Unfolding Theory

In: Unidimensional Scaling

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Unfolding Theory

The scaling methods discussed in the three previous chapters (Likert and Guttman scaling) have been widely applied throughout the social sciences. One can easily find hundreds of substantive applications of each of these methods. Not so with the scaling model to be discussed in this chapter. The unidimensional unfolding model, introduced by Coombs (1950, 1964), has found only limited applications in the social sciences, especially outside psychology. But its infrequent use, we would argue, is not an accurate indication of the potential contributions that the unfolding model can make to an understanding of social, political, as well as psychological phenomena. On the contrary, we believe that its potential role in the social sciences is substantial and that it has been only partially realized at the present time.

The purpose of this chapter is to outline the principal features of Coombs's unfolding model. In the process, we shall illustrate some possible uses of this scaling model in the social sciences. We shall focus primarily on the underlying logic of this method, paying less attention to a variety of issues that can arise in its actual application (for a more extended discussion see Coombs, 1964: 80–139).

The Basic Model

The unfolding model is based on the analysis of preferential choice data. This type of data, as we pointed out in Chapter 1, generally involves the ranking of stimuli from most to least preferred.[20] Each individual's preference ordering is called an *I scale.* For example, let us suppose a sample of voters has been asked to rank four presidential candidates—McGovern, Humphrey, Nixon, and Wallace—from most to least preferred. Letting M represent McGovern, H Humphrey, N Nixon, and W Wallace, the I scales for three hypothetical voters might be MHNW, WNHM, and NHWM. Thus, the first voter prefers McGovern to Humphrey, Nixon, and Wallace; Humphrey to Nixon and Wallace; and Nixon to Wallace. The other two voters have different preference orderings with the second voter most preferring Wallace and least preferring McGovern, while the third voter most prefers Nixon and least prefers McGovern.

The key question posed by the unidimensional unfolding model is whether there exists a common latent attribute—referred to as *J* (Joint) *scale*—underlying the different preference orderings of a set of individuals. Can both individuals and stimuli be represented in a unidimensional space such that the relative distances between them reflect the psychological proximity of the stimuli to the individuals? Alternatively stated—can the preferences of individuals, the various I scales, be consistent with a single J scale? If so, then it is reasonable to presume that individuals are employing a common criterion in evaluating the various stimuli.

If not, then two distinct possibilities exist. Perhaps individuals are responding to the stimuli in purely idiosyncratic ways. No common attributes underlie their perceptions. The other possibility is that individuals employ multiple criteria in their evaluation of the stimuli. Thus, voters might react to political candidates based on their party affiliation, ideological complexion, and personality makeup. In this case, individuals' preference orderings will *not* be compatible with a single dimension, but several underlying dimensions might provide a very adequate fit to the data. (For the development of the multidimensional unfolding model, see Bennett and Hays, 1960; Hays and Bennett, 1961; Green and Carmone, 1969).

Unfolding in a Single Dimension

The process of evaluating the consistency of the individual I scales with a common J scale is known as “unfolding” the I scales. “Unfolding” also describes geometric manipulation of each I scale from the respondent's ideal or preferred location on the J scale. This procedure is exactly comparable to the reverse process of being able to fold the J scale about the points representing the person's preferred position to form the individual's own preference ranking or I scale.

These processes are illustrated in Figure 2 (adapted from Dawes, 1972). The J scale is represented along the horizontal line. The I_1 and I_2 vertical lines represent two preference orders—the first given by DECBA, the second by CBADE. Can these preference orders be unfolded to form a single J scale? The arrows marked unfolding show how both I_1 and I_2 can be represented on the same J scale. This J scale maintains the essential integrity of the individual I scales in the sense that a particular stimulus is closer on the dimension to a given individual than a second stimulus if and only if it is preferred to the second. For example, examining Figure 2, we see that for I_1 stimulus C is preferred over Band that on the J dimension C is closer to I_1 than is B. Similarly, again referring to I_1, D is preferred in relation to C and on the J scale D is closer to I_1 than is C. This preference-distance relationship also holds for I_2. Therefore, both of these preference orderings can be unfolded on the same dimension.

