct lines, such as $\{\text{PO}, \text{OX}, \text{XP}\}$ in which every adjacent pair of lines shares a point—distinct for every pair—and in which the first and the last lines are adjacent as well. A semicycle is positive if it contains an even number of positive lines, and negative otherwise. The degree of balance is "...the ratio of the
number of positive semicycles to the total number of semicycles" (Cartwright & Harary, 1956; p. 288). The question which we wish now to raise is whether cognitive bias which derives from structural balance has as one of its components a bias toward positive semicycles. The question, in effect, is whether the formal components of the definition of balance proposed by Cartwright and Harary (1956) reflect psychological component processes.

All semicycles in the six structures were divided into positive and negative, according to the formal definition, and errors per line on semicycles were computed. These results are summarized in Table 2.

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Insert Table 2 about here
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It appears that, in general, lines embedded in positive semicycles are learned with fewer errors than in negative semicycles (2.45 vs 3.09). This result, however, holds only when the entire structure is characterized by a high degree of balance, and primarily when it contains a reciprocated interpersonal relationship. Looking at the data in Fig. 1, we note that the interpersonal component of the structures employed in the present experiment (i.e., the semicycle defined by the set of lines \([\text{PO}, \text{OP}]\)) shows the same pattern of error scores. These interpersonal semicycles are learned with fewer errors when they are positive than when they are negative (that is, when their component lines have the same rather than different signs), but again only when the structures in which they are embedded have a high degree of balance. In the HIGH BALANCE group these interpersonal semicycles show 2.04 errors per line in the non-reciprocated structure (i.e., when the interpersonal semicycle is
negative), and .80 and 1.17 in the two reciprocated structures (i.e.,
when the interpersonal semicycle is positive). In the LOW BALANCE
structures, however, these average error scores are 2.00, 2.07, and 2.17
respectively. It should be noted that for each given type of recipro­
city, these interpersonal semicycles are identical in structures of high
and low balance.

It should also be noted that the differences in errors per line which
result from semicycle sign cannot be attributed to a possible confound­
ing with the general positivity bias. Positive lines are not over­
represented in the positive semicycles. In the HIGH BALANCE group, for
all types of reciprocity combined, the average number of errors per line
embedded in positive semicycles is based on the same proportion of
positive and negative lines as the average number of errors in negative
semicycles. Yet the results favor the learning of positive semicycles.
In the LOW BALANCE group the proportion of positive lines in positive
semicycles is the same as in negative semicycles, but here we find no
difference in errors as a function of semicycle sign. In the HIGH BALANCE
group, on non-reciprocated structure, the average number of errors per
line embedded in positive semicycles is based on six positive and on four
negative lines. In negative semicycles it is based on three positive
and five negative lines. Yet the results favor the learning of
negative semicycles.

The length of a semicycle is defined as the number of lines of which
it is comprised. Since the errors per line in the interpersonal
semicycles which are all semicycles of length two were found to be
relatively lower than the overall error scores previously discussed,
the length of semicycles may in itself appear to be an independent source of cognitive bias. Table 3 shows errors per line broken down in terms of the length of semicycles. The results are quite consistent. Independently of the degree of balance and of the type of reciprocity, semicycles of longer lengths are learned with greater difficulty. 3

Individuals own attitude as a source of cognitive bias

In considering results pertaining to Ss' own attitudes we must remind the reader that attitude measures were collected only after the completion of the learning session. These results are, therefore, partly confounded by a possible sequence effect. The ideal design would have been to select for the experiment Ss with previously known and independently measured attitudes. However, the impact of the Ss' attitudes on the learning of balanced and unbalanced structures was of incidental interest for our purposes; and the attitude data were collected, because they might possibly prove to be of some interest.

