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Source Credibility in Social Judgment: Bias, Expertise, and the Judge's Point of View

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Mathematical models of source credibility were tested in five experiments in which judges estimated the value of hypothetical used cars based on blue book value and/or estimates provided by sources who examined the cars. The sources varied in mechanical expertise and in bias; they were described as friends of the buyer or seller of the car or as neutral. Individuals judged the highest price the buyer should pay, the lowest price the seller should accept, and the "true" value ("fair" price) of the car. Data indicated that expertise amplifies the effect of the source's bias. This effect is predicted by a scale-adjustment model, in which the source's bias shifts the scale value of the source's estimate. The weight of an estimate depends chiefly on the source's expertise. The weight of an estimate also depends configurally on the other estimates: Judges instructed to take the buyer's point of view give greater weight to the lower estimate, whereas judges who identify with the seller place greater weight on the high estimate. Simple premises about human judgment give a good account of the data.

Social judgments often require the combination of pieces of information provided by sources who vary in credibility (Hovland, Janis, & Kelley, 1953; McGuire, 1968). Rosenbaum and Levin (1968, 1969), Anderson (1971), Birnbaum, Wong, and Wong (1976), and Birnbaum (1976) have proposed and/or tested formal theories of source credibility. The present research extends these developments and argues that the concept of *credibility*, used loosely in early persuasion research to mean "believability," can be profitably decomposed into at least three constructs: expertise, bias, and the judge's point of view.

The *judge* is the person (the subject in the present experiments) who combines information provided by one or more *sources* to make an overall evaluation or judgment. The juror, who decides guilt based on contradictory evidence, the voter, who chooses among candidates who disagree, and the consumer, who evaluates the worth of a product, are examples of people acting as judges.

The *expertise* of the source refers to the perceived correlation between the source's report and the outcomes of empirical verification. Expertise would be expected to depend upon such factors as training, experience, and ability. For example, a doctor whose diagnoses are often confirmed in the post mortem would be considered a more expert source of information about the state of a person's health than would an untrained student.

The *bias* of the source refers to factors that are perceived to influence the expected algebraic difference between the source's report and the true state of nature. For example, a Republican might be considered a biased source of information about a Democrat who is running for office.

The distinction between expertise and bias is like the distinction between regression slope and intercept. For example, a used car salesman might be an expert source of information about the value of his cars; however, the salesman's estimates may be biased upward, since the seller stands to profit by convincing potential

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buyers of the high worth of the car. Similarly, an insurance claims adjuster is an expert source who might underestimate the value of damaged goods on which his or her company is required to pay claims.

The judge's bias is termed the judge's "point of view." Thus, a judge who is a Republican or a Democrat may treat information provided by a Republican source and a Democratic source differently. It is important to maintain the distinction between the bias of the sources and the point of view (bias) of the judge who combines the information from the sources.

Previous Research on Source Expertise

Rosenbaum and Levin (1968, 1969) extended an averaging model of impression formation to account for source credibility effects. Anderson (1971) discussed additive and averaging models of source credibility and theorized, on the basis of previous research (on the set-size effect in impression formation), that averaging models would prove superior. Wyer (1974) revived an additive model for source credibility as a "case against averaging." Lichtenstein, Earle, and Slovic (1975) offered a constant-weight averaging model of numerical cue prediction (each cue can be thought of as a source). Additive and averaging models both predict that the effect of a source's report should increase with increased credibility, but the models make different predictions for the effect of the credibility of one source on the effect of information provided by another source.

Birnbaum et al. (1976) and Birnbaum (1976) conducted three experiments testing three models for the effect of source expertise in information integration. In one experiment (Birnbaum et al., 1976, Experiment 1) undergraduates judged the value of used cars based on two cues: blue book value and an estimate provided by one of three sources who examined the car. The three sources differed in mechanical expertise. For example, how much is a car worth if its blue book value is $500 but an expert mechanic who has examined the car evaluates its worth at $700? In the second experiment, judges rated the likableness of hypothetical persons described by personality-trait adjectives attributed to sources who varied in their length of acquaintance with the person they described. For example, how much would you like a person who was described by an acquaintance of 3 years as *sincere* and by an acquaintance of 3 weeks as *phony?* In a third experiment (Birnbaum, 1976), students were trained with feedback to predict a numerical criterion from single independent cues separately, then asked to predict (without feedback) the criterion from pairs of cues.

The results of the used car, impression formation, and numerical prediction studies form a coherent picture. The effect of a cue varies inversely with the number of cues presented, contrary to the additive models. Furthermore, the effect of a cue varies inversely with the credibility of the other cues, in violation of the constant-weight averaging model (including the models of Rosenbaum & Levin, 1968, 1969, and Lichtenstein et al., 1975, as special cases). The results of Birnbaum et al. (1976) and Birnbaum (1976) were qualitatively consistent with a relative-weight averaging model, in which the effect of information provided by one source is inversely related to the number and credibility of the other sources.

Since the results of the three quite different experiments were consistent with the same general model, it is inductively appealing to theorize that the model will hold across different judgmental domains. Values of the estimates, adjective likableness values, and numerical values of the cues are represented by scale values. Levels of mechanical expertise, length of acquaintance, and cue-criterion validity are represented by changes in weight.

The relative-weight averaging model for used car judgment can be written as follows:

$$R = \frac{w_0 s_0 + w_V s_V + w s_E}{w_0 + w_V + w}, \qquad (1)$$

where R is the judged worth; w_0, w_V, and w are the weight of the initial impression, the blue book, and the source, respectively; and s_0, s_V, and s_E are the scale values of the initial impression (the presumed response in the absence of information), the blue book value, and the source's estimate, respectively.

Purposes of the Present Research

The present research investigates the effects of the source's *bias* and the judge's *point of view* on the information integration process. Judges made evaluations of hypothetical used cars based in part on estimates provided by sources who varied in bias and expertise. Bias was manipulated by stating that the source was either a friend of the buyer or the seller or an independent. The judge's point of view was manipulated by asking the judge to identify with either the buyer or the seller of the car. For example, subjects were asked to judge the *most they would advise the buyer to pay* for a car, given that the blue book value is $500 and an *expert* mechanic, who is a *friend of the seller,* estimates its value at $700. The bias of a source may affect either the weight or the scale value of the information provided by the source. Furthermore, the effects of the source's bias may depend on the judge's point of view. The next section shows that certain experimental designs make it possible to distinguish different theories of the effect of source characteristics on weight and scale value.

The first four experiments compare three models of the effects of the source's bias. These relative-weight averaging models are compatible with previous research; however, they make strikingly different predictions for the interaction of the source's expertise and bias. The models can be distinguished by qualitative comparisons that do not require metric assumptions about the dependent variable or global tests of goodness of fit.

The fifth experiment tests a theory of configural effects. Deviations from the relative-weight averaging model obtained in previous research (Birnbaum, 1974; Birnbaum et al., 1976) and in the first four experiments of this article are presumed to depend on the stimulus configuration. Implications of a configural-weight theory (Birnbaum, 1974) are explored in the fifth experiment.

Weight and Scale Value

Figure 1 shows how effects of the source on scale value and weight can be separated and analyzed in a relative-weight model. The three examples show hypothetical predictions assuming that the source affects weight only (A1 & B1), scale value only (A2 & B2), or both (A3 & B3).[1] Panels A1, A2, and A3 plot

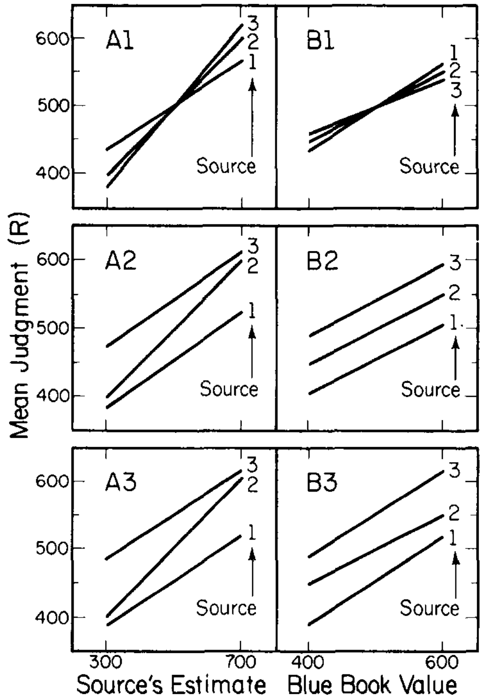

Figure 1. Hypothetical results assuming that sources affect weight only (Panels A1 & B1), scale value of the source's estimate only (A2 & B2), or both weight and scale value (A3 & B3). (Panels A1, A2, and A3 show mean judgments, averaged over blue book value, as a function of the source's estimate with a separate curve for each source. Panels B1, B2, and B3 show mean judgments, averaged over source's estimate, as a function of blue book value with a separate curve for each source. Note that changes in either weight or scale value of the source's estimate can affect the slopes in the A panels. Differences in slope in the B panels are not affected by changes in the scale values of the source's estimates, but depend upon the source's weights.)

[1] In all three examples in Figure 1, scale values for the blue book value were $400 and $600, with a weight of 2; the scale values for estimates of Source 2 were always $300 and $700, with a weight of 2; the weight of the initial impression was 0. In the first example (A1 & B1), the weights of Sources 1, 2, and 3 were 1, 2, and 3, respectively, and scale values remained fixed at $300 and $700. In the second example (A2 & B2), the weights of all three sources were 2; the scale values for Source 1 were $450 and $725, for Source 2 they were $300 and $700, and for Source 3 they were $275 and $550. For the third example, the weights of Sources 1 and 3 were 1, and the weight of Source 2

judged value as a function of the source's estimate with a separate curve for each source. The effect of the source's estimate, ΔR_E, that is, the change in response due to the source's estimate (averaged over blue book value), from Equation 1, will be given by the expression:

$$\Delta R_E = \frac{w}{w_0 + w_V + w} \cdot \Delta s_E, \qquad (1a)$$

where Δs_E is the range of scale values of the source's estimates. Note that the slopes in the A panels of Figure 1 will depend on both weight (w) and the range of scale values, Δs_E. The slopes are proportional to ΔR_E because the abscissa values are constant for all sources; Δs_E and w may or may not vary for different sources.

Panels B1, B2, and B3 of Figure 1 show the response plotted against the blue book value, averaged over the source's estimate, with a separate curve for each source. For the B panels, the effect of blue book value, ΔR_V, is given by the following equation:

$$\Delta R_V = \frac{w_V}{w_0 + w_V + w} \Delta s_V, \qquad (1b)$$

where Δs_V is the range of scale values of the blue book values. Note that if w_0, w_V, and Δs_V are presumed to be independent of the source, the effect of the blue book value (slope) should vary inversely with the weight of the source, w.

Change of weight only. The pattern of results in Figure 1, Panels A1 and B1, is consistent with the results of Birnbaum et al. (1976), who varied expertise (but not bias) of the source. For that experiment, Sources 1, 2, and 3 would represent low, medium, and high expertise, respectively. It was concluded that expertise affects weight, not the range of scale values, since the effects of blue book value (slopes in Panel B1) are lower for sources of higher expertise, as predicted by Equation 1b if expertise affects weight.

Change of scale value only. It seems unlikely that manipulation of the bias of a source, holding expertise constant, would affect only weight and produce the pattern of Panels A1 and B1. If the source's bias affects the scale values of the source's estimates, one would expect main effects of bias and possibly interactions between the bias of a source and the source's estimate. Figure 1, Panel A2, illustrates such a possibility. In this case, Sources 1, 2, and 3 might represent friend of the seller, independent, and friend of the buyer, respectively. At first, the increased slope for Source 2 in Panel A2 might be thought to indicate that Source 2 has greater weight. However, Panel B2 shows the weights are equal, since the curves are parallel. Parallelism implies that the effect of blue book value is independent of the source, indicating (by Equation 1b) that the sources have equal weights.