Figure 2: How I Scales Are Unfolded To Form a J Scale and How a J Scale Is Folded To Form I Scales

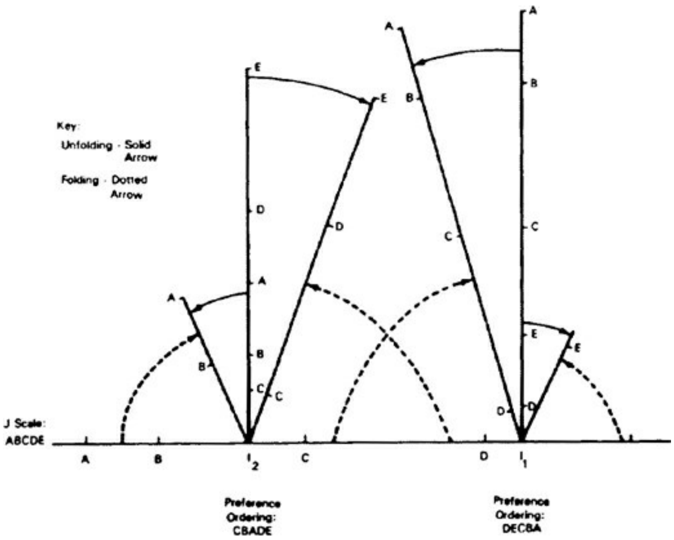


Figure 2 also illustrates how the J scale can be folded to reveal the preference orders represented by I_1 and I_2. When the J scale is folded about the ideal point representing the individual, the preference ordering may be read on the vertical scale from bottom to top. The dotted lines indicate how the J scale is folded to represent the individual I scales.

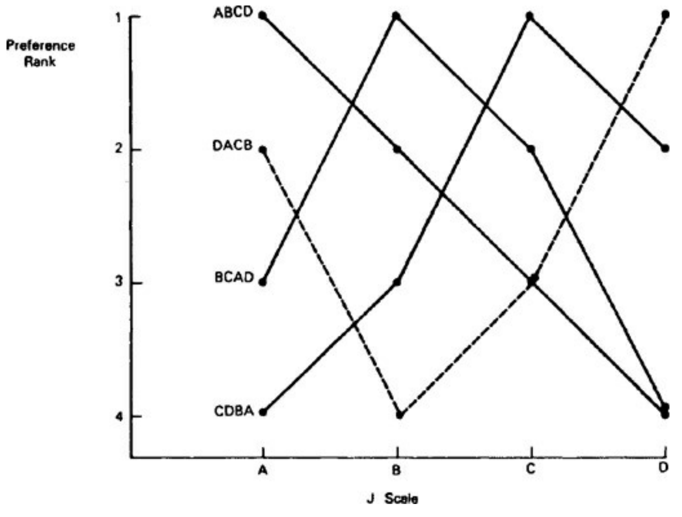
An alternative but equivalent way of demonstrating the compatibility of a set of I scales with a particular J scale is to see if each I scale can be represented as a single-peaked curve on a graph of preference rankings by the J scale. Single-peaked preference orderings imply that the more preferred a given stimulus, the closer it is to the individual's ideal position on the J scale. Conversely, the less preferred a given stimulus, the further away the stimulus is from the most preferred position. If each individual can be represented on the same J scale, we expect to see the preference functions of each decline monotonically from his or her ideal point. Figure 3 provides an example of three I scales, CDBA, ABCD, and BCAD, that are all consistent with a common J scale, ABCD. The I scale, DACB, cannot be unfolded on the J scale, ABCD. It also cannot be represented in Figure 3 as a single-peaked preference function. We can either conclude that the J scale that the other individuals share is not perceived by the person with preference ordering DACB or that this individual does not or is unable to accurately report his true preference rankings given a common J scale.

