MEASURING DISAGREEMENT IN GROUPS FACING LIMITED-CHOICE PROBLEMS [1]

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Abstract

Agreement is an important concept in group interaction, both for computer-mediated and face-to-face groups. This paper presents a measure of disagreement, **D**, *for groups facing limited-choice problems, based on the average pair-wise separations between group member responses. It allows a meaningful disagreement value to be assigned to any group response pattern. The same logic also provides an individual level measure,* **d,** *giving the disagreement of individuals within the group. The properties of this measure are explored and found to be similar to those expected of a measure of disagreement. For nominal data, such as produced by questionnaire responses,* **D** *offers a standard scale of disagreement from 0 to 1 for any size group facing any number of mutually exclusive choices. The measures can be inverted to show agreement, although this does not necessarily predict group coalescence, as polarized groups can also contain considerable agreement. The measure can be extended to ranked, interval and ratio scale solution choices. In this case* **D** *is equal to twice the variance of the solution scores. The existence of an equivalent measure of ecological diversity further suggests the possibility of a generalized concept of dispersion. An example application is given, illustrating how disagreement at both the individual and group levels can be meaningfully and usefully represented by* **d** *and* **D**.

Keywords

Disagreement, consensus, agreement, computer-mediated groups, decisions, normative influence, CMC, GSS, CSCW

Introduction

Forty years ago Asch presented subjects with a simple perceptual task of choosing the longest of two lines, a task they completed correctly over 99% of the time when acting alone. However when responding to the same task in a group, after six other group members had chosen the clearly shorter line as longer, 76% of subjects went along with the group for

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at least one of six trials. A powerful force of social influence seemed to be operating to generate group consensus or unanimity. To disagree with a group seemed very difficult, so the effect was called conformity. While some effect was always expected, what was surprising was its strength in the face of unequivocal sensory evidence. Conformity research suggests a group process whose effect is to create common behavior among group members. Sherif illustrated this with the autokinetic effect, a visual illusion in which a stationary point of light appears to move when viewed in total darkness (Sherif, 1936). When people viewed such lights alone, each arrived at stable (but different) estimates of how the light moved. When they viewed it publicly in a group, their divergent estimates converged until they closely resembled each other. The same process seems to cause the dropping of idiosyncratic behavior in groups. For example, speech samples of five person groups over four months showed idiosyncrasies of metaphor usage gradually disappeared, until at the final meeting a single category of metaphor (visual) dominated (Owen, 1985). This generation of common behavior, or reduction of individualistic behavior, was interpreted as the creation by the group of its sense of "we-ness", or identity. Agreement has thus long been recognized as an important concept for groups (Maier, 1963). Studies of computer-supported groups also often investigate agreement or consensus (Mejias, Shepherd, Vogel, & Lazaneo, 1997; Watson, DeSanctis, & Poole, 1988, Sep), though here consensus can be used to mean majority as well as unanimous agreement. (Winniford, 1991). A recent review found 67 studies of computer-support used consensus as a dependent variable, but concluded "It is obvious that the relative lack of ability to reach consensus is a problem for groups using GSS." (Fjermestad & Hiltz, 1999). This matches earlier reviews, which found that while computer support may improve task performance, it often reduces or has no effect on agreement (McGrath & Hollingshead, 1991; McLeod, 1992). A comparison of face-to-face (FTF) and computer-mediated communication (CMC) groups for both preferential and intellective tasks found no differences in solution quality, but only one of eight CMC groups reached consensus, while seven of eight FTF groups did so (Adrianson & Hjelmquist, 1991). While the argument continues over what causes group members to adopt common behavior (Andrews, 1992), agreement is clearly an important concept for computer-supported as well as FTF groups. This paper analyses the meaning and measurement of that concept.

Definition

Webster's dictionary defines agreement as the state of being in accord (Marckwardt, Cassidy, & McMillan, 1992). It can be conceived as sameness of behavior, for example a herd or flock that moves together (in the same way) can be said to be in accord, or to agree. Without some "conformity" in a herd, its members would wander apart, and the herd would cease to exist as a unit. Humans are also group based beings, but with intellectual advancement. Even so, agreement can equally be conceived to occur intellectually as well as physically, and when people adopt a common intellectual position, they are said to agree on that topic. In the case where subject's responses are limited to a fixed set of choices, say buy, hold or sell, such positions are clearly defined. Communications between individuals in a group, whether CMC or FTF, can imply a choice, or position, as in the statement "I think we should sell!". Alternatively subjects may be given a fixed set of response options, as in a multi-choice questionnaire. In either case, when two individuals choose the same position, we say they agree, and when they choose a different position, we say they disagree.