On the whole, the Ss' attitudes toward INTEGRATION and BIRTH CONTROL were extremely favorable and the variance on the attitude scores quite small. INTEGRATION was generally considered by them as the more important issue. No difference in errors was found in the learning of lines terminating at INTEGRATION and of lines terminating at BIRTH CONTROL. Neither balance nor reciprocity influenced these results. Ss' own attitudes, however, seemed to have an effect on the number of errors. Since the variances of the attitude scores and of the importance scores were quite small, a combined index was constructed by using their product.
We shall call this product the AI score. Ss were divided at the approximate medians of the distributions of AI scores on INTEGRATION and BIRTH CONTROL. Ss with high AI scores on INTEGRATION made on the average 2.54 errors on positive lines issuing at INTEGRATION. These Ss, however, made 3.82 errors on negative lines issuing at INTEGRATION. Ss with AI scores below median made 3.99 and 3.44 errors respectively on these two types of lines. This effect was found to be significant at the .05 level ($F = 6.53; df = 1,28$).

With respect to BIRTH CONTROL no such interaction between S's own attitude and the sign of line which he was learning was obtained. These differences in the effects of Ss' own attitudes between INTEGRATION and BIRTH CONTROL might be perhaps attributed to the fact that BIRTH CONTROL was judged a less important issue than INTEGRATION.

Discussion

Together with the results of the previous study (Zajonc & Burnstein, 1965), the present findings disclose several sources of cognitive bias. Sources previously identified are balance, positivity, and relevance of issue to the interpersonal relationship. The present study confirmed balance and positivity as sources of bias. In addition, it demonstrated the existence of other sources: reciprocity, sign of semicycles, length of semicycles, and the S's own attitude. With regard to balance and positivity the present results are remarkably similar to those obtained previously. In the present experiment the average numbers of errors per line in balanced and unbalanced structures were 2.41 and 3.30. In the previous experiment these figures were 2.50 and 3.05.
The overall errors on positive lines in the present experiment reached an average of 2.54, and on negative of 3.12. In the previous study these figures were 2.21 and 3.35 respectively. It is of interest to note that in an experiment by DeSoto and Kuethe (1959) in which Ss were asked simply to guess the probability of "JIM liking BILL" without any prior information about "JIM" or "BILL", their average estimate of this probability was .59. We may take the departure of this probability from .50 as representing the extent of the positivity bias found by these authors. Considering responses on the first trial alone, the probability of an error on positive relationships was, in the present experiment, .35 and on negative relationships .57. These figures represent a positivity bias of \( \frac{1.00 - .35 + .57 - .50}{2} \). In the previous study the probability of a first-trial error on positive lines was .44 and on negative lines .64, or a bias of .09. These figures are remarkably similar to those reported by DeSoto and Kuethe (1959).

The interactions found among the effects of balance, reciprocity, and positivity are of particular interest. These interactions, however, will become more meaningful if we first consider the effects due to semicycle length. It will be recalled that, independently of the effects of balance and reciprocity, lines embedded in semicycles of shorter lengths were easier to learn than lines embedded in longer semicycles (Table 3). Lines in semicycles of length two showed an average of 1.71 errors, those in semicycles of length three 2.87 errors, and of length four 3.44 errors. The question immediately arises about a confounding source of variance in the above findings. Semicycles of length two include only relations of one person to another, PO and OP. Semicycles
of length three consist not only of interpersonal relations, such as $P \rightarrow O$ and $O \rightarrow P$, but also of attitudinal relations, that is, the feelings of P and O toward X or Y. A semicycle of length three is, for instance, the set of lines $[P \rightarrow O, O \rightarrow X, X \rightarrow P]$. All semicycles of length three in the present experiment consist of two attitudinal relations and of one interpersonal relation. Semicycles of length four, however, consist of attitudinal relations alone. All semicycles of length four are of the form $[P \rightarrow X, X \rightarrow O, O \rightarrow Y, Y \rightarrow P]$.

The question which arises, therefore, is whether the above bias is a function of semicycle length or a function of the preponderance of interpersonal lines in the semicycle, or, of course, a function of both factors. The results of the previous study (Zajonc & Burnstein, 1965), might suggest an answer. The structures used in that study were all composed of three lines, one interpersonal and two attitudinal. Furthermore, they were all composed of just one semicycle of length three. Examining the results of that study for the condition in which balance was found to be a significant source of cognitive bias, we find that 1.92 average errors were made on interpersonal lines, and 2.49 on attitudinal lines. The corresponding figures in the present experiment, (which correspond to errors on lines in semicycles of lengths two and four), are 1.71 and 3.44, respectively (see Table 3).