Above, we have shown how a set of individual I scales can be unfolded to form a common J scale (Figure 2). But we were only dealing with two I scales and so our task was quite simple. Given a large sample of I scales—that is, many individuals that have rank ordered multiple stimuli from most to least preferred—how can we determine whether the various preference orderings can unfold along a single dimension? Fortunately, Coombs (1964) has shown that a set of preference orderings must have certain properties for them to unfold into a common space.

An important distinction must be made initially between a *qualitative* J scale and a *quantitative* J scale. The former scale is simply an ordering of stimuli from one extreme to the other. A total of 2^{n-1} (where n is the number of stimuli) I scales will be consistent with any given qualitative J scale. Thus, a qualitative J scale of four stimuli will permit eight consistent individual preference orderings. As many as 16 I scales will be compatible with a five-stimuli qualitative J scale. A qualitative J scale is an ordinal scale, that is, we know the relative position of all stimuli on the scale, but not the distances between them.

It is possible, however, to extract additional information from rank order data. Not only do such data provide us with the necessary information to identify the relative position of all stimuli on a single scale but they also permit us to infer relative distances on this scale. Such a scale is known as a quantitative J scale. Some but not all of the distances between different pairs of stimuli on this type of scale may be ascertained (as we will demonstrate shortly). Because relative distances between stimuli are recovered, a quantitative J scale is often referred to as an "ordered metric" scale.

Figure 3: The Relationship Between I Scales and a Common J Scale: A Requirement of Single-Peaked Preferences



Each quantitative J scale will be composed of some subset of the I scales that are consistent with the same qualitative J scale. The particular subset of I scales that are offered by respondents identifies which distances are larger or smaller than others. Coombs (1964) lists the following four characteristics of a quantitative J scale:

(1)

The number of distinct 1 scales must be no more than $\binom{n}{2}$+ 1, where n is the number of stimuli.[21] Thus, for four stimuli, only seven I scales should be present.

(2)

The I scales must *end* in either the first or last stimulus of the J scale.

(3)

The set of I scales cannot include more than one pair of scales that are mirror images of each other. One of these I scales must begin with the first stimulus and end with the last, and the other must begin with the last stimulus and end with the first. They must be exact opposites of one another.

(4)

If a complete set of I scales fit the J scale, it must be possible to arrange the I scales such that movement from adjacent scales involves the reversal of an adjacent pair of stimuli.

Next, we examine a hypothetical example of how qualitative and quantitative J scales are related to their component I scales and to each other.

Let us return to the four-candidate example we used earlier. Furthermore, let us assume that the qualitative J scale that underlies voters' preferences for these candidates is a simple liberal-conservative continuum in which George McGovern (M) is the left wing candidate, Humphrey (H) and Nixon (N) are the centrist candidates with Humphrey perceived as the more liberal, and George Wallace (W) is the most conservative candidate. Given the known relationships between quantitative J scales and individual preference rankings, we can make some predictions about the set of voter I scales that will fit the J scale. With four candidates, no more than $\binom{4}{2}$ + 1 or seven I scales will be consistent with a given quantitative J scale. (2^{4-1} or 8 I scales will fit the qualitative J scale.) Second, each of the I scales observed should end with one of the extreme candidates, either M or W. We expect one pair of I scales that are mirror images of one another. If voters perceive these candidates to be located as we have suggested, then these two I scales should be opposites with one beginning with M and ending in W, while the second begins with W and concludes with M.

TABLE 15 presents two sets of I scales that meet all of the criteria enumerated above for a quantitative J scale, both of which are consistent with a common qualitative J scale. Four stimuli have been rank ordered by our hypothetical respondents. In this instance there are exactly seven distinct I scales in each quantitative J scale. That is, every entire set of I scales contain only two scales that are exact opposites of one another. I_1 begins with the first stimulus

M and ends with the last stimulus W; I_7 begins with the last stimulus W and ends with the first stimulus M. Moreover, their preference orderings are exact reversals of each other since I_1 is MHNW and I_7 is WNHM. Finally, notice that the remainder of the I scales (I_2 to I_6) are ordered in such a way that they satisfy the condition that an adjacent pair of stimuli is reversed in adjacent I scales. For example, I_1 and I_2 are exactly the same except that the pair MH in I, is reversed to HM in I_2. Similarly, I_5 and I_6 have the pair HW reversed in their preference orderings. In sum, the I scales given in Table 15 meet all of the criteria necessary to be represented in a common unidimensional space.