A simple way to measure agreement is in terms of *commonality*, or the number of people who choose the most common option (Lorge, Fox, Davitz, & Brenner, 1958, p364). This however only uses the responses of those who chose the common option, and ignores any variation among those who did not. Another method is to instruct the group to reach *consensus* or unanimity, and then calculate the percentage of unanimous groups (Sniezek, 1992). This also ignores data, namely the varying degrees of agreement possible in groups who achieve less than complete unanimity. Recent experiments with electronic groups have used a more sensitive measure of group agreement (Sambamurthy & Chin, 1994; Tan, Wei, & Krishnamurthy, 1991; Watson et al., 1988, Sep), derived from the mathematics of fuzzy set theory (Spillman, Spillman, & Bezdek, 1980), and calculated by computer program. However this method only works with interval data, not nominal or ordinal data, such as often produced in the limited-choice case (Tan, Teo, & Wei, 1995). It also requires the data from the group to be in the form of probabilities of voting for the various options.

Term	Meaning
N	Number of group members.
K	Number of response options.
A,B,C,..	Different response options.
f_j	Number who chose the *jth* option.
$\mathbf{d_{ij}}$	Disagreement between persons choosing option *i* and option *j*.
$\mathbf{d_i}$	Average disagreement of individual choosing option *i* with the rest of the group.
D	Average of individual disagreements over the entire group.

Table 1. Definition of terms

The measure proposed in this paper is based on the actual response pattern of the group, and can be applied to interval, ordinal and nominal data. It is based on *regarding the disagreement between the response positions of two group members relative to some issue as the distance apart of their positions on that issue.* Naturally two people may disagree on one issue but not on another. It is not a measure of agreement because it was conceptually difficult to regard the distance between two positions as “distance together”, although an inverse can be calculated for the nominal case. The situation under consideration is where N group members ($N > 1$) face a situation with K mutually exclusive response options ($K > 0$. e.g. options A, B, C, ...). See Table 1 for definitions of our basic terms. For a nominal data choice, such as selecting a color, if two people choose different colors we can define their disagreement ($\mathbf{d_{ij}}$) as one, and as zero if they choose the same color:

$$\mathbf{d_{ij}} = 1 \text{ if } i \# j, \quad \text{else } \mathbf{d_{ij}} = 0$$

From this simple concept, a measure of group disagreement can be derived. The disagreement between one person who chooses option i and the rest of the group ($\mathbf{d_i}$) can be defined as the sum of the disagreements between that person and each of the other group members, divided by the possible number of relationships:

$$\mathbf{d_i} = \frac{1}{(N-1)} \sum_{1 \le j \le K} \mathbf{d_{ij}} \, f_j$$

where f_j is the number of people who chose option j. If all participants choose the same option, then $\mathbf{d_i} = 0$ (no disagreement), whereas if everyone chooses a different option then $\mathbf{d_i} = 1$ (maximum disagreement). If N_i group members choose option i, then the disagreement of one individual choosing option i is the number of disagreements they have with the rest of the group ($N - N_i$), divided by the number possible disagreements ($N - 1$), so:

$$\mathbf{d_i} = \frac{N - N_i}{N - 1}$$

Table 2 shows how individual disagreement can be measured for a group of five members (N=5) given four solution choices, namely A, B, C and D. Individual disagreement is the number of others who disagree with them, divided by the maximum number of disagreements. For this nominal case, the maximum value is 1, so an inverse can be calculated: **a = 1 – d**, reflecting the relative number of pair-wise agreements.