Whether semicycle length is in itself an independent source of cognitive bias, must be examined in an experiment designed for that purpose in particular. Nevertheless, the above results strongly suggest that there exists a cognitive bias which favors the learning of interpersonal over attitudinal relations. This new source of cognitive
bias might shed some light on the interaction between reciprocity and positivity. In structures with no reciprocity and with positive reciprocity, the nature of this interaction involved a greater number of errors on negative than on positive lines, and in structures with negative reciprocity a greater number of errors on positive than on negative lines (see Table 1). Consider now that in structures with positive reciprocity, out of a total of eleven negative relationships, two were interpersonal. But in the structures with negative reciprocity, four of the eight negative relationships were interpersonal. Moreover, in the two structures with negative reciprocity, no positive relationship was interpersonal. Thus, since interpersonal lines are easier to learn than attitudinal lines, the negative lines in the structures with negative reciprocity received exceptional advantage, which is apparently greater than the advantage deriving from the positivity bias.

We now turn to the interaction between reciprocity and balance. The results in Table 3 showed a considerably smaller number of errors on lines embedded in semicycles of length two than on any other lines. These results were interpreted in terms of a cognitive bias favoring the learning of interpersonal over attitudinal relationships. It might be safely assumed that the number of errors in the present experiment reflects fairly reliably the speed of learning. That is, not only did the Ss make fewer errors on interpersonal lines, they made fewer errors on these lines because they learned them first. The semicycles of length two constitute perhaps the mnemonic "anchors" for the learning of other relationships in the structures.
Suppose now that the semicycle of length two, which is the nucleus of reciprocity, once learned, itself constitutes a source of cognitive bias of the following nature. Having learned a positively reciprocated semicycle of length two the S might suppose that the two individuals who make up that semicycle agree with respect to their attitudes toward X or Y. If P likes O and O likes P, they both probably like or both dislike X. This assumption is strongly supported by data reported by Morrissette (1958), and by DeSoto and Kuethé (1959). Having learned a negatively reciprocated semicycle of length two the S might suppose that the two hypothetical individuals who make up that semicycle disagree with respect to their attitudes toward X or Y. In either case, however, the S would be biased in the direction of greater degree of balance. We would expect, as a consequence of such a cognitive bias, more overall errors on reciprocated structures with a low degree of balance than on reciprocated structures with a high degree of balance. That in effect was the case, as it is clear from Table 1. If the S learns that there is no reciprocity (an accomplishment which incidentally seems to take him considerably longer than the learning of reciprocity), he has no clear-cut prediction about the hypothetical individuals' agreement or disagreement, i.e., he has no bias. When "BILL likes BOB" and when at the same time "BOB dislikes BILL", it is just as likely, apparently, that BILL and BOB agree as that they disagree about INTEGRATION. We would, therefore, expect no differences in errors between high and low balance structures with no reciprocity—a finding also apparent from Table 1.
The above hypothesis suggests that reciprocity and balance are not entirely independent sources of cognitive bias. The exact nature of the interdependence of the reciprocity and balance biases requires further research. What is clear from the present results and those reported previously, however, is that several sources of cognitive bias may operate simultaneously—some independently, some in interaction with one another—to affect the learning of hypothetical social structures. Among those identified were balance, positivity, reciprocity, semicycle sign, the learner's own attitude toward the issues, the relevance of the issue to the interpersonal relationship, the nature of the relationship (interpersonal vs attitudinal), and possibly semicycle length.
References


Table 3

Average Errors per Line as a Function of Semicycle Length

<table>
<thead>
<tr>
<th>Degree of balance</th>
<th>NO</th>
<th>POSITIVE</th>
<th>NEGATIVE</th>
<th>All structures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>High balance</td>
<td></td>
<td></td>
<td></td>
<td>1.17</td>
</tr>
<tr>
<td>Low balance</td>
<td></td>
<td></td>
<td></td>
<td>2.17</td>
</tr>
<tr>
<td>Both groups</td>
<td></td>
<td></td>
<td></td>
<td>1.67</td>
</tr>
</tbody>
</table>