Change of weight and scale value. Panels A3 and B3 of Figure 1 indicate a pattern in which the source affects both weight and scale value. The curve with the steeper slope in Panel A3 also has the flatter slope in Panel B3.

These examples illustrate that in order to separate the influences of the source on weight and scale value, one must examine not only the effect of a source's estimate (A panels) but also the effect of another cue such as the blue book value (B panels). The effect of the source's *estimate* depends on *both* the source's weight and the range of scale values (Equation 1a and A panels). The effect of blue book value, however, provides an unambiguous constraint on the source's weight (Equation 1b and B panels). By comparing Panel A with Panel B one can tease apart the effects of source variables such as bias on weight and scale value.

Experiments 1–4: Three Models of Source Bias

Figure 2 shows three models of source bias (on the left) and an important prediction of each (on the right). All of the models are relative-weight averaging formulations and can be represented by lever and fulcrum models. The lever is an analog computer that can be used to make predictions for the three models. In each case, the scale value of the source's estimate is represented by the *location* along the lever where the weight is placed,

was 2; the scale values for Source 1 were \$450 and \$850, for Source 2 they were \$300 and \$700, and for Source 3 they were \$150 and \$550.

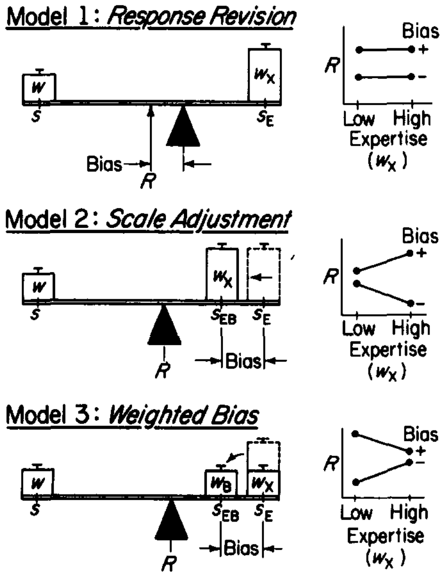

Figure 2. Three models of source bias. (Scale value, s, corresponds to a point along the lever; mathematical weight, w, corresponds to physical weight placed on the lever. Apart from the effects of bias, the response [R] would be the center of gravity, fulcrum balance. Model 1 predicts no interaction between bias and expertise. Model 2 assumes that bias affects the scale value of the source's estimate and predicts that the effect of bias increases with the increasing expertise of the source. Model 3 assumes that the source's bias and estimate are two pieces of information that are averaged to form an overall assessment. Since the relative weight of bias decreases as expertise increases, Model 3 predicts that the effect of bias diminishes with increasing expertise.)

weight corresponds to *weight*, and the response is represented by the *center of gravity* (location of the fulcrum at equilibrium).

In each model, the scale value and weight of the other information (e.g., blue book value) are s and w, the scale value of the source's estimate is represented by s_E, and the weight of the source's expertise is w_X. To represent the initial impression, the plank alone is presumed to have a weight of w_0 with a center of gravity at s_0. The change in response due to bias is shown in each figure by a comparison of solid and dashed symbols (weights or arrows). The direction of bias illustrated in the figure is negative, consistent with the source being a friend of the seller.

Model 1: Response Revision

According to the first model, bias produces a shift in the response, rather than affecting weight or scale value. As shown in Figure 2, this can be represented by the lever if the response is assumed to be the weighted average of a bias-free response, R^*, and a response effect of bias, b_B. A special case of this model can be written as follows:

$$R = \left(\frac{w_{R^*}}{w_{R^*} + w_B}\right)R^* + \left(\frac{w_B}{w_{R^*} + w_B}\right)b_B, \quad (2)$$

where w_{R^*} and w_B are the weights of the bias-free response and the bias adjustment, respectively, which are assumed to be constant, and R^* (fulcrum, or balance point not considering bias) is given by Equation 1:

$$R^* = (w_0 s_0 + ws + w_X s_E)/(w_0 + w + w_X).$$

This model predicts no interaction between bias and any of the other factors. In particular, the effect of bias is predicted to be independent of expertise, as shown in the upper right section of Figure 2.

A more complicated version of Model 1 would allow the source's weight (w_X) to depend on both expertise and bias. The changes in weight due to bias and expertise can be estimated from the effects of blue book value (as in Figure 1). This more general model still predicts that once the weights have been estimated in this fashion, the residual effect of bias will be independent of expertise. The response revision model represents the judgment as a two-stage process in which the average value is first computed without paying attention to bias, then bias is averaged together with this implicit response.

Model 2: Scale Adjustment

The second model assumes that the bias of the source causes a shift in the value of the information provided by the source. Thus, the scale value of information from a biased source is adjusted "prior" to the integration process. Figure 2 depicts this process by showing that the source's weight is *not* placed at the scale value of the estimate, s_E, but instead at a bias-corrected value, s_{EB}, which depends on both bias and estimate. A special case of this model, which assumes that $s_{EB} = s_E + b_B$, can be written:

$$R = \frac{w_0 s_0 + ws + w_X(s_E + b_B)}{w_0 + w + w_X}. \quad (3)$$

This scale-adjustment model predicts that the effect of bias will be greater for sources of high expertise than for sources of low expertise, since expertise (w_X) multiplies the bias correction (b_B).

A more complicated version of this model allows the weight of the source to depend on both expertise and bias and allows the corrected scale value to depend on both estimate and bias. This general version of Model 2 can be written as follows:

$$R = \frac{w_0 s_0 + ws + w_{XB} s_{EB}}{w_0 + w + w_{XB}}, \qquad (4)$$

where the subscripts of w_{XB} and s_{EB} suggest that the weight of a source depends on both expertise (X) and bias (B), and scale value depends on both estimate (E) and bias (B). The more general model does not require estimate and bias to combine additively to produce scale value.

Model 3: Weighted Bias

The third general theory assumes that the source's estimate and the source's bias are both pieces of information that must be integrated to form an overall evaluation. The scale value of the source's estimate, s_E, receives a weight that depends on the source's expertise, w_X. However, the scale value of the source's bias, b_B, has a weight that depends only on bias, w_B. Thus, as the expertise increases, the source's estimate receives greater relative weight, and the source's bias receives reduced relative weight. Model 3 can be written:

$$R = \frac{w_0 s_0 + ws + w_X s_E + w_B b_B}{w_0 + w + w_X + w_B}. \qquad (5)$$

Model 3 predicts that the effect of bias will be *inversely* related to the expertise of the source: As w_X increases, the relative weight of bias, $w_B/(w_0 + w + w_X + w_B)$, decreases. Model 3 can also be extended to allow the weight of the source's estimate to depend on bias, w_{XB}, or to allow the bias correction to depend on estimate and bias. Model 3 asserts that as a source grows in expertise, the judge places more weight on what the source *says* and therefore less relative weight on the correction for bias.

In sum, the three models predict that increasing expertise either increases the effect of bias (Model 2), decreases the effect of bias (Model 3), or does not interact with bias (Model 1). These differential predictions, shown on the right in Figure 2, are tested in the first four experiments.

Method

Instructions

The task was to judge the values of hypothetical used cars based on *blue book value* and/or *estimates* of value provided by sources who varied in *bias* and *expertise*. The sources of the estimates were described as people who attempted to judge the "true" value of the cars, based on a 30-minute inspection and test drive. Their relationship with the buyer or seller and their expertise in judging the value of automobiles were specified.

Source expertise. Separate paragraphs discussed the training and mechanical skill of the sources, who were described as low, medium, or high in expertise. The low-expertise source was described as a competent person who drives a car regularly and has purchased cars for himself. The medium-expertise source was a person who has taken some classes in auto shop and can make some repairs himself. The high-expertise source was described as an expert mechanic whose hobby is the repair and modification of sports cars.

Source bias. Each source was described as a friend of the buyer, a friend of the seller, or an independent. It was explained that the buyer's friend would be expected to be sensitive to his friend's desire to get a good value for his or her money and might emphasize the car's bad points. The independent was characterized as a neutral person with no relationship with the buyer or seller and no reason to under- or overestimate. The seller's friend would be concerned with the seller's desire to get as much money as possible for the car. He might be optimistic about the car and emphasize its good points.

Blue book value. The blue book value was described as a standard "fair" price that is determined by such factors as year, model, make, and mileage. It was remarked that blue book value is widely relied upon by businesses that deal in large numbers of cars, but that it would not describe individual cars.

Procedure and Designs

Each test booklet contained three pages of instructions, 20 warm-up trials, and 293 randomly ordered test trials. The test trials were constructed from the following designs:

Source estimate. A 3 × 3 × 5 (Bias × Expertise × Estimate) factorial design generated 45 trials on which the only information presented was the estimate of a source whose expertise and bias were specified. The three levels of the source's bias were friend of the buyer, friend of the seller, and independent. The three

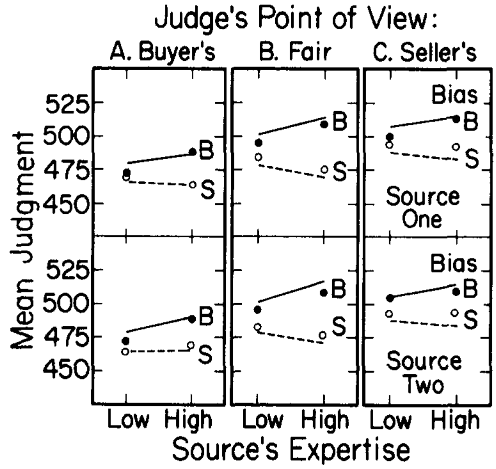

Figure 3. Mean judgment of value as a function of the source's expertise with a separate curve for each level of the source's bias. (Points are empirical means, and lines are predictions based on the scale-adjustment model, Equation 4. Solid points and lines are for friends of the buyer [B]; open circles and dashed lines are for friends of the seller [S]. Upper and lower rows of panels are for the first and second sources, respectively. Panels A, B, and C represent different points of view for the judge, Experiments 1–4.)

levels of source expertise were high, medium, and low. The five levels of estimate were $300, $400, $500, $600, and $700.

Source estimate and blue book value. The entire 3 × 3 × 5 source-estimate design was factorially combined with the four levels of blue book value: $350, $450, $550, and $650. The resulting (3 × 3 × 5) × 4, (Bias × Expertise × Estimate) × Blue Book Value, design yielded 180 trials on which the information consisted of a source's estimate and a blue book value.

Two source estimates. Two separate 2 × 2 × 2 source-estimate designs were factorially combined to generate 64 trials ([2 × 2 × 2] × [2 × 2 × 2]) with estimates from two sources. For both sources, the two levels of bias were friend of the buyer and friend of the seller; the two levels of expertise were high and low. The levels of estimate for the first source were $400 and $600; for the second source, they were $300 and $700.

In addition, there were four trials in which only the blue book value was presented: $350, $450, $550, and $650.

Judge's Point of View and Research Participants

All four experiments used the same test trials and warm-ups, but three different points of view were given to different groups of judges, who were instructed to identify with either the buyer, the seller, or an independent. The judges were 121 undergraduates at the University of Illinois who received extra credit in an introductory psychology course. A small number of additional students failed to follow instructions or complete the task and were excluded.

Experiments 1 and 2: Fair price. The judges were instructed to imagine that they had been hired by an "independent, unbiased assessor to estimate the 'true' value of many cars." They were told to neither over- nor underestimate "true worth." Experiment 1, with 51 participants, was conducted a year before the others. Experiment 2, with 19 judges, was a replication of Experiment 1 conducted contemporaneously with Experiments 3 and 4. The data for Experiments 1 and 2 were analyzed separately and were virtually identical; consequently, the data were pooled.

Experiment 3: Buyer's price. The buyer's task was to estimate the highest price for which he or she would recommend buying a car. The 26 judges in Experiment 3 were instructed to imagine that they were acting as the agent of someone who would be buying used cars and to ask themselves, "What is the *maximum* amount I would advice *paying* for each car?"