The disagreement for the group (**D**) can be obtained by averaging the disagreements of its members:

$$\mathbf{D} = \frac{1}{N} \sum_{1 \le i \le K} f_i \, \mathbf{d_i}$$

$$= \frac{1}{N.(N-1)} \sum_{1 \le i \le K} \sum_{1 \le j \le K} \mathbf{d_{ij}} \, f_j \, f_i$$

Individual	Rest of group	d	a
A	AAAA	0.0	1.0
A	AAAB	0.25	0.75
A	AACD	0.5	0.5
A	ABBC	0.75	0.25
A	BCCD	1.0	0.0
A	BBBB	1.0	0.0

Table 2. Individual disagreement (d) for N=5 and K=4

The minimum value of **D** is 0, when all members of the group agree. For nominal data, **D** becomes:

$$\mathbf{D} = \frac{\sum_{1 \le i \le K} N_i \, \mathbf{d_i}}{\sum_{1 \le i \le K} N_i} = \frac{N^2 - \sum N_i^2}{N^2 - N}$$

where $N = \sum_{1 \le i \le K} N_i$

Table 3 shows an example of possible group disagreement (**D**) values. The maximum **D** value of 1.0 (everyone disagrees) is not possible when there are five group members but only four choices. The line indicates where the group moves from majority agreement to being unable to make a majority decision.

Group response	Example	D	A
Unanimous	AAAAA	0.0	1.0
All but one	AAAAB	0.4	0.6
3-2 split	AAABB	0.6	0.4
3-2 majority	AAABC	0.7	0.3
Hung group	AABBC	0.8	0.2
Maximum disagreement	AABCD	0.9	0.1

Table 3. Group disagreement (D) for N=5 and K=4

Again, for nominal choices, the maximum is 1, and so an inverse measure of agreement can be calculated, **A = 1 – D**. This can be compared to the use of the index of the actual number of mutual friendships in a group divided by the number of possible mutual friendships as “one of the best indicators of a group’s cohesion” (Dimock, 1986, p123), although here what is being considered is pair-wise agreement between positions, not friendships.

The advantages **D** and **d** as measures of group and individual disagreement are they are:

1. *Simple***.** They can be calculated manually for small groups.
2. *Sensitive*. For example, a group response of *AAABC* (**D** = 0.7) shows more disagreement than a group response of *AAABB* (**D** = 0.6).
3. *Valid***.** They derive from a definition of the disagreement between two individuals which is meaningful in terms of what is normally understood to be disagreement.
4. *Scaled***.** For nominal data, they offer a fixed scale, from 0 (unanimity) to 1 (everyone disagrees), regardless of group size and number of choices.

5. *Adaptable***.** Disagreement can be measured at both the group (**D**) and individual level (**d**), depending on the research unit of measurement.

In addition, for nominal data, inverse measures of agreement are available, and may be found more meaningful.

Maximum value of D

The maximum disagreement of 1.0 only occurs if the number of group members is less than, or equal to, the number of choices ($N \leq K$). If the number of group members is greater than the number of choices ($N > K$), it is not possible for everyone to disagree, and the maximum **D** is less than 1. Table 4. shows how the maximum value of **D** reduces from 1.0, as the group size increases, for selected vales of *K*.

Group size	Number of Options			
	K = 2	K = 3	K = 5	K = 10
2	1.000	1.000	1.000	1.000
3	0.667	1.000	1.000	1.000
5	0.600	0.800	1.000	1.000
10	0.556	0.733	0.889	1.000
100	0.505	0.673	0.808	0.909
1,000	0.501	0.667	0.801	0.901

Table 4. Maximum D by increasing N for various K

The maximum **D** occurs when the group is spread as evenly as possible over all *K* options. Suppose *r* is the integral quotient and *a* is the remainder when *N* is divided by *K*, so that $N = rK + a$. Then **D** will be maximized when all the N_i values are as close to *r* as possible. Thus let $N_i = r$ for $i = 1, 2, \dots K - a$ and $N_i = r + 1$, for $i = K - a + 1, \dots. K$. Then the maximum value of **D** will be:

$$\mathbf{D}_{max} = \frac{N^2 - (K-a)r^2 - a(r+1)^2}{N^2 - N}$$

If $N \leq K$ then obviously $\mathbf{D}_{max} = 1$, however if $N > K$ then the maximum **D** is less than 1. In general, as *N* gets very large, $\mathbf{D}_{max}$ tends towards $1 - 1/K$. For example in the case where there are two solution choices ($K = 2$), as *N* becomes very large, $\mathbf{D}_{max}$ tends to 0.5.

Other measure properties

When a group of five moves from consensus to one person disagreeing, the dissenting individual's disagreement changes from **d** = *0.0* to a maximum of **d** = *1.0* (Table 2). This seems to reflect the nature of the situation. Any group member who breaks group unanimity moves from disagreeing with no-one to disagreeing with everyone. It is not possible for them to change position and disagree with only one or two of the others. To effect such a major change, from no disagreement to maximum disagreement, can be expected to be difficult to do. There seems to be a certain inherent stability in group unanimity or consensus.

