EXPECTATIONS IN A SOCIAL NETWORK: THE SMALL WORLD OF BOCHNER, BUKER, AND MCLEOD REVISITED

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ABSTRACT. Some of the data from a "small world" study by Rochner, Buker and McLeod (1976) are reanalyzed to illustrate one of the difficulties in the statistical treatment of such social networks data. A conclusion reported in the original article is found to be incorrect and a new result is recorded.

The purpose of this note is to explore one of the special problems in the statistical analysis of data generated in the study of social networks: the calculation of expected frequencies. This will be done in the context of a reexamination of the data from Table 4 of a recent study by Bochner, Buker and McLeod (1976) hereafter referred to as BB&M.

The BB&M Study

The article by BB&M provides an excellent illustration of one of the special problems of statistical analysis of social network data. It describes an inherently interesting problem and includes an imaginative design for the collection of data. BB&M were concerned with the problem of evaluating the effectiveness of an international educational and living center in fostering friendships among people from vastly different backgrounds. Do experiences in such a center, they asked, generate warm and intimate connections between the people involved?

BB&M designed a variation of Milgram's (1967) small world experiment in which they had persons in a sample of students in an international living center each pass a packet to another whom they considered to be a friend. Persons chosen this way were requested to continue passing the packet. Thus, the data generated were a set of 18 chains, varying in length from 0 to 15 steps, each representing the history of the passage of a packet. Various kinds of personal attribute data on each subject were also recorded.

The problem, as defined by BB&M, was to assess the impact of individual attributes--like nationality, sex, program of instruction in the center and location of residence--on choice of friends. Thus, their independent variables were attributes of persons and their dependent variable was the dyadic relation of friendship choice. Their research goal was to determine the degree to which any friendship choice is biased by the characteristics of the chooser and his or her potential targets. They were not concerned with choice biases determined by the structure of the relations between points established earlier in the chain.[2]

BB&M define a transaction as "the handing on of