Experiment 4: Seller's price. The seller's task was to estimate the lowest price for which he or she would recommend selling a car. These 25 judges were instructed to imagine that they were acting as the agent of someone who would be selling used cars and to ask themselves, "What is the *minimum* amount I would advise *accepting* for each car?"

Results

Figure 3 shows the interaction between expertise and bias for the two-source design, plotted for comparison with the predictions on the right in Fig. 2. Mean judgments of value are plotted as a function of the source's expertise, with solid points for the friend of the buyer (B) and open circles for the friend of the seller (S). As expected, judged values are greater when the source is a friend of the buyer than when he is a friend of the seller. The upper panels are for the first source, averaged over levels of both estimates and over expertise and bias of the second source. Lower panels are for the expertise and bias of the second source.

Panels A, B, and C show the results for the buyer's point of view (Experiment 3), the independent, "fair" point of view (Experiments 1 & 2), and the seller's point of view (Experiment 4), respectively. Comparing the three panels shows that the mean judgments are greater for estimates of the "lowest selling price" (Panel C) than they are for the "highest buying price" (Panel A).

All six panels show a divergent interaction: As expertise increases, the difference due to the source's bias increases. Divergence is also characteristic of plots made for individual judges. Analysis of variance tests of the inter-

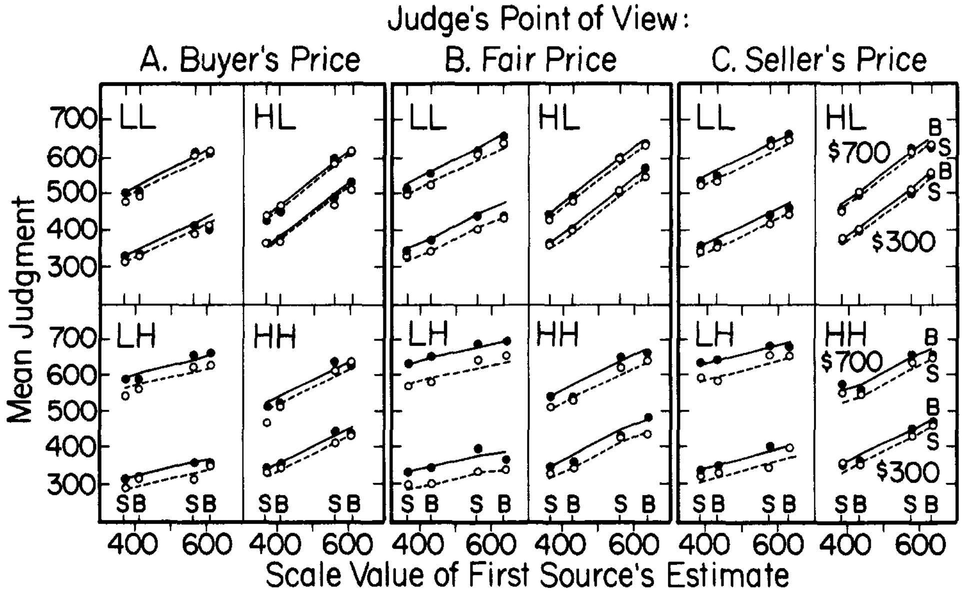

Figure 4. Mean judgment of value based on estimates provided by two sources, as a function of the scale value of the first source's estimate. (The four abscissa values represent scale values for estimates of $400 or $600, by a friend of either the buyer [B] or seller [S]. Upper panels represent data for second sources of low expertise [L]; lower panels are for second sources of high expertise [H]. Open circles and solid points represent second sources who are friends of the seller and friends of the buyer, respectively. Lines represent theoretical predictions based on scale-adjustment theory, with dashed lines for friends of the seller, Experiments 1–4.)

action between bias and expertise of the second source yielded $F(1, 25) = 12.7$, $F(1, 69) = 36.6$, and $F(1, 24) = 10.2$ for buyer's, fair, and seller's points of view, respectively. This divergence is predicted by the scale-adjustment model (Model 2 of Figure 2), which assumes that the source's bias causes a shift in the scale value of the information he provides. The solid and dashed lines plotted on Figures 3–5 represent predictions for Model 2 of Figure 2 (Equation 4). Model analyses will be discussed in a later section.

Figure 4 shows the results for all 64 two-source combinations, with a separate set of four panels for each point of view of the judge. Each panel within Figure 4 contains letters representing the expertise of the first and second sources, respectively. Thus the upper, left panel of each figure represents the results for two low-expertise sources (LL); the upper right panel shows the results for a high-expertise first source and a low-expertise second source (HL). The abscissa is spaced according to the scale value of the first source's estimate, derived from Equation 4. The letters S and B on the abscissa show the scale values for the first source's estimates (either $400 or $600), provided by a friend of the seller (S) or buyer (B), respectively. The four separate curves within each panel are for levels of bias and estimate of the second source. Solid points and lines are used for second sources who are friends of the buyer; open circles and dashed lines are used for friends of the seller.

There are four important results in Figure 4 that are common to all points of view, characteristic of the majority of individual subjects, statistically reliable, and (importantly) relevant to evaluation of the models. First, the effect of a source's estimate is greater for sources of higher expertise. Within each set of panels, proceeding from the upper left to the upper right corresponds to an increase in the expertise of the first source. Since the first source's estimate is on the abscissa, the increase in slope represents an increase in the effect of this estimate. The vertical separation between the two curves of the same type (either solid or dashed) represents the effect of the second source's estimate, which was

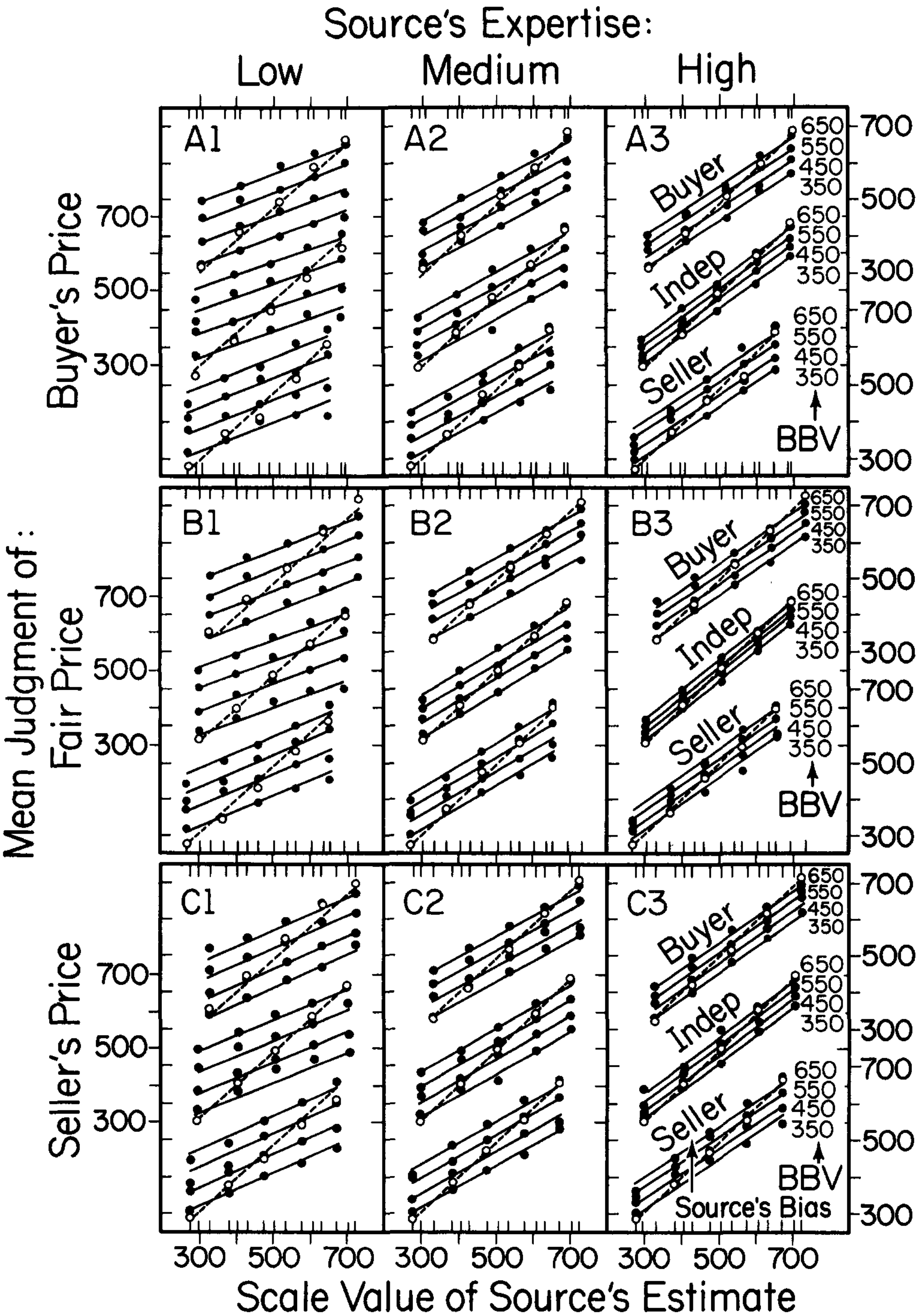

Figure 5. Mean judgment as a function of the source's estimate and blue book value. Panels A1–A3: Judgments of the highest price a buyer should pay (Experiment 3). Panels B1–B3: Judgments of "true" value (Experiments 1 & 2). Panels C1–C3: Judgments of the lowest acceptable selling price (Experiment 4). (Columns represent different levels of source expertise. Data for biased sources have been shifted vertically on the ordinate, $250 up for the friend of the buyer and $250 down for the friend

either \$300 or \$700. Dropping from an upper panel to a lower one corresponds to an increase in the expertise of the second source. Accordingly, the spread between the curves is greater in the lower panels. The tests of the Expertise × Estimate interactions for the first source yielded $F(1, 25) = 60.7$, $F(1, 69) = 239.2$, and $F(1, 24) = 45.0$ for the buyer's, fair, and seller's price judgments, respectively.

Second, the effect of either source's estimate is *inversely* related to the expertise of the *other* source. Thus, as the slopes increase from left to right, the spreads decrease. As the spreads increase from the upper to the lower panels, the slopes decrease. For the Expertise of the First Source × Estimate of the Second Source interaction, the *F*s were $F(1, 25) = 56.0$, $F(1, 69) = 329.3$, and $F(1, 24) = 59.6$ for buyer's, fair, and seller's price conditions, respectively.

Third, the effect of bias varies *directly* with the expertise of the same source. Note that the spread between open and filled circles (effect of the bias of the second source) is greater in the lower than the upper panels (when the expertise of the second source is greater). Fourth, the effect of bias varies *inversely* with the expertise of the other source. The spread between solid and dashed curves is *smaller* in the panels on the right (HL and HH, where the first source is high in expertise) than in the panels on the left. For the Expertise (of the first source) × Bias (of the second source) interaction, the *F* values were $F(1, 25) = 6.8$, $F(1, 69) = 26.2$, and $F(1, 24) = 21.3$, for buyer's, fair, and seller's price, respectively. Thus, bias interacts with expertise in the same fashion as estimate, consistent with the scale-adjustment model.

Figure 5 shows the results for the source-estimate and blue book value designs for all three points of view. The abscissa of each figure is spaced according to least squares estimates of the scale values of the source's estimate, based on Equation 4. The three leftmost notches on the abscissa, facing into each panel, show the positions of the scale values for an estimate of \$300 provided by a seller's friend, an independent, or a buyer's friend, respectively.