Table 3 shows that for a consensus group of five, when one person disagrees, the group **D** registers a change of almost half the scale (**D** = *0.4*), suggesting that for a group of this size the disagreement of one person is a major event. This effect however reduces as group size increases. For a group of ten, one person disagreeing gives a **D** change of *0.2*, and for a group of 100 the **D** change is only *0.02*. Again it seems reasonable that the effect of one person's choice on the group's agreement is less for larger groups.

Disagreement depends on *N* as well as the group response ratios. For example an individual in a polarized group of two facing two choices has a disagreement of 1.0, the highest possible, but an individual in a polarized group of 1,000 has only about half that disagreement (because 499 people agree with them). If these values are accepted as valid descriptions of the two situations, then the disagreement measures proposed can be used to compare across groups of different sizes. This would be especially useful where research groups have missing members.

Although the maximum value of **D** is a function of *K* (the number of choice options), the calculation of **D** itself is independent of *K*. For example a group response pattern AAABB has a disagreement of 0.6, whether the group is facing two choices, four choices, or a thousand. For a given size group, the more choices confronting it the more disagreement is possible, up to the point where there are as many choices as there are members in the group, when everyone can disagree. That large groups facing limited choices cannot reach maximal disagreement (because some people must agree) also seems a conceptually reasonable and understandable property of the measure.

Numeric data

For ranked, interval and ratio scale data, a numeric value can be given to the distances between the response positions. For example, consider a group selecting a color from lime green, mint green, sea green, forest green, and deep purple. A group whose members are split between lime green and purple can be said to have more disagreement than a group split between lime green and mint green. If number values can be given to the colors, the different distances between them can be reflected in **D**.

Let R_i be the number attached to option *i*, either a rank position or an absolute value. If we follow the standard statistical practice of squaring a difference to remove negative differences, then $\mathbf{d_{ij}} = (R_i - R_j)^2$, and:

$$\mathbf{D} = \frac{1}{N(N-1)} \sum_{1 \le i \le K} \sum_{1 \le j \le K} (R_i - R_j)^2 \; f_j f_i$$

$$= \frac{1}{N(N-1)} \{ \sum_{1 \le i \le K} \sum_{1 \le j \le K} R_i^{\,2} f_j f_i + \sum_{1 \le i \le K} \sum_{1 \le j \le K} R_j^{\,2} f_j f_i - 2 \sum_{1 \le i \le K} \sum_{1 \le j \le K} R_i R_j f_i f_j \}$$

$$= \frac{1}{N(N-1)} \{ 2N \sum_{1 \le i \le K} R_i^{\,2} f_i - 2(\sum_{1 \le i \le K} R_i f_i)^2 \}$$

$$= \frac{1}{N(N-1)} 2N(N-1) s^2 = 2s^2$$

In other words, the group disagreement measure we have defined for nominal data is equivalent to the variance for interval data. It is equal to twice the variance, because in averaging the **d** values, **D** counts each pair-wise disagreement twice, once for each participant. This finding provides some basis for confidence in **D,** since variance seems a reasonable and reliable measure of disagreement for group responses that produce numeric data. However since most do not, the usefulness of **D** remains, as a variance is not normally applied to nominal choice data. Conversely, while the disagreement of an individual with the rest of the group has meaning, one does not normally calculate the "variance" of a single point in a data set, still less regard the variance of the set of points as the average of the variance of the individual points in the set.

Choices that are not mutually exclusive

The logic presented here can be extended to the case where the choices are not mutually exclusive. Suppose a group faces choices where each option can be accepted or not, and the group can accept any, all, or none of the options. Each option can be considered a yes/no choice in itself, and **D** can be calculated for that option. Averaging these values over all the options will give a measure of the group disagreement for the choice set as a whole .

Probability distribution

Assuming all solution options are equally likely to be chosen by all group members gives the probability distribution shown in Table 5, for N = 5 and K = 4. The distribution of **D** is positively skewed, suggesting there are more ways a group can disagree than there are ways they can agree. The mean value of **D,** given the distribution shown, is 0.75, half way between the smallest majority (a 3-2 majority) and a hung group. This is represented by the line in Table 5, showing the point at which the group no longer has a majority decision.