It is important to recognize that all of these conditions must be met for the various I scales to be represented perfectly by a common J scale. Thus, preferential choice data may fail to meet the unidimensional unfolding model for one or more of the following reasons. First, there may be more distinct preference orderings than can be represented on a single dimension. Earlier we noted that the total number of I scales that can be accommodated by a single quantitative J scale is given by the formula $\binom{n}{2} + 1$ where n is the number of stimuli. But n stimuli can be ordered in n! distinct ways.[22] For example, four stimuli can be ranked in 4! = (4) (3) (2) (1) = 24 nonredundant ways, although only seven will fit a common J scale. Five stimuli can be ranked in 5! = (5) (4) (3) (2) (1) = 120 different ways. But only $\binom{n}{2} + 1 = \binom{5}{2} + 1 = 5!/[(2!(5-2)!]|+ 1 =$ 11 of these preference orderings are possible *if they are to be represented on a single scale.* Thus, actual data may fail to meet the unfolding model because there may exist preference orderings that are not assumed by a specific J scale. Second, the I scales may not end in either the first or last stimulus. Instead, an I scale may end with a “middle” stimulus. Third, the set of I scales may include more than one pair of scales that are mirror images of each other. Appearance of two or more pairs of scales that are mirror images may suggest a multidimensional preference structure. Fourth, it may be impossible to order the I scales in such a way that adjacent scales involve the reversal of an adjacent pair of stimuli. (This assumes condition 1 has not been violated, that is, that there are at most $\binom{n}{2} + 11$ scales.) If *any* of these conditions exist, then the set of I scales cannot be unfolded to form a single J scale. That is, no common J scale can be formed such that the relative distances between the points reflect the proximity of the stimuli to each individual's ideal point. One or more individual preference orderings cannot be represented on the J scale.

TABLE 15 A Set of I Scales and Their Common J Scales

I Scale Number	Qualitative J Scales (MHNW)	Quantitative J Scales (MHNW)	
		I	II
1	MHNW	MHNW	MHNW
2	HMNW	HMNW	HMNW
3	HNMW	HNMW	HNMW
4	NHMW–HNWM	NHMW	HNWM
5	NHWM	NHWM	NHWM
6	NWHM	NWHM	NWHM
7	WNHM	WNHM	WNHM

I Scales that Do Not Fit Either Quantitative J Scale:

MNHW	HNWM	HMWN	WNMH
WHNM	NWMH	WMNH	MWNH
NMWH	WMHN	MWHN	WHMN
NMHW	MHWN	HWMN	MNWH

Key: M = McGovern, H = Humphrey, N = Nixon, W = Wallace

As we have previously pointed out, Table 15 contains two sets of seven I scales that can be unfolded to form a single quantitative J scale. That is, these I scales meet each of the four conditions imposed by the unfolding model. Any other preference ordering cannot be represented on this scale because it would violate one or more of the four rules implied by the unidimensional unfolding model. To convince yourself that this is the case, select a preference ordering not included in the MHNW scale in Table 15 and try to unfold it on the already established J scale. No matter which I scale is chosen, the result is the same: It cannot be represented on the J scale.