The solid points represent mean judgments based on a source's estimate and the blue book value (indicated next to curves). Open circles and dashed lines denote judgments based only on a source's estimate (no blue book value). Panels 1, 2, and 3 show the effects of increasing the source's expertise. It can be seen that proceeding from left to right, the slopes increase but the vertical spreads between the blue book value curves decrease. The curves for biased sources are shifted vertically (\$250 up for the friend of the buyer and \$250 down for the friend of the seller). The ordinate on the far right is labeled for these two; the left ordinate is labeled for the independent-source data.

A portion of the present experiment (independent sources, fair price condition) replicates Experiment 1 of Birnbaum et al. (1976). These 60 data points give virtually identical results to those of the earlier experiment.

The effects in Figure 5 for the source-estimate and blue book value design are highly reliable relative to the error terms. More importantly, similar effects occur in each experiment, providing evidence of replication. Statistical analyses confirm these graphic interpretations. For example, for the fair point of view, the $F(2, 138)$ for the main effect of bias was 102.3. The divergent interaction between bias and expertise, predicted by the scale-adjustment model, has an $F(4, 276) = 15.9$. The interaction between expertise and estimate yields $F(8, 552) = 122.5$. The theory that the weight of a source depends on expertise predicts the Expertise × Blue Book Value interaction, in which the effect of the blue book value is inversely related to expertise, $F(6, 414) = 114.7$. The effect of the blue book value also depends on the bias of the source, $F(6, 414) = 4.4$, and on the Expertise × Bias interaction, $F(12, 828) = 7.3$, consistent with the

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of the seller [right-ordinate scales]. Separate curves are drawn for different levels of blue book value [BBV]. Open circles represent judgments based on one source's estimate only. Lines represent predictions based on scale-adjustment theory. Abscissa spacing represents fitted scale values, which are permitted to depend on source bias and estimate [Experiments 1–4].)

interpretation (Equation 4) that the source's weight depends on both bias and expertise.

The data for the blue book value and source-estimate design are consistent with the following: Scale value depends not only on the source's estimate but also on the source's bias. This theory (scale adjustment) explains the divergent Expertise × Bias interaction. Bias also affects the weight of a source, as evidenced by the differences in slope in Figure 5 for different bias–expertise combinations, in conjunction with the corresponding changes in the spread of the curves. Appendix A considers a complex alternative to all three models in Figure 2, which attempts to explain the effect of bias without scale adjustment. The complex model makes several incorrect predictions.

Confidence Intervals

The point size in Figures 4 and 5 is such that the solid and open circles contain a confidence interval of at least ±1 probable error in most cases. For Experiments 1 and 2, 42% of the means had standard errors less than $6.00, 64% were less than $8.00, 80% were less than $10.00, and 93% were less than $12.00. For Experiment 3, 35% of the means had standard errors less than $8.00, 51% were less than $10.00, and 63% were less than $12.00. For Experiment 4, 50% of the standard errors were less than $8.00, 58% were less than $10.00, and 60% were less than $12.00. These data seem quite neat, considering that adding another point size vertically on either side would include a 95% confidence interval in most cases.

Analyses for Individual Judges

Examination of data indicated that the group means are representative of the data for the vast majority of single judges. For example, four Expertise × Bias interactions were drawn separately for each of the 70 judges of Experiments 1 and 2. Model 2 predicts that the effect of bias should vary directly with the source's expertise and inversely with the expertise of the other source. The two-source design allows two examinations of each of these two predictions. Of the 70 subjects, 66% had either three or four interactions of the predicted form. Only 7 subjects had a greater number of inconsistent patterns than consistent patterns; 2 of these appear to have reversed the directions of bias for buyer and seller. Only 2 subjects had the pattern predicted by Model 3. Given that each point was the average of only 16 judgments and the fact that the Expertise × Bias interactions are predicted to be small, the small number of "deviant" judges doesn't provide evidence for the existence of large subgroups obeying different models. Of the 280 figures, 206 were of the predicted form, the same proportion for each prediction, suggesting that the group means are highly representative of individual data.

Model Analyses

Choice among models. Model 2 is vastly superior to Models 1 and 3, since it correctly anticipates the divergent Expertise × Bias interaction, in which the effect of bias is magnified by expertise. Accordingly, the 289 data points for each experiment were separately fit to Equation 4 by means of a computer program, which used Chandler's (1969) STEPIT subroutine to minimize the sum of squared model–data discrepancies.[2]

The data of Experiments 1 and 2 were analyzed separately with nearly identical results, showing excellent cross-validation of both the model and parameter values upon replication. The data of Experiments 1 and 2 are pooled in the analyses reported here.

Weights and scale values. The scale value for the blue book value of $550 was set to its monetary value, and the weight of the blue book was arbitrarily set to 1.0. There were 29 parameters to estimate, 9 weights for the sources (Expertise × Bias), 15 scale values (Estimate × Bias), 3 scale values for the blue book value, and a weight and a scale value for the initial impression.

The weights of the initial impression were small: .08, .08, and .10 for the buyer's price, fair price, and seller's price, respectively. Scale

[2] We thank Ron Hinkle for checking our parameter estimates from STEPIT against those obtained by his subroutine, BLACKBOX, which uses an improved minimization algorithm.

Table 1
Estimated Weights and Scale Values for the Scale-Adjustment Model

	Judge's point of view								
	Buyer's price			Fair price			Seller's price		
	Source's bias			Source's bias			Source's bias		
Variable	Buyer	Independent	Seller	Buyer	Independent	Seller	Buyer	Independent	Seller
	Estimated weights of sources[a]								
Source's expertise									
Low	.68	.59	.71	.76	.62	.84	.90	.76	.92
Medium	1.35	1.32	1.32	1.43	1.62	1.62	1.42	1.49	1.46
High	2.22	3.21	2.25	2.63	4.33	2.77	2.76	3.45	2.44
	Estimated scale values[b]								
Source's estimate									
$300	307	291	271	330	301	267	330	297	276
$400	407	397	370	430	401	364	428	404	380
$500	515	491	464	538	502	459	534	504	474
$600	608	594	562	633	601	561	629	607	576
$700	692	686	647	729	691	651	723	702	671

[a] Each entry in the upper portion of the table is the estimated weight for each source as a function of the source's expertise and bias. A separate analysis was performed for each point of view. The weight of the blue book value was set to 1.0. For example, the weight of the high-expertise friend of the buyer was 2.22 for Experiment 3 (buyer's price).
[b] Each entry in the lower portion of the table is the estimated scale value as a function of the source's estimate and the source's bias. For example, the largest scale value for Experiment 3 (buyer's price), $692, was for an estimate of $700 by a friend of the buyer. For Experiment 4 (seller's price), the same estimate from the same source had an estimated scale value of $723.

values for the initial impression were related to the point of view: 243, 368, and 390 for buyer's, fair, and seller's price, respectively. Estimated scale values for the blue book were 339, 446, 550, and 648 for the fair point of view (values were very similar for the other points of view). The least squares estimates of weights and scale values are shown in Table 1.

Table 1 shows that the weights depend mostly on expertise, but tend to be larger for the independent source of high expertise and possibly smaller for the low-expertise, independent source. This pattern of weights appeared in all experiments. The weights for the 9 sources estimated from the least squares analysis are consistent with weights estimated graphically, from the effect of blue book value, using the method of Figure 1.

The scale values depend on three factors: estimate, source's bias, and judge's point of view. For example, a $500 estimate provided by an independent has a scale value of only 491 from the buyer's point of view, 502 from the fair price point of view, and 504 from the seller's point of view. If the $500 estimate in the fair price condition is provided by a friend of the buyer, the scale value jumps to 538, compared with only 459 if the estimate is provided by a friend of the seller.

Fit of the scale-adjustment model. Predictions of the model are shown in Figures 3, 4, and 5 and come very close to the data. The square roots of the mean squared model–data discrepancies were 12.15, 10.16, and 11.16 for buyer's, fair, and seller's price, respectively. Hence, the average discrepancy between the model and sample means is not much larger than the expected discrepancy (standard error) between sample and population means.

Figures 3, 4, and 5 show that Model 2 makes the following correct predictions: First, it correctly predicts the divergent Expertise × Bias interactions. These interactions are best seen in Figure 3, where they have been plotted for comparison with Figure 2. The

Expertise × Bias interactions can also be seen in Figure 4. Figure 5 does not permit one to see this prediction easily, but when data for the Blue Book Value × Source Estimate design were plotted as in Figure 3, a similar pattern was evident: The greater the expertise, the greater the effect of bias.

Second, Model 2 gives a good description of the slopes and spreads of the curves in Figures 4 and 5. The greater the expertise of a source, the greater the effect of that source's estimate and bias and the *less* the effect of the estimate and bias of another source (Figure 4) or of the blue book value (Figure 5).

Third, Model 2 gives a good account of the single-source data (open circles and dashed lines in Figure 5), which cross the curves for different levels of blue book value.

Deviations of fit. The deviations from the model should be taken seriously, since each circle in Figures 4 and 5 contains a fair-sized confidence interval. The model predicts that the curves in each set in Figure 5 should be parallel. Instead, the interaction between estimate and blue book value shows a divergence to the right for the buyer's and the independent's points of view, $F(12, 300) = 6.6$ and $F(12, 828) = 11.2$, respectively. Similar divergence was also obtained by Birnbaum et al. (1976) and can be described by a configural-weight model, which assigns greater weight to the lower estimate. A configural-weighting revision of the scale-adjustment model is tested in Experiment 5.

There is also a hint of a higher order configural effect. When the judge has the seller's point of view and the buyer provides a low estimate, the effect of blue book value is greater than predicted (points are spread wider than predictions), as though the buyer's low estimate receives reduced weight. When the buyer provides a higher estimate, the data points are compressed, as if the buyer receives higher relative weight for providing an unexpected estimate.

In summary, the results of Experiments 1–4 are generally consistent with the scale-adjustment model (Model 2) of Figure 2. Deviations are small but regular. Consequently, Experiment 5 explores these deviations, testing modifications of Model 2 that allow the weight of an estimate to depend on the stimulus configuration.

Experiment 5: Test of Configural Weighting Models

Experiment 5 addressed three issues raised by the first four experiments. First, although the between-subjects manipulation of point of view did affect scale values in a predictable fashion, the pattern of weights did not support a prior conjecture that the weight of a source would be greater when the source's bias matched the judge's point of view (Table 1). Interpretation of between-subjects results requires extreme caution, however, since the effects of a variable such as point of view may depend on the establishment of a context of comparison for the individual judge. Consequently, Experiment 5 allowed each judge to experience all three points of view.

Second, the fact that the effect of a source's estimate and bias varies inversely with the number and expertise of other sources would also be consistent with a linear-weighted model in which the effective weight of a source varies with the *difference* between the source's weight and some function of the total absolute weight instead of the *ratio;* that is, the effective weight would be $w - f(\Sigma w)$ instead of $w/\Sigma w$. In order to test this linear-weight model against relative-weight averaging models (such as Model 2), it is necessary to have at least two sources that each take on more than two levels of expertise. Therefore, Experiment 5 was designed to compare the success of the relative-weight model versus the linear-weight model.

Third, systematic deviations of fit appeared in Experiments 1–4. These deviations appear consistent with previous results obtained by Birnbaum (1972, 1973, 1974) and by Birnbaum et al. (1976). The deviations in Experiments 1–4, although convincing, were not large enough to warrant detailed theoretical analysis. In previous tests of averaging models, deviations from parallelism were found to be related to the range (maximum–minimum) of scale values within the set of stimuli to be integrated. Consequently, Experiment 5 contained greater variation in the range of scale values within sets in order to permit a better examination of the deviations from the averaging model.

Configural-Weight Theory

To account for stimulus interactions, simple configural-weight theories have been proposed and tested by Birnbaum, Parducci, and Gifford (1971), Birnbaum (1972, 1973, 1974), and Birnbaum and Veit (1974). The scale-adjustment model (Model 2 of Figure 2) can be modified to allow for configural weighting. The simplest configural-weight theory was termed the range model. According to this model, the relative weight of a stimulus depends in part on the rank of that stimulus in the configuration of stimuli to be integrated on a given trial.