Group Response	Example	Group Disagreement	P( )
Unanimous	AAAAA	**0.0**	4/1024
All but one	AAAAB	**0.4**	60/1024
3-2 split	AAABB	**0.6**	120/1024
3-2 majority	AAABC	**0.7** mean = 0.75	240/1024
Hung group	AABBC	**0.8**	360/1024
Maximum disagreement	AABCD	**0.9**	240/1024

Table 5. Probability distribution for D (N=5 and K=4)

A distribution, such as shown in Table 5, can be used to define a null hypothesis that all solution options are equally likely. It represents a situation where subjects have no reason to select one option over another, either because the problem is very difficult, and subjects do not know which option is correct, or because subjects are given choices they find equally attractive. By contrast, for an easy problem, such as 2 + 2 = ?, the correct answer will have a high probability and the others very low ones. The same situation would arise if subjects had a strong preference or bias for one option.

This null hypothesis does not recognize a distinction between intellective problems (which have a right/wrong answer) and preference problems (whose answer depends on user preference), as defined in McGrath's task circumplex (McGrath, 1984). An even distribution of solution option selection could occur either because subjects found an intellective problem very difficult, or because they had no particular bias on a preference problem. Indeed from a subject's point of view, there may be very little difference between a difficult intellective problem and a preference problem. Subjects could be presented with a problem the experimenter considers to be an intellective one, but treat it as a preference problem. Using subject *response probabilities*, rather than the experimenter defined task context, may be an alternative and more objective way to define choice situations.

Ecological diversity

An equivalent formula to that derived here for group disagreement has been used in mathematical ecology to measure habitat ecological diversity. The situation here is a given habitat containing *N* creatures of *K* types of species. If all *N* creatures are of the same species (*K* = 1), then the ecological diversity is low, whereas if every animal is a different species (*K* = *N*), then the ecological diversity is high. Simpson's measure of ecological diversity (Pielou, 1969, p223) applies to this case of *N* animals of which N_j belong the *j'th* species (*j = 1,2, ... K*). The probability of choosing one animal without replacement from species *j* is (N_j / N), and the probability of choosing a second from the same species is $(N_j - 1)/ (N - 1)$. Summing the probability of choosing two animals of the same species over all species and subtracting from 1 gives Simpson's measure:

$$\mathbf{D} = 1 - \sum_{1 \le i \le K} \frac{N_j (N_j - 1)}{N(N-1)}$$

which may be rearranged to give:

$$\mathbf{D} = \frac{N^2 - \sum N_i^2}{N^2 - N}$$

This is the same as the group disagreement measure defined earlier for the nominal case. It is interesting that two situations so different as group disagreement and ecological habitat diversity, can give rise to the same formula, derived in different ways. The measures are mathematically the same, although the situations seem different. For example, subjects asked to choose again may show a test-retest correlation less than one, while animals do not change their species on re-sampling. Perhaps the species of an animal equates to the choice of an individual on a more abstract level. There may be a higher concept of *dispersion* that incorporates group disagreement, variance and ecological diversity as specific cases.

Example application

This example illustrates how **D** can allow agreement to be the dependent measure in an experimental design, and how **d** can be used to give a perspective on what is going on within the group. The experiment postulated a normative influence process based only on the exchange of choice position information (Whitworth, 1997). The psychological process proposed to underlie normative influence was group members adopting the identity of the group, as described by social identity theory (Abrams & Hogg, 1990). Personal influence was minimized by making all interactions anonymous, and no task information was exchanged, to minimize task informational influence. First year students formed themselves into five person groups with class mates, to compete in a quiz competition, with a prize of movie tickets. Computer-mediated groups completed tests of twelve multi-choice questions, each question having four response options, under blind and group aware treatments. Under the blind (control) treatment, subjects could not see the response positions of others. Under the group aware treatment, subjects completed three vote sets, but interacted only through a computer network. First they voted without seeing how others voted. On their second vote however, they could see the group first vote, and likewise on the third vote, they could see their group's second votes. The computer-mediated interaction was designed to isolate the proposed normative process, so subjects could not discuss the questions at all, and no-one knew who voted which way. The main dependant measure of the experiment, group disagreement (**D)**, changed significantly ($F = 242.6$, $p < 0.000$***) from blind to group aware, supporting the theory.