Metric Information from Ordinal Data

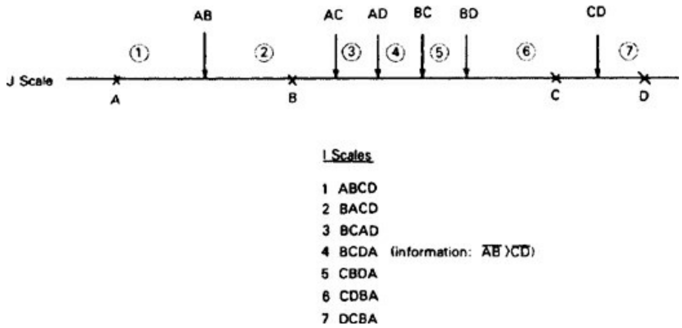
Unfolding can provide more information than simply the relative position of the stimuli on a single dimension. Provided we are considering more than *three* stimuli, additional information about the relative distances between stimuli can be ascertained. The more stimuli, the more pieces of information about distances on the J scale can be deduced. With a four-item scale, we can determine if the distance between the two stimuli on the left end of the J scale is greater than the distance between the two stimuli on the right end. With five stimuli we can determine four more distances. In general, it is possible to get (3) pieces of information on distances from a set of n stimuli (Torgerson, 1958), that is, we get an additional piece of information for every subset of four stimuli.[23] (Some of this information, however, will be redundant.) Because this information about distances between stimuli can be extracted from the ordinal data, the J scale is often referred to as an “ordered-metric” scale.[24]

How do we determine distances between stimuli by the unfolding method? First, we assume that distance on the J scale is a linear function of intensity of preference or, alternatively, that the midpoint between two stimuli on the J scale is the point of equality of preference for either.

Next we simply observe which I scales are manifest by our respondents. The presence of certain 1 scales and the absence of others identifies the location of the midpoints between stimuli and consequently the relative distances between pairs of stimuli. This may be illustrated with Figures 4 and 5.

Figure 4 is the four-item J scale, ABCD, onto which we have superimposed the midpoints between each pair of stimuli (denoted by the arrows). These six midpoints cut the J scale into seven sections, each one associated with a particular preference ranking. These I scales are listed beneath the J scale.

Figure 4: A Four-Stimuli Quantitative J Scale and Its Associated I Scales

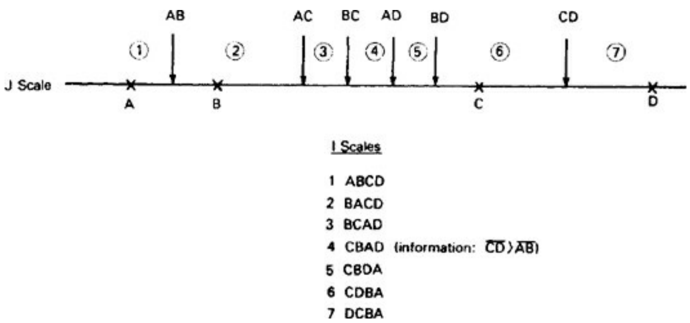


As noted in Figure 4, if these seven I scales are observed, we can deduce that the distance between A and B is greater than the distance between C and D. How? The key is the fourth I scale, BCDA. If observed, it indicates that the midpoint AD is to the left of the midpoint BC. Since B and C are by definition equidistant from the midpoint of the line connecting them, the fact that the midpoint AD is to the left of the BC midpoint indicates that A is farther from B than D is from C. If the segments $\overline{AB}$ and $\overline{CD}$ were equal, the midpoints BC and AD would fall at the same point on the J scale. If, however, $\overline{CD}$ is greater than $\overline{AB}$, the midpoint AD will fall to the right of the BC midpoint as it does in Figure 5.[25] In this case, however, the fourth I scale is CBAD rather than BCDA. All other I scales in Figures 4 and 5 are identical. Thus, in a four-item J scale the middle I scale provides information on the relative distances between the two extreme pairs of stimuli. In empirical situations, however, things are never so straightforward. Often both middle I scales, BCDA and CBAD, will be observed. Distances are usually inferred from the relative frequency of these two preference orderings.

Goodness-of-Fit Criteria

A major problem with unidimensional unfolding theory as we have presented it here is the lack of specific goodness-of-fit criteria such as the coefficients of reproducibility and scalability associated with Guttman scaling or the reliability estimates appropriate to summative scales. As a deterministic model, any I scale that does not fit the J scale is sufficient evidence to permit rejection of the hypothesis of unidimensional structure in a set of individual preference rankings. This is, of course, a problem for all deterministic models, such as Guttman scaling. What is required is recognition of the pervasiveness of measurement errors and some set of guidelines to judge the extent of these errors and their consequences on the model. Unfortunately, we have only a rudimentary understanding of the prevalence of error in preference data and its influence on the identification of a common qualitative and quantitative J scale.

Figure 5: A Second Four-Stimuli Quantitative J Scale and Its I Scales



General suggestions for evaluating the quality of J scales have been offered. Most obvious perhaps is that the common J scale be dominant, that is, it should be compatible with a greater number of I scales than any other possible J scale. Niemi (1969) points out that given n alternatives, the *minimum* proportion of I scales that must satisfy a common (qualitative) J scale is $2^{n-1}/n!$ Thus, for three stimuli we know that at least two-thirds of the 1 scales must fit a common J scale. The value of this criterion as a lower bound, however, seems to diminish rapidly. For n = 4, one-third of all individual preference orderings will fit a J scale. For n = 6, only about 4% need fit a common scale.

Several standards have been suggested for ordered-metric J scales. According to Goldberg and Coombs (1963), the fit of 50% + 1 of the set of I scales to a common quantitative J scale is a passable criterion for unidimensionality. Lord and Wilkin (1974: 54–55), however, argue that any such criterion must take into account the number of stimuli in the scale. Based on simulations, they suggest that 50% is an acceptable criterion for five stimuli and 30% is adequate for six stimuli. With a large number of stimuli, measurement error may preclude identification of a dominant quantitative J scale. But, in the presence of error-laden data, the fit of only a small number of I scales to a J scale may be enough to infer the existence of preferences constrained by a common unidimensional structure. Alternatively, if only a limited number of I scales are consistent with any single J scale, a multidimensional preference structure may underlie individual responses.

The above discussion has hinted at a conclusion that can now be stated explicitly. The assumptions underlying the deterministic unidimensional unfolding model are sufficiently stringent that it is quite rare to find actual data that meet them. When preference data do meet the assumptions, then, as we have seen, the technique allows the researcher to represent respondents and stimuli *jointly* in a unidimensional space in such a way that the relative distances between the points reflect the psychological proximity of the stimuli to the individual's ideal point. The different preference orderings of individuals can be represented on a common scale.

But what conclusions can be drawn if the more typical situation exists—a situation in which one or more of the assumptions underlying the model are violated thereby preventing the I scales from being fitted on a single J scale? Does the analysis provide any useful information in this situation? Fortunately, the unfolding model, as we will see below, allows the researcher to draw some useful conclusions even when analyzing an “imperfectly” ordered set of preference data.

An Example—Measuring Cosmopolitanism

As an example of the use of the unidimensional unfolding model to analyze preferential choice data, we discuss some of the results presented in M. Kent Jennings's (1967) article, “Pre-Adult Orientations to Multiple Levels of Government.” In his article Jennings is concerned with the differential interest that high school seniors have in various levels of government—international, national, state, and local—and the extent to which variation in the perceived salience of these political spheres is related to a variety of other political orientations (e.g., knowledge, discourse, and politicization).

Through a series of questions, Jennings is able to ascertain his respondents' rankings of their interest in each of these four political units. Twenty-four possible I scales can be represented by four stimuli, but as we have seen, only seven of these preference orderings can be unfolded to form a single J scale. Based on prior research and theorizing, Jennings expects the seven relevant I scales to be those presented in Table 16. These I scales conform to a basic geopolitical or cosmopolitan ordering with the international-national-state-local order (INSL) and its converse (LSNI) representing the polar types. The interior scales are constructed so that they meet the two other fundamental requirements presumed by the unfolding model—that the I scales end in either the first or last stimulus and that movement from adjacent scales involves the reversal of an adjacent pair of stimuli.

TABLE 16 A Unidimensional Unfolding Scale of Multiple Levels of Government

Scale No.	I Scale	% Fitting I Scale
1	INSL	20.6
2	NISL	14.6
3	NSIL	5.1
4	NSLI - SNIL	4.2 - 1.8
5	SNLI	1.4
6	SLNI	1.8
7	LSNI	3.4
		52.9%
		(N = 1,837)

SOURCE: Adapted from Jennings, 1967: 297.
I = International Affairs, N = National Affairs, S = State Affairs, L = Local Affairs.

Jennings finds that the I scales of 53% of his respondents can be represented on this common J scale. That is, slightly more than a majority of these high school seniors have a preference ordering represented in Table 16. Respondents having nonscalable preference orderings were assigned the scale type that most closely approximated their I scale. For example, those individuals with 1 scales INLS and NILS were assigned to the original 1 scale NISL.[26] Similarly, I scales LSIN and SLIN were assigned to the scale type SLNI. By following this procedure, Jennings is able to assign scale types to nonscalar patterns that involve the least violation of the derived unidimensional solution.

Having assigned the high school seniors to their appropriate scalar type, he then relates their rankings on this cosmopolitanism scale to a variety of cognitive, behavioral, and affective orientations. Not surprisingly, he finds that students who are more cosmopolitan in orientation are more knowledgeable about and interested in world affairs, more tolerant of social and political diversity, and more trustful of higher level governmental systems.

Jennings's article demonstrates four important points about applications of the unfolding method. First, as we have pointed out earlier, it is indeed rare to find preferential choice data that only vary along a single underlying continuum. Jennings's results are not atypical—the discovery of a dominant J scale that can accommodate a significant proportion of the I scales, but with some preference orderings that cannot be represented in the unidimensional space. Substantively, this evidence indicates that not all of the subjects are viewing the stimuli from the same perspective. Instead, it is obvious, as Jennings observes, that “a number of variables other than the geopolitical space encompassed may reasonably impinge upon the differential saliency of the four system levels” (Jennings, 1967: 299). Second, Jennings's analysis shows that the model is not rendered useless in the face of a set of less than perfectly ordered data. On the contrary, the requirements imposed by the model can be used as a guide to assign scale types to the nonscalar patterns. Third, this example illustrates again the importance of theoretical guidance of research questions.[27] Jennings chose to investigate a particular J scale that met his expectations concerning the salience of levels of government. A substantial number of his students fit the cosmopolitanism scale, and it demonstrated predictive validity when correlated with other political variables. This does not mean Jennings necessarily reported the "best" scale that might be constructed from his data. A considerably greater number of students fit two other J scales: 66% fit an NLIS J scale while 65% fit an LNIS scale. Yet neither J scale has the intuitive interpretation of the cosmopolitan scale that Jennings reported. Finally, we have seen that since the unfolding method is used to scale people as well as stimuli, the derived scale scores can be related to other measures of interest.

Trust in Government: A Second Example

In 1976, the Center for Political Studies at the University of Michigan, as part of their election year national survey, asked respondents to rank their trust in the various institutions of our national government—the President (P), the Congress (C), and the Supreme Court (S).[28] In Table 17 we present the possible I scales and the frequency with which the survey respondents ascribed to each.

What J scale might underlie the preferences of the respondents? With three stimuli, three J scales are possible. Each has a legitimate interpretation in light of the reference to institutional trust. The scale CSP/PSC suggests trust may be perceived to be a function of size of organization. Alternatively, trust may be a function of the possibility of electoral accountability. In this case we might observe scale PCS/SCP. Finally, trust could be a function of past performance or accessibility. The dominance of J scale CPS/SPC might indicate the growth of diffuse support with the preservation of minority of majority rights by each institution. Lacking sufficient cause to prefer one hypothesis over another, we submit all three to the data.

TABLE 17 Trust in Government, 1976

CSP	245
CPS	265
SCP	380
SPC	354
PCS	263
PSC	232
	N = 1,739

All Possible J Scales

Size (CSP)	Electoral Accountability (PCS)	Representativeness/Support for Equal Rights (CPS/SPC)
CSP	PCS	CPS
SCP	CPS	PCS
SPC	CSP	PSC
PSC	SCP	SPC
1,211/1,739	1,153/1,739	1,114/1,739
70%	66%	64%

The bottom half of Table 17 describes each of the J scales and the proportion of the sample that fits each. For three stimuli, there must exist a common J scale that fits at least two-thirds of the respondents (see above). While no J scale performs much better than the others, only one, the CSP/PSC scale, fits a greater than minimum proportion of the sample; that is, 70% of the respondents fit this J scale. Acceptance of the hypothesis that trust is a function of the size of government institutions requires corroborating evidence, but is suggested by our unfolding analysis.

Conclusion

The purpose of this chapter has been to provide an introduction to the unfolding model in a single dimension, paying particular attention to the logic underlying this scaling method. The unidimensional unfolding model attempts to scale both stimuli and individuals so that the preference orderings among various individuals is consistent with the placement of those individuals on a common continuum. The psycnological proximity of the stimuli to the individuals, as revealed by the ranking of their preferences, is reflected in the relative distances between the points in the unidimensional space.

What does it mean if a set of 1 scales can be unfolded along a single dimension? Logically, this implies that a particular stimulus is closer on the J scale to a given individual than is another stimulus if and only if it is more proximal psychologically. This property allows the researcher to represent the various preference orderings in a unidimensional space. Substantively, a perfect unfolding scale suggests that “the preferences were generated by people having different ideals but viewing the stimuli in a similar manner” (Dawes, 1972: 67). In other words, they evaluate the stimuli differently (as revealed by their different preference orderings), but their differences are constrained in such a way that they lie along the same dimension (as revealed by the existence of a common J scale). Voters, for example, may evaluate candidates differently depending on the political ideologies they represent, but as long as ideology is the sole criterion used in their judgmental process, then their preferences can be represented in a unidimensional space.

Conversely, if a set of I scales *cannot* be unfolded in a common dimension, not only do their preferences differ but they also do not share a common frame of reference for their preferences. In other words, they are not viewing the stimuli along the same dimension. Instead, they are focusing on different attributes of the phenomena in question. To refer to our earlier example, voters may be reacting to the candidates not only on the basis of a common political ideology but also in terms of perceived personal attributes and professional qualifications.

As we pointed out at the beginning of this chapter, unidimensional unfolding has been infrequently used in the social sciences. This is not to say it has been proved useless in empirical research. As we have illustrated in this chapter, unfolding has been put to important use by political scientists. Niemi (1969) provides an important link between this empirically based model of preferential choice and theories of voting. Weisberg (1972) and Karns (1972) have examined congressional voting behavior using a “proximity” model, a relative of the unfolding model developed for use with dichotomous choice data.[29]

Unfolding has also been used by psychologists, sociologists, and economists. Coombs (1950, 1964) demonstrates the applicability of unfolding theory to the study of gambling and the prediction of grade expectations. Goldberg and Coombs (1962) analyze the child bearing of Detroit women with respect to their preferences for an ideal family size. Unfolding has proved useful in advertising and marketing research (Taylor, 1969). Runkel (1956) displays the relevance of this method for communication research. Israel (1959) analyzes intragroup pressure from the perspective of unfolding theory.

Beyond these examples, however, unfolding is rarely found in the social science literatures. Collection of data may be one problem. Rating or pick methods are much simpler collection procedures than the ranking methods required by the unfolding model. Perhaps the failure of researchers to find dominant J scales when rank-order data are collected is one reason for lack of examples in the literature. The lack of a goodness-of-fit measure is also troublesome. Ability to estimate scale reliabilities, an attractive feature of the summative scaling, is underdeveloped for unfolding analysis. Finally, the methodology gets very unwieldy beyond five stimuli. The lack of widely available computer software to assist analyses of order data may present some barriers to use of the model. We hope these problems will be alleviated as the methodology becomes more widely recognized.

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