For two stimuli, the range model may be written:

$$R = \frac{w_0 s_0 + w_1 s_1 + w_2 s_2}{w_0 + w_1 + w_2} + \omega_P |s_1 - s_2|, \quad (6)$$

where ω_P is the weight of the configural, or range ($|s_1 - s_2|$) effect, which, in the present case, would presumably depend on the judge's point of view. Note that when $s_1 > s_2$, the relative weight of s_1 can be written:

$$\frac{w_1}{w_0 + w_1 + w_2} + \omega_P. \quad (7)$$

However, when $s_1 < s_2$, the relative weight of s_1 can be written:

$$\frac{w_1}{w_0 + w_1 + w_2} - \omega_P. \quad (8)$$

The range model assumes that the effective relative weight of a stimulus depends on the rank of its scale value in the set of stimuli to be combined. As a limiting case, when ω_P equals the relative weight of a stimulus, the range model can become a maximum or minimum (conjunctive or disjunctive) model, depending on the sign of ω_P. The model implies that the response varies linearly with the range of scale values, holding mean scale value constant.

If the two stimuli are two estimates provided by different sources, if the weight depends on the expertise and bias of the source (e.g., $w_1 = w_{X_1B_1}$), and if the scale value depends on the source's estimate and bias (e.g., $s_1 = s_{E_1B_1}$), then Equation 6 becomes an extension of the scale-adjustment model (Model 2 of Figure 2). This configural-weight model adds a single parameter, ω_P, to account for the effects of the judge's point of view.

Note that ω_P in Equation 7 is the amount of relative weight taken from the lower valued stimulus and given to the higher. If ω_P is negative, weight is added to the lower valued stimulus, yielding a divergent stimulus interaction. Such an interaction might be expected in the buyer's point of view. A convergent interaction (positive ω_P) might be expected in the seller's point of view, since the larger of two estimates should receive greater weight.

Method

The instructions, stimuli, and procedure were similar to those of Experiments 1 through 4. The chief differences were as follows: (a) Each judge was exposed to all three points of view via instructions and then judged all of the 146 stimulus combinations separately under each point of view. (b) Descriptions of the levels of expertise were modified to provide five levels. (c) The experimental designs in Experiment 5 permitted assessment of previously untested predictions of the models.

Experimental Designs

The trials selected were a subset of a (5 × 3 × 9) × (5 × 3 × 9), First Source (Expertise × Bias × Estimate) × Second Source (Expertise × Bias × Estimate) factorial design. The complete design would have required 18,225 trials; therefore, six smaller factorial designs involving these six variables were selected to test particular implications of the models. These designs are shown in Table 2 and described below.

Estimate × Estimate. Two related (1 × 1 × 4) × (1 × 1 × 4) factorial designs investigated the hypothesis that the configural weight of the lower scale value depends on the point of view of the judge. In both designs, both sources were medium in expertise; the levels of estimate for Source 1 were $350, $450, $550, and $650; and the levels of estimate for Source 2 were $300, $400, $600, and $700. In one design, the first source was a friend of the buyer and the second was a friend of the seller; in the other design, the biases were reversed.

Bias × Bias. The design was a (1 × 3 × 2) × (1 × 3 × 2), in which both sources were medium in expertise; the three levels of bias for both sources were friend of the buyer, independent, and friend of the seller; the estimate of Source 1 was either $350 or $650; the estimate of Source 2 was either $300 or $700. The purpose of the Bias × Bias design was to investigate the hypothesis that when a source provides an estimate contrary to what one would expect from that source's bias, the weight of that estimate is increased.

Bias × Expertise. Two related designs reexamined the predictions of Model 2 that expertise amplifies the effect of bias (and estimate) in the same source and

Table 2
Two-Source Designs in Experiment 5

	First source			Second source		
Design	Expertise	Bias	Estimate	Expertise	Bias	Estimate
$Est_1 \times Est_2$ (BS)	1 (Med)	1 (B)	4	1 (Med)	1 (S)	4
$Est_1 \times Est_2$ (SB)	1 (Med)	1 (S)	4	1 (Med)	1 (B)	4
Bias × Bias	1 (Med)	3	2	1 (Med)	3	2
$Bias_1 \times Exp_2$	1 (Med)	3	2	5	1 (I)	1 ($500)
$Bias_1 \times Exp_1$	5	3	2	1 (Med)	1 (I)	1 ($500)
Exp × Exp	5	1 (I)	1 ($300)	5	1 (I)	1 ($650)

Note. Each entry represents the number of levels of the factor listed above the column. The product of the entries in each row gives the number of cells in each design. For example, the first row indicates that an Estimate (Est) × Estimate design consisted of 16 trials in which the first source was a medium-(Med) expertise, friend of the buyer (B) who provided one of four estimates, and the second source was a medium-expertise friend of the seller (S) who provided one of four estimates. The last row shows that the Expertise (Exp) × Expertise design contains 25 cells in which the expertise of each source could attain one of five levels, the first source was an independent (I) who gave an estimate of $300, and the second source was also an independent with a $650 estimate.

diminishes the effect of bias (and estimate) in a second source. A (1 × 3 × 2) × (5 × 1 × 1) factorial design used five levels of expertise (very low, low, medium, high, or very high) for the second source, an independent who gave an estimate of $500, combined with a medium-expertise first source, with three levels of bias of Source 1 (S, I, B) and two estimates, $350 or $650. A second factorial design, a (5 × 3 × 2) × (1 × 1 × 1), was identical, except that it shifted the five levels of expertise to the first source and held the expertise of the second source at medium. The purposes of these two designs were to constrain the estimates of weights and to replicate the Bias × Expertise × Estimate interactions of Experiments 1–4.

Expertise × Expertise. To test the averaging model against the linear-weighted model requires more than two levels of expertise for two sources. Hence, a (5 × 1 × 1) × (5 × 1 × 1) factorial design was empolyed in which the five levels of expertise for each source were very low, low, medium, high, and very high. The bias of each source was "independent." The estimate of the first source was $300, whereas the second source gave an estimate of $650.

The designs employing two sources generate a total of 153 stimulus sets, 15 of which are shared by two designs, leaving 138 distinct two-source test trials. These designs constrain all of the two-way interactions and many of the three- and four-way interactions among the six variables. In addition, 8 trials were produced by a single-source design, in which only one source provided an estimate. The design was a 2 × 2 × 2, Expertise × Bias × Estimate, factorial design, in which the two levels of expertise were low and high, the two levels of bias were friend of buyer and friend of seller, and the estimate was either $300 or $700.

Procedure

The 146 trials were printed in random orders in booklets in three sets, with additional instructions and 10 warm-up trials reminding the judge of the point of view for each set. Judges were permitted to work at their own paces, completing the 438 experimental trials in about 2 hours.

Research Participants

The judges were 60 undergraduates at the University of Illinois who received extra credit in introductory psychology for participating. Ten students served in each of the six possible orders of three points of view.

Results

The upper panels of Figure 6 show mean judgments as a function of the estimate provided by a medium-expertise seller with a separate curve for each level of estimate provided by a medium-expertise buyer. The lower panels plot judgments as a function of the buyer's estimate, with a separate curve for each level of seller's estimate. Panels A to C represent the judge's point of view. Lines in Figures 6–9 are predictions of the range model (Equation 6), an extension of Model 2 of Figure 2, using a different value of ω_P for each point of view. This model is discussed in a later section.

Figure 6 shows a striking result. Whereas the models considered in Experiments 1–4 predict parallel curves in each panel, the curves in Figure 6 are systematically nonparallel. Furthermore, the interactions are related to the judge's point of view. The curves

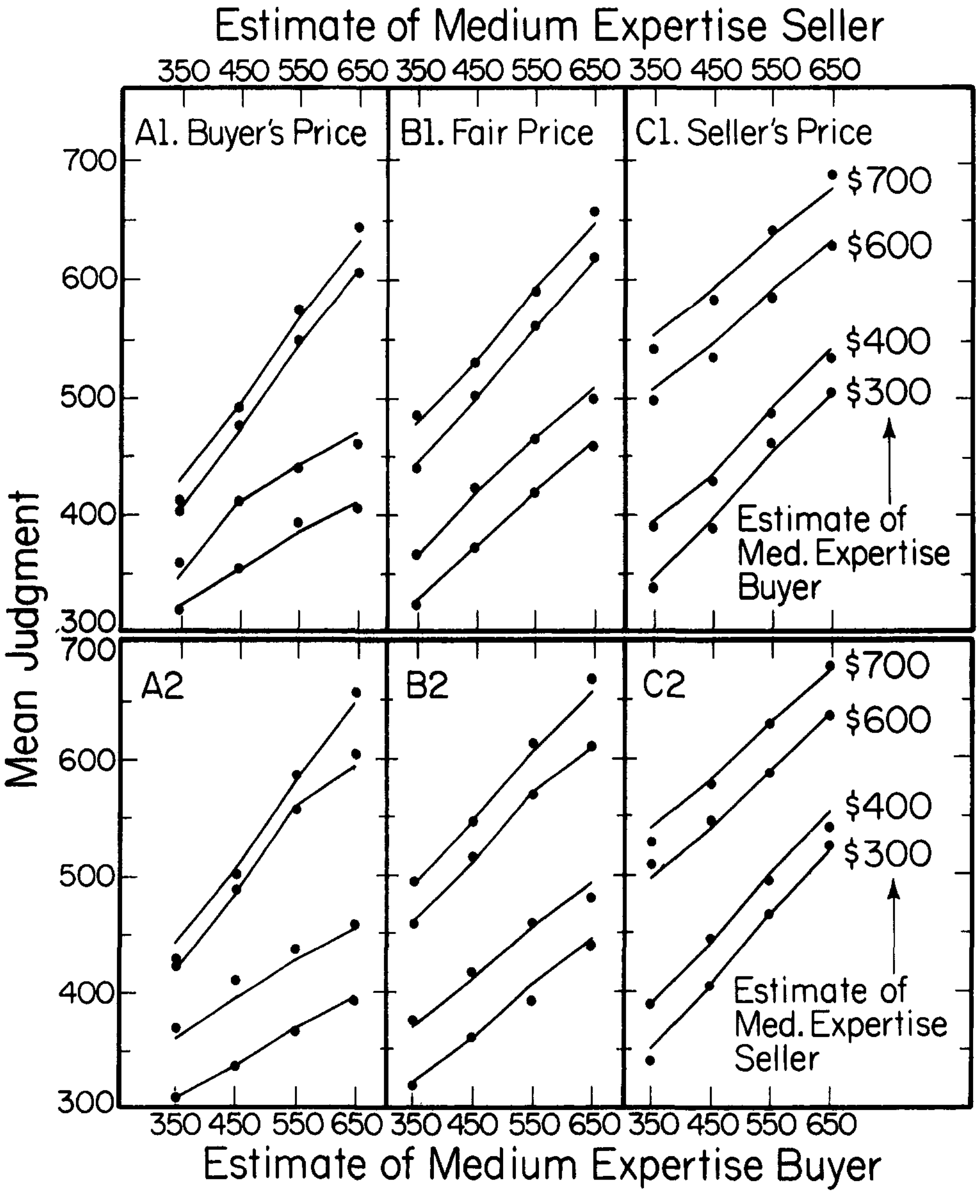

Figure 6. Upper panels: Judgment of value as a function of the estimate of the medium-expertise friend of the seller with a separate curve for each estimate of the medium-expertise friend of the buyer. Lower panels: Judgment of value as a function of the estimate of the buyer's friend (on the abscissa) with separate curves for the estimates of the seller's friend. (Panels A, B, and C are for the judge's point of view. Lines represent predictions of the range model [Experiment 5, Estimate × Estimate designs].)

diverge for the buyer's point of view and for the fair price point of view; however, they converge for the seller's point of view. It is as if the judge places greater weight on the lower estimate when identifying with the buyer and places greater weight on the higher estimate when identifying with the seller. The three-way interaction of Point of View × First Estimate × Second Estimate yielded Fs(18, 1062) = 11.8 and 11.3 for the two panels of Figure 6.