The disagreement measures made it possible to analyze the data in further detail. Before their second vote, subjects could find themselves in the minority (**d** ≥ 0.75) or in the majority (**d** < 0.75). The computer recorded what subjects saw at the moment of voting. It was expected those in the minority would tend to change their vote, and those in the majority would not. The results, shown in Table 6, indicated a clear trend in the expected direction, with a threshold effect once the voter moved into a minority situation, as has been found in other studies (Hoffman, 1978).

Individuals in a minority seemed to be influenced by the rest of the group. However individual disagreement (**d**) alone does not indicate whether the rest of the group agreed or disagreed among themselves. For example, if an individual disagrees with everyone else, then they are in a minority, but if the rest of the group disagrees with each other as well, then everyone is in the minority, and there is no majority to attract the individual to change position. It was proposed that an individual disagreeing with the rest of the group would be more likely to change their position if the rest of the group agreed among themselves, so a group disagreement score was calculated *for the other four members* of the group, called **DRest**. Table 7 shows the possible combinations of **d** and **Drest**, and in each cell gives an example of the vote situation, e.g. ***A**AAAB* describes the case where the individual (shown in bold) finds that one person in the group disagrees with them. Not all combinations of **d** and **DRest** are possible. Table 8 shows the percentage who changed their vote position in each situation, and the number of times that combination occurred (in brackets).

The results followed an interesting pattern. Firstly 83.6% of all vote events involved no change in vote position, so subjects tended to stay with their previous vote position. For **d** = *0.5* and **d** = *0.75*, the percentage who changed position decreased as the others in the group disagreed more, as expected. However when **d** = *1.0,* and the subject disagreed with everyone, a majority of four in agreement against the subject produced no greater effect than a majority of three, perhaps indicating some sort of threshold had been reached. The case ***D****AABB* is interesting, as it involved two other competing candidates for the group majority, and this produced the highest vote change. If the individual is identified with the group, and if the group needs agreement, then the likelihood of vote change can be taken as the probability that the individual's solution choice will form a majority, compared to the probability that another solution choice can form a group majority.

Vote 2	Individual disagreement				
	0.0	**0.25**	**0.5**	**0.75**	**1.0**
% who changed their vote	0.8%	2.0%	7.1%	36.3%	72.6%
N	479	403	368	355	551

Table 6. Percentage of changed votes by prior individual disagreement

Individual disagreement	**Rest of group disagreement**				
	0.0 AAAA	**0.5 AAAB**	**0.67 AABB**	**0.83 AABC**	**1.0 ABCD**
0.00 Disagree with no-one	**A**AAAA				
0.25 Disagree with one		**A**AAAB			
0.50 Disagree with two			**A**AABB	**A**AABC	
0.75 Disagree with three		**B**AAAB		**B**AABC	**B**ABCD
1.00 Disagree with all	**D**AAAA	**D**AAAB	**D**AABB	**D**AABC	

Table 7. Example vote patterns for individual by rest of group disagreement

Individual disagreement	**Rest of group disagreement**				
	0.0 AAAA	**0.5 AAAB**	**0.67 AABB**	**0.83 AABC**	**1.0 ABCD**
0.00 Disagree with no-one	**1.0%** (1625)				
0.25 Disagree with one		**2.9%** (886)			
0.50 Disagree with two			**8.3%** (289)	**3.8%** (261)	
0.75 Disagree with three		**45.0%** (238)		**25.3%** (190)	**14.7%** (34)
1.00 Disagree with all	**66.1%** (369)	**68.4%** (247)	**77.0%** (61)	**60.3%** (78)	

Table 8. Vote change by vote situation

These ideas can be put as propositions:

1. *Individuals will tend to maintain their previously adopted position.*
2. *The likelihood of no change depends on the probability that the individual's current position will form a group majority, with a threshold effect occurring at the minority/majority boundary.*
3. *The likelihood of change to a particular alternative depends on the probability that the alternative will form a group majority.*

A small amount of random change can also be expected to occur. These propositions could form the basis of a computer simulation of normative group behavior. Parameter values for this task are suggested by the results given. For example the probability of remaining with the previous position regardless seems to be about 33%, the random change factor about 1%, the majority-minority threshold from 0% to about 45%, and the likelihood of change induced by alternate positions from 2% to about 20%, depending on group situation. Such a program could operate dynamically, and simulate not only computer-mediated normative effects (Lea & Spears, 1991; Sia, Tan, & Wei, 1996), but also the sequence effects that occur when individuals respond in any order (McGuire, Kiesler, & Siegel, 1987).