Figure 7 shows Estimate × Estimate interactions with a separate panel for each combina-

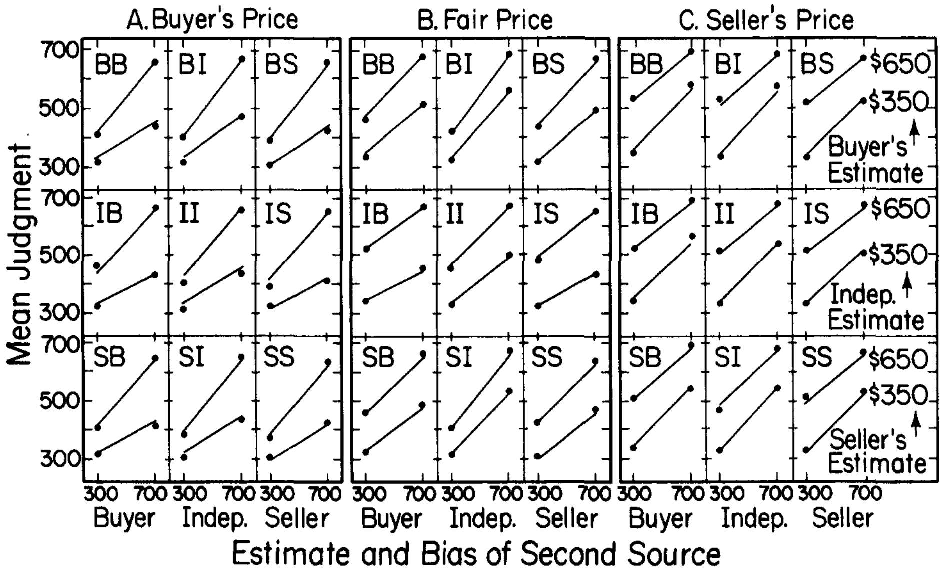

Figure 7. Mean judgment of value as a function of the estimate provided by the second source, with a separate curve for each level of estimate of the first source. (Letters within panels [B = buyer; S = seller; I = independent] represent the biases of the first and second sources, respectively, who were both medium in expertise. Panels A, B, and C are for the judge's point of view. Lines show predictions of the range model [Experiment 5, Bias × Bias design].)

tion of biases for the sources. Each panel plots mean judgments as a function of the estimate of the second source (plotted on the abscissa) with a separate curve for each level of estimate of the first source. Letters inside panels represent biases of first and second sources, respectively.

The interactions in Figure 7 are divergent for all nine buyer's price panels (7A) and for all nine fair price panels (7B); however, the interactions are *convergent* in all nine seller's price panels (7C). Combined with the data of Figure 6, all 11 tests of the Estimate × Estimate interaction show the same form within each point of view. Assuming a relative-weight averaging model (all of the models in Figure 2 predict parallelism), it would be extremely unlikely to obtain 11 divergent or convergent interactions, all of the same type, within each point of view.

The group means are highly representative of data for individual judges. For example, 58 of 60 judges show the divergent Estimate × Estimate interaction of Figure 7 for the buyer's point of view; 48 judges show divergence for the fair price of view, and 40

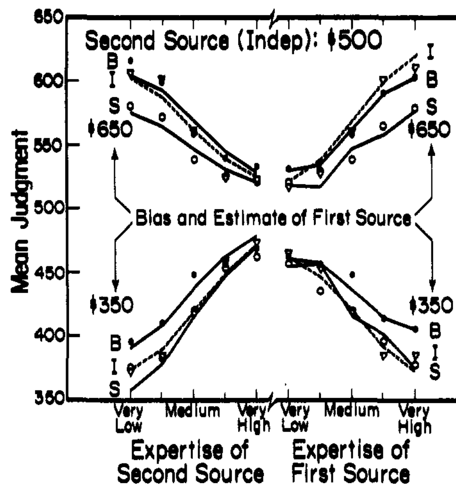

Figure 8. Left: Mean judgment of value as a function of the expertise of the independent second source (who said $500), with a separate curve for each level of bias (B = buyer; S = seller; I = independent) and estimate of the first source. Right: Mean judgment of value as a function of the expertise of the first source. (The second source was a medium-expertise independent who said $500. Lines show predictions of the range model [Experiment 5, Bias × Expertise designs].)

judges show convergence for the seller's point of view. Hence, these data provide strong evidence that the Estimate × Estimate interactions of Experiments 1–4 and of Birnbaum et al. (1976) are "real" and, most importantly, that the Estimate × Estimate interaction can be reversed by manipulating the judge's point of view. For the data of Figure 7, this three-way interaction yielded $F(2, 118) = 39.7$. Thus, some modification of the relative-weight models, such as configural weighting, is necessary.

Figure 8 shows the results for the Bias × Expertise × Estimate designs, averaged over the judge's point of view. These designs retested the implications of the models of Figure 2. The left panel of Figure 8 shows that as the expertise of the second source increases, the effects of the bias and estimate of Source 1 (the distances between the curves) decrease. The Expertise × Bias interaction yielded $F(8, 472) = 6.1$, and the Expertise × Estimate interaction had an $F(4, 236)$ of 226.1. The right-hand panel shows that as the expertise of the first source increases, the effects of bias and the estimate of the first source increase, $F(8, 472) = 4.8$ and $F(4, 236) = 158.2$, respectively. The general pattern was similar for all three points of view, drawn separately. These data reconfirm the results of Experiments 1–4; this pattern of results is predicted by the scale-adjustment model (Model 2 of Figure 2).

Figure 9 shows the results for the Expertise × Expertise design, with a separate panel for each point of view. The abscissa represents the expertise of an independent source who gave an estimate of $650; the separate curves are for levels of expertise of the independent source who said $300. The positive slopes indicate that judged value increases with the expertise of the source giving the higher estimate. Judged value decreases as a function of the expertise of the source giving the lower estimate.

Averaging models predict a nonparallel set

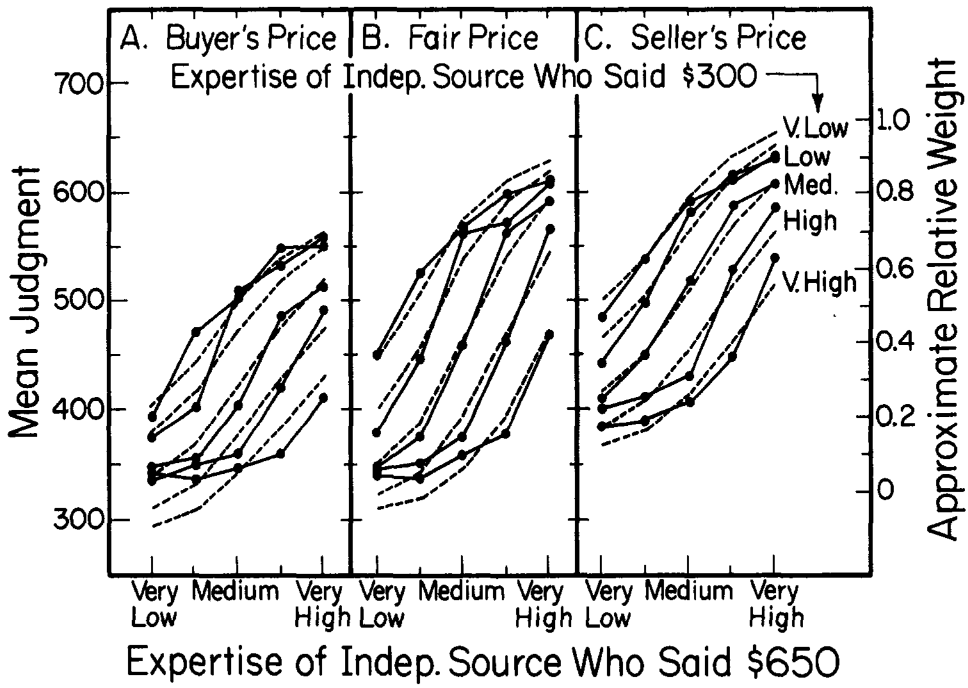

Figure 9. Mean judgment of value as a function of the expertise of an independent source who gave an estimate of $650, with a separate curve for each level of expertise of the first source, an independent who said $300 (Panels A, B, and C are for buyer's, fair, and seller's points of view, respectively. Dashed curves show predictions of the range model. Right ordinate represents an approximate scale of relative weight [Experiment 5, Expertise × Expertise design].)

Table 3
Estimated Bias Adjustments for the Range Model

	Source's bias		
Point of view	Buyer	Independent	Seller
Buyer's price	8.79	6.39	−33.50
Fair price	20.22	0	−34.76
Seller's price	24.26	1.26	−14.79

Note. Each entry is the estimated value of b_{BP} in Equation 9: $s_{EBP} = s_E + b_{BP}$. The estimated values for s_E are $322, $352, $410, $451, $511, $563, $620, $662, and $703 for the nine levels of estimate ranging from $300 to $700. For example, the largest value in the table (24.26) means that the scale value for an estimate provided by a friend of the buyer raises the scale value $24.26 when the judge takes the seller's point of view. Thus, an estimate of $500 has a scale value of $511 + $24 = $535 in this condition. The negative numbers show that when a friend of the seller provides the estimate, the scale value is reduced. The value for the independent source in the fair price condition was set to 0.

of curves that bulge in the middle. An opposing linear-weights theory that predicts parallelism is clearly refuted by the data. The interaction between the expertises of the two sources has an $F(16, 944) = 29.7$. In fact, the data pinch in at the ends even more than would be predicted by a differential-weight averaging model. The averaging model predicts that as the expertise of a source increases, the response should asymptotically approach the scale value of that source's estimate. Note that for the buyer's point of view, when a very low-expertise source rates the car at $300, even a very high-expertise source reporting $650 cannot bring the mean judged value above $550. Although the range model approximates the shape of the data (dashed lines), it requires a revision to account for the data of Figure 9.

Confidence Intervals

The standard errors of the means for Experiment 5 were comparable with those of Experiments 1 and 2. Of the 483 standard errors, 37% were less than $6.00, 64% were less than $8.00, and 76% were less than $10.00. As in the other experiments, the size of the standard error correlates with the range of estimates. The point size in Figure 7 contains a fair-sized confidence interval; however, note that the ordinate scales in Figures 6, 8, and 9 are expanded, so that a point size does not necessarily contain a large confidence interval.

Model Analyses

Range model. The range model (Equation 6) was fit to the data by means of a computer program utilizing the STEPIT subroutine, designed to minimize the sum of squared data–model discrepancies over all 483 (161 × 3) cells in the experiment. Except for the configural-weight parameter, ω_P, the model is a form of scale-adjustment model (Model 2 of Figure 2).

The number of parameters required to estimate scale values was reduced by the simplifying assumption that the scale value of a biased source's estimate is an additive function of a scale value depending on the estimate alone and a bias parameter depending on the source's bias and the judge's point of view:

$$s_{EBP} = s_E + b_{BP}, \tag{9}$$

where s_{EBP} is the effective scale value for an estimate, E, provided by a source of bias, B, for a judge of point of view, P; s_E depends only on the estimate, and b_{BP} depends on the source's bias and the judge's point of view. The value of b_{BP} for the independent source in the fair price point of view was set at zero. Hence, scale values require the estimation of 17 parameters, 9 for the s_E and 8 $(3 \times 3 - 1)$ for b_{BP}.

Table 3 shows the values of bias adjustments for the scale values. The estimated scale values, s_E, for the independent source for the fair price condition were 322, 352, 410, 451, 511, 563, 620, 662, and 703, respectively, for the nine levels of estimate ranging from $300 to $700 in $50 increments. Table 3 shows that for the fair price condition, the scale values would be about $35 less if the estimate were provided by a friend of the seller or about $20 more if provided by a friend of the buyer. As one might expect, the absolute value of the bias adjustment is less when the source's bias matches the judge's point of view, as if the judge views a source of his or her own point of view as less biased.

To permit examination of how weights for different sources might depend on point of view, a different weight was estimated for each type of source in each point of view. Thus, 45 weights, w_{XBP}, were estimated for the 5 × 3 × 3, Expertise × Bias × Point of View combinations. The weight of the low-expertise independent in the fair price condition was set to 1.0, leaving 44 parameters to be estimated.

The least squares estimates of weights are shown in Table 4. The general pattern of weights in Experiment 5 is similar to that of Experiments 1–4. The ratio of the weight of high- to low-expertise independents for the fair price condition is 6.78, not far from the corresponding value of 6.98 for Experiments 1 and 2. The weights depend mostly on expertise, with the greatest weights being for independents of very high expertise. For the buyer's point of view, the buyer's weight exceeds that of the seller for all levels of expertise. For the seller's point of view, the friend of the seller receives greater weight than the corresponding buyer for the very high-expertise source. There is thus a very slight hint of support for the notion that biased sources receive relatively higher weight when the judge shares the source's bias, but the evidence does not seem decisive.

In addition, separate weights and scale values for the initial impression and separate values of ω_P, the configural weight parameter, were permitted for each point of view. These 9 parameters, plus 44 source's weights, plus 17 for scale values make a total of 70 parameters to be estimated to describe the data in Figures 6–9.

The estimated scale values of the initial impressions were 281, 308, and 413, with weights of .30, .15, and .24, for buyer's, fair, and seller's price, respectively. The values of the configural-weight parameter, ω_P, were −.194, −.066, and .055 for the buyer's price, fair price, and seller's price, respectively.

The predictions of this model are shown in Figures 6–9. The model is an extension of Model 2 of Figure 2, with only one elaboration—the configural-weight effect to allow for Estimate × Estimate interactions. Considering that only one additional parameter is used for each point of view, the range model gives a very good account of the data in Figure 6

Table 4
Estimated Weights of Sources for the Range Model

Source's bias	Expertise of source: Very low	Low	Medium	High	Very high
	Buyer's point of view				
Buyer	.91	.80	2.42	4.52	6.42
Independent	1.00	1.53	3.05	5.70	9.98
Seller	.76	.45	2.39	2.63	4.90
	Fair price point of view				
Buyer	.66	.77	1.40	3.22	4.89
Independent	.47	1.00	2.68	6.78	17.57
Seller	.43	.38	1.50	2.34	4.13
	Seller's point of view				
Buyer	.96	1.43	2.37	4.10	4.95
Independent	.75	1.22	2.62	5.44	10.20
Seller	.85	1.08	2.25	3.47	6.35

Note. Each entry is the least squares estimate of weight for each type of source under each condition. The weight of the low-expertise independent source in the fair price condition was set to 1.0. For example, the table shows that when the judge takes the seller's point of view, the very high-expertise friend of the seller has greater weight (6.35) than the very high-expertise friend of the buyer (4.95).

and a good account of the data of Figure 7. The root mean squared errors were 6.83 and 10.40 for Figures 6 and 7, respectively. The overall sum of squared deviations was 61,497 over 483 points, yielding a root mean squared deviation of 11.28. This value was 13.08, 10.23, and 10.30 for the buyer's, fair, and seller's price conditions, respectively.

The range model would have been a great success had the data of Figure 9 not been collected. When a very high-expertise, independent source gives an estimate of $300 and a very low-expertise independent source gives an estimate of $650, the mean judgment for the buyer's point of view is $342, compared with a prediction of $292, a deviation of about $50. The range model makes this extremely low prediction because the relative weight of the $650 estimate is so low in this case (.09) that when the negative value of ω_P(−.194) is added to it, the effective relative weight of the $650 estimate becomes negative. In other words, the best-fit value of ω_P for the entire experiment (including the data of Figures 6 and 7) is a poor value for the data of Figure 9.

To examine the effective relative weights, the right ordinate of Figure 9 has been labeled from 0 to 1. Since the scale values are approximately equal for the independent sources from different points of view, and since the weight of the initial impression is so small, the right-ordinate values can be read off to give the approximate relative weight of the $650 estimate for each point in Figure 9.

Revised configural-weight theory. The assumption of the range model that the configural change of weight is independent of relative weight appears inconsistent with the data of Figure 9. The model was revised to incorporate the principle that the amount of *decrease* in absolute weight is directly proportional to the absolute weight apart from the configural effect. Weight taken from one stimulus is given to another. Hence, if a source's estimate loses weight, it does so in proportion to its original weight; if a source's estimate gains weight, it does so in proportion to the weight of the other source's estimate. Thus, there is a conservation of absolute weight: The loss of one source is another source's gain.

The revised configural-weight model is a scale-adjustment model (Equations 4 & 9). It is distinguished from the range model (Equation 8) in that the configural change of weight operates on absolute rather than relative weight. The weights are given by the following equation:

$$w_{XBPE} = w_{XBP} + \omega_P \sigma_E \rho_{PE}, \qquad (10)$$

where w_{XBPE} is the effective absolute weight of an estimate; w_{XBP} is defined as in the range model; ω_P is the configural-weight parameter; $\sigma_E = 1$, if the estimate is the largest in the set, $\sigma_E = -1$ if it is the smallest, and $\sigma_E = 0$ otherwise. By definition, $\rho_{PE} = w_{XBP}$ if $\omega_P \sigma_E \leq 0$; otherwise, $\rho_{PE} = w_{X'B'P'}$, where $w_{X'B'P'}$ is the absolute weight of the other source. Thus, a source loses weight in proportion to its original value but increases by taking the weight lost by the other source.

This modified configural-weight model (Equations 4, 9, & 10) provides a great im-

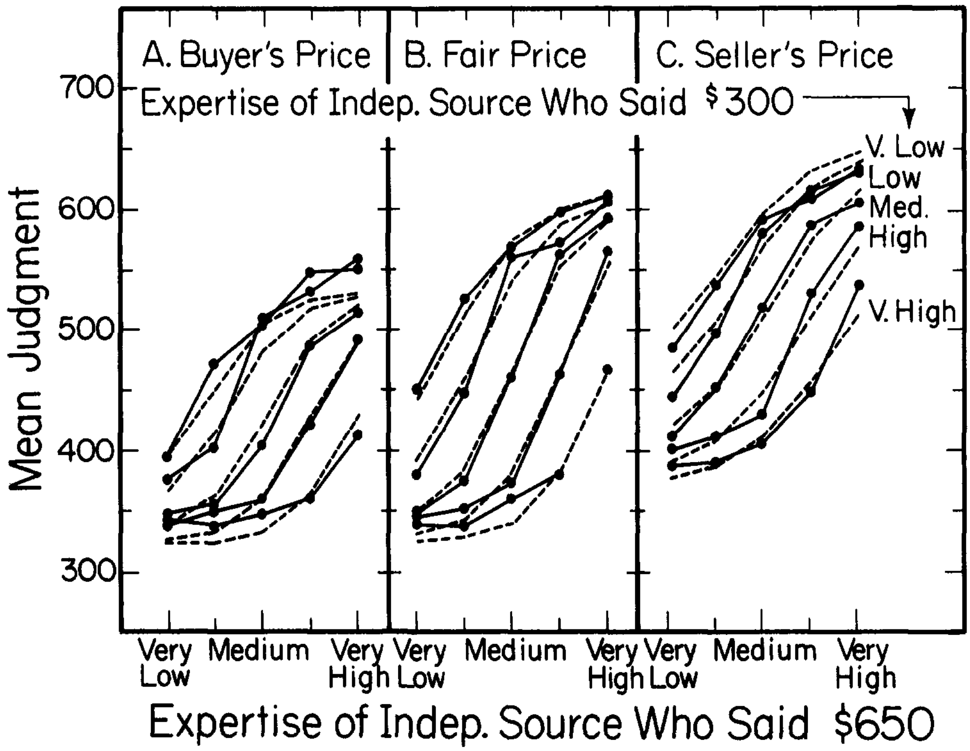

Figure 10. Data of Figure 9 with predictions (dashed curves) of revised configural-weight theory.

provement over the simple range model (Equations 4, 6, & 9), though it uses the same number of parameters. The total sum of squared deviations over all 483 cells was reduced from 61,497 to 48,333, yielding a root mean squared error of 10.00. The improvement in fit was greatest for the Expertise × Expertise design (Figure 9), where the root mean squared mistake was reduced from 17.24 to 13.09. The fit was also noticeably better for the Expertise × Bias design (Figure 8). Fit was about the same or slightly better in the other designs.

Figure 10 shows the fit of the improved configural-weight model to the Expertise × Expertise design. Solid points are empirical means; dashed curves represent predictions. As can be seen by comparing Figures 9 and 10, the revised configural-weight theory gives a superior description of these data, especially for the fair price point of view.

The estimated scale values and bias parameters of this configural model were similar to those of the range model. The pattern of estimated weights was also similar, except that the weights always increased with expertise for this model (an improvement), and the range of weights increased (especially for the independent sources). The values of ω_P were $-.385$, $-.155$, and .130 for the buyer's, fair, and seller's points of view, respectively. An extension of the configural-weight model is discussed in Appendix B.

Differential-weight theory. In differential-weight theory, the weight of a stimulus is permitted to depend on the estimate. For the present data, the weight would be required to depend on point of view as well. The most complex, scale-adjustment, differential-weight model allows an increment in weight to depend on three factors: bias, point of view, and estimate. There are 81 values of the weight increment, 9 of which (for the independent, fair price conditions) were set to 0, leaving 72 weight parameters to be estimated (69 more than the configural-weight model). Two versions were tried: In one version the added increment in weight was independent of w_{XBP}; in the other it was proportional to w_{XBP}. Scale adjustment was allowed, in accordance with Equation 9. Neither of these differential-weight models described the data of Figure 9 as well as the configural-weight model (Equation 10). The best-fitting differential-weight model can be written as follows:

$$w_{XBPE} = w_{XBP}(1 + \theta_{BPE}), \qquad (11)$$

where θ_{BPE} is the weight increment and w_{XBP} is defined as in Equation 10. The root mean squared deviations for the Expertise × Expertise design were 16.8, 16.9, and 14.3 for the buyer's, fair, and seller's price judgments, respectively, compared with 15.3, 10.6, and 12.9, respectively, for the modified configural-weight theory (Equation 10).

The differential-weight theory requires a relationship between the shape of the curves in Figure 9 and their approach to the scale values. The curves should "bow over" only as they asymptotically approach the scale values (Birnbaum, 1973; Riskey & Birnbaum, 1974). As can be seen from Figure 9, however, the curves bow over long before reaching the estimated scale values. For example, the highest point in Figure 9B was predicted to be $641 by the differential-weight averaging model, compared with $610 for the data and $608 for the prediction of the configural-weight model (Equation 10). This deviation from the averaging model is similar to that obtained by Birnbaum (1973) and by Riskey and Birnbaum (1974). Since the differential-weight model of Equation 11 uses nearly twice as many parameters yet fits the data of Figure 9 worse, configural-weight theory seems preferable.

Discussion

The purpose of this research is to examine theories of how judges (who may be biased) combine information from sources who vary in their ability to report the truth (expertise) and their motivation to distort it (bias). By representing these processes with mathematical models, it becomes possible to test experimentally among explicit theories of social judgment.

Experiments show that certain algebraic representations cannot account for the judgments. Additive and constant-weight averaging formulations have been tested and rejected in previous studies of information integration (T. Anderson & Birnbaum, 1976; Birnbaum, 1972, 1973, 1974, 1976; Birnbaum et al., 1976). The present data are in agreement with these previous studies in refuting additive and constant-weight averaging models in favor of some form of configural, relative-weight averaging model.