Limitations

These measures must be applied carefully in situations where causality is unclear. If a majority can exert influence in a group, then agreement can be either a cause or an effect, or both. For example, studies show the first person advocating a position is a better predictor of the group final decision than the pre-decision group preferences (McGuire et al., 1987), which seems to favor a persuasive arguments view of group cohesion (Vinokur & Burnstein, 1974). The first advocate seems to be influencing the rest. However, when no prior discussion is allowed, the first advocate effect disappears, suggesting the first advocate is simply listening and reflecting the evolving group norm, rather than directing it (Weisband, 1992). The behavior of the first advocate was considered to be the cause of the group's agreement, when it seems actually to have been the effect of manifest groups agreement. Such agreement could be manifested through position information implied in discussion comments. For example agree/disagree information has been called comment "valence", and experiments suggest group members are sensitive to the group's "valence index" when discussing issues (Hoffman & Maier, 1964).

Sequence effects, where initial group responses affect those following, can also create problems of interpretation, especially in very small groups. This measure assumes **D** is measured at a given moment in time. Where group members "discover" the positions of other members in a dynamic way, the cause-effect relations can be confusing. For example, in a group of three the first advocate needs assent from only one of the remaining two to create a majority, giving quite favorable odds. Sequence effects are avoided if data is gathered at the moment of choice, or if subject positions are only presented to the rest of the group when everyone has given their opinion. A computer-mediated study, using the latter method to control for sequence effects, exchanged position information with and without arguments and found no difference in choice shift, which clearly suggesting normative influence can generate agreement independently from informational influence (Sia et al., 1996). As in the experimental example presented earlier, group position information alone seemed sufficient to induce vote change.

Future directions

What has been proposed is an operational, or process-independent, measure of disagreement. It is based on the actual, or observed, pair-wise disagreements, and makes no statements about how that group state came about, nor does it predict future responses (although it may be used in models that do). For example, in a group of eight facing four choices, a polarized situation (AAAABBBB) gives an agreement value of A = 0.43, while a majority of five with the rest of the group split over all options (AAAAABCD) gives a lower agreement of A = 0.36. Yet it is the latter group which is more likely to reach consensus if a majority influence process exists. Polarized or “hung” groups show relatively high agreement on this measure, because there is pair-wise agreement within each pole. This is not a problem with the measure, as becomes apparent should the group split into two halves, each with total agreement. The measure **D** gives an objective snapshot of actual group disagreement at a moment in time, it is not a model of how groups coalesce.

The concept of group disagreement, as the maximum separation of subjects, differs from the concept of group polarization, as the maximum separation of the group into two opposing sub-groups. A polarized group may have little chance of ever reaching a unanimous decision, while a group holding widely dispersed positions may do so over time. It is a moot question whether the opposite of group consensus is maximum dispersion or maximum polarization, this being another reason the measure proposed here is founded on disagreement rather than agreement. One could envisage a group process generating agreement which, over time, either coalesces the group or polarizes it, both results forming a steady state. It may be possible to distinguish a coalescence/polarization construct, indicated for example by the relative size of the largest common choice response set. Minimum polarization and disagreement would then be the same thing, but maximum disagreement and maximum polarization would not. What we traditionally call agreement could be a complex construct, and not necessarily the simple opposite of disagreement.

Final words

A group may meet, quickly decide an issue by majority vote, and yet spend further time discussing to reach consensus. If groups see agreement as an important goal or purpose in itself, then it is important to measure this, and the uses of this are many. For example, measurement of group agreement could be a useful indicator. Facilitators could measure agreement prior to a meeting on a given subject, and adapt the meeting’s style to be more group focused for groups with higher disagreement. Such measures can also be used as indicators of progress. It may be useful feedback for a group, especially a large one, to know whether their agreement is going up or down over time. Further, being able to quantify the agreement a meeting produces can make it easier to justify the time spent generating that agreement. These measures are particularly suitable for computer-mediated groups, as disagreement values can be so easily calculated, and responses are often in fixed choice format. A group’s agreement for each item on a set of critical issue questions can be presented on fixed scale display that is common across a set of issue questions, even where the number of choices differs. This could allow groups to focus limited face-to-face meeting time on issues they disagree on, and avoid wasting discussion time on areas where they already agree (Whitworth & McQueen, 1999). With the increasing development of groupware and computer-mediated teams, the measurement of agreement as the product of group social activity should be useful in a wide variety of situations, both research and practical.

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