The present research goes beyond previous work to test three distinct forms of the relative-weight averaging model that attempt to explain the effects of the source's bias. In one, the effect of the source's expertise does not alter the effect of his or her bias; in another, expertise magnifies the effect of bias; in the third, expertise diminishes the effect of the source's bias. The data give a clear indication that the response-revision and weighted-bias models can be rejected. The retained model, scale-adjustment, which predicts that expertise will magnify the effects of bias, makes additional, independent predictions that are fulfilled by the data. By making these correct predictions, the status of the model as a representation of source effects is enhanced. The present research also extends the investigation to examine configural-weight theories of how the judge's point of view affects the weights and scale values of estimates from biased sources.

Source Bias and Expertise

The scale-adjustment model of Figure 2 (Model 2) correctly predicts that the source's expertise will amplify the effect of the source's bias, a prediction that was confirmed in all five experiments. The model does not imply that experts are necessarily *judged* to be more biased, only that the *effect* of bias will be greater for sources of greater expertise. It is as if the judge, hearing that the seller's friend provided an estimate of $500, thinks, "That means $470," before averaging the information, giving greater weight to the estimate provided by the source of greater expertise.

The weight of an estimate depends mostly on the source's expertise; however, weight also varies with bias. A consistent trend across all experiments is that the unbiased source (the independent) of high expertise tends to have greater weight than either biased source of the same expertise.

It is important to note that the effect of bias on weight and its effect on scale value can work in tandem or in opposition in any given instance. Perhaps this would explain the seeming contradictions in research on attitude change for the effects of source's trustworthiness, or bias (see McGuire, 1968). Bias is both a signed variable (plus or minus) in its effect on scale value and an *absolute* variable in its effect on weight. For example, a biased source (e.g., a scientist employed by a utility company using nuclear reactors) might produce larger attitude change in favor of his message than an unbiased source if he said, "Nuclear reactors are unsafe." On the other hand, the effect of this message on the impact of *other* messages (weight) might be less than that of an unbiased source of the same expertise who gave the same message.

The data are suggestive, but by no means conclusive, on two other weighting effects. First, a source may receive extra weight for making an estimate that would not be expected on the basis of his or her bias. Second, the weight of a biased source may be greater if the judge is of the same point of view as the source.

Judge's Point of View

The judge's point of view consistently affects the scale values and the value of the initial impression: The values tend to be lower for the buyer's point of view and higher for seller's point of view. Perhaps the buyer's and seller's price estimations reflect persuasive judgments, meant as the opening round for bargaining. Interestingly, the absolute value of the bias adjustments in the scale values are less when the source's bias matches the judge's point of view, as if the judge perceives a compatible source to be less biased.

The effects of point of view are best represented in Experiment 5, which used a within-subjects design. This experiment showed that the weight of the lower estimate is greater for the buyer's point of view and that the weight of the higher estimate is greater for the seller's point of view. The fair price judgments were intermediate, but showed the divergent interaction characteristic of the buyer's point of view. Similar divergence was also obtained for fair price judgments in Experiments 1 and

2 and by Birnbaum et al. (1976), who obtained fair price judgments. Perhaps undergraduates tend to identify with the consumer under the fair price condition.

A modified configural-weight theory (a simple extension of the range model) gives a good account of this change of weight across points of view. The configural-weight theory uses just one additional parameter, besides the basic structure of Model 2 of Figure 2, to represent the configural effect of point of view.

Comparison of Configural- and Differential-Weight Theories

In configural theories, stimulus parameters depend on the stimulus pattern. Hence, the *higher* or *lower* estimate receives extra weight in the seller's or buyer's point of view, respectively. On the other hand, differential-weight theories assume that weight depends on stimulus magnitude, a seemingly context-free theory. In actuality, differential-weight theory requires (implicitly) a contextual theory that assigns the weights as a function of the context of the entire distribution of weights and scale values presented. For the present study, $400 would be a low estimate, deserving of a large weight from the buyer's point of view.

In contrast, configural-weight theory would not declare a $400 estimate to be low, *except in comparison with the other estimate of the same car*—that is, except with respect to the *within-set context* (Birnbaum et al., 1971). Thus, $400 would be a low estimate if the other stimuli are greater, but it would be high if the other estimates were lower. It is the *relationships* among estimates of the same car that define the configural weights. Thus, configural-weight theory takes the implicit context theory of differential weighting and extends it explicitly to the immediate (within-set) context of stimuli presented on each trial.

Configural-weight theory can be represented by means of a fulcrum and balance analogue, as in Figure 2. The configural parameter, ω, represents the proportion of weight that, depending on the point of view, is taken from either the higher or lower stimulus and given to the other. Differential-weight theory can also be represented by the lever and fulcrum; however, each location on the lever has a different weight associated with it. In addition, differential weighting requires a complete remapping of weights to locations for each point of view, using many more parameters than the configural-weight models.

Differential weighting may be required for certain situations in which multidimensional social stimuli vary in both weight and scale value simultaneously (e.g., T. S. Anderson & Birnbaum, 1976). Differential weighting is an extremely powerful curve-fitting device, one that requires special experimental designs to test. When appropriate designs have been employed, differential-weight models have failed to account for the data (Birnbaum, 1973; Riskey & Birnbaum, 1974). Judgments of morality fail to show the compensatory effects predicted by nonconfigural averaging theories: Given that a person has committed a very bad deed, there appears to be no number of good deeds that will make the person's judged morality approach the same high asymptote as if the person had done only good deeds. Similarly, the data of Figure 9 suggest that from the buyer's point of view, if a low-expertise source says $300, no level of expertise of the $650 estimate will compensate to bring the judged value above $550. For the present interactions, the simple configural-weight models provide a more elegant, accurate, and theoretically appealing description of the interactions.

Concluding Comments

This research investigates information integration under conditions in which the relevant variables can be manipulated, and it attempts to discover principles that explain the results. The hope is that principles that apply in controlled experiments are characteristic of basic psychological processes that have applicability to a wide range of judgmental phenomena. Results of experiments in a large number of domains encourage the hope that a reasonably small set of premises may account for a large array of data. Previous research has shown that the same principles of source expertise can be applied to intuitive numerical predictions, ratings of likableness, and judgments of the value of used cars. We are currently investigating the generality of the principles of bias discovered here to see if they account for judgments of probable guilt in simulated court cases.

The present research suggests that a simple algebra can account for the complex effects of bias in information integration. Judgments can be represented by the center of gravity of a lever. Information can be represented by weights placed at various locations along the lever. The location, or scale value, of the information depends on the source's communication. This location is adjusted to account for the source's bias and the judge's point of view. The weight of a source's communication depends mostly on the source's expertise, but diminishes if the source is biased. In addition, judges appear to increment the weight of the communication most consistent with their own bias, or point of view.

Given these rules of operation, the lever is an analog computer, or model, that will reproduce the judgments obtained in these experiments. When a model can give a qualitative account of a variety of predictions, its plausibility is increased. It may then be used as a measuring device to study the effects of other variables on its parameters. With this Archimedian lever, a fulcrum, and a place to stand, we hope to raise our understanding of human judgment.

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Appendix A

An alternative to all three of the models of source bias presented in Figure 2 is a differential-weight model:

$$R = \frac{w_0 s_0 + ws + w_{XBE} s_E}{w_0 + w + w_{XBE}},$$

in which the weight of an estimate, w_{XBE}, depends on expertise, bias, and estimate, but the scale value is independent of bias. This model assumes that a high estimate provided by the buyer's friend receives greater weight then if the seller's friend had made the same estimate. Consequently, the judged worth would be greater for the buyer's high estimate than for the seller's. Similarly, a low estimate is assumed to receive greater weight if it is provided by the seller's friend than if provided by the buyer's friend; consequently, judged worth would still be greater for the buyer's than the seller's estimate.

This differential-weight model cannot describe the present data. It makes three incorrect predictions for effects that are correctly predicted by the scale-adjustment model. First, it predicts that if w_0/w_{XBE} is near zero, the effects of *both* bias and expertise should be very small in the source-estimate designs, where blue book value is not presented, since $w_{XBE}/(w_0 + w_{XBE}) \approx 1$. In contrast, Equation 3 predicts that the Expertise × Estimate interaction should be small but the effect of bias should be maximal, since if $w_0/w_X \approx 0$ for all w_X, then

$$\frac{w_X(s_E + b_B)}{w_0 + w_X} \approx s_E + b_B.$$

The data for the source-estimate designs (open circles in Figure 5) show a small Expertise × Estimate interaction and a large effect of bias. The average effect of bias is $76.6 in the source-estimate design of the fair price condition, compared with $46.6 when blue book value is also presented. The differential-weight model incorrectly predicts that the effect of bias should have been larger when blue book value is presented.

Second, the differential-weight model predicts that there exists some level of estimate for which bias has no effect, contrary to the data. Third, the differential-weight model predicts a complex four-way interaction between expertise, bias, estimate, and blue book value that did not materialize in the predicted form. Consequently, differential weighting alone cannot explain the effect of bias—scale adjustment appears to be necessary.

Appendix B

It seems intuitively reasonable that if a source gives an estimate that would not be expected on the basis of his bias and the other estimate, he might receive greater weight. For example, if a *friend of the seller* gave an estimate below the blue book value, his estimate might receive greater weight.

To investigate this hypothesis, the data of Experiment 5 were fit using the following equation:

$$w_{XBPE} = w_{XBP} + \omega_P \sigma_E \rho_{PE} + \alpha_{PB} \beta_B \sigma_E \delta_{PBE},$$

where w_{XBPE} is the absolute weight of an estimate, E, by a source of expertise, X, and bias, B, from a point of view, P; w_{XBP} is the configural free weight, as in Equation 10; α_{PB} is the estimated configural-weight parameter that expresses the magnitude of the expectancy-contrast effect; ω_P, σ_E, and ρ_{PE} are defined as in Equation 10; $\beta_B = -1$ if the source is a seller, $\beta_B = 0$ if the source is an independent, and $\beta_B = 1$ if the source is a buyer; $\delta_{PBE} = w_{XBE}$ if $\alpha_{PB}\beta_B\sigma_E \leq 0$, and otherwise δ_{PBE} equals the configural free weight of the other source.

The product $\beta_B\sigma_E$ will be positive when either (a) a buyer provides the higher estimate or (b) a seller provides the lower estimate—instances in which the source seems to deserve extra weight for doing the unexpected. It will be negative when either a buyer provides the lower estimate or a seller provides the higher (i.e., when the source's estimate is expected). Notice that δ_{PBE} and ρ_{PE} make a decrease in weight proportional to the weight to be decreased.

Figure 7A, Panel IB shows that when the buyer gives an estimate of $300, the effect of the independent's estimate is greater than predicted, as if the buyer lost weight. Figure 7A, Panel IS, shows that when the seller says $300, the effect of the independent is decreased relative to the predictions of the range model.

For the buyer's point of view, the α_{PB} weights for the buyer and seller are −.08 and .20, respectively; for the fair price point of view, the values are close to zero, −.04 and −.01, respectively; and for the seller's point of view, they are .05 and .11, respectively. Thus, it appears that for either biased point of view, the seller receives extra weight for making the lower estimate. The friend of the buyer receives additional weight for the seller's point of view when he provides the higher (unexpected) estimate; however, for the buyer's point of view, the buyer receives greater weight for providing the lower estimate. The near-zero values for the fair price condition may reflect the fact that the fit of Equation 10 was already quite good in that condition (see Figure 7B).

The expectancy weight modification reduces the overall sum-of-squares discrepancies from 48,333 to 44,267, an improvement of 8.4% over Equation 10. The root mean squared deviation was 9.57. Improvements were greatest for the Expertise × Expertise, Bias × Bias, and Expertise × Bias designs for the buyer's point of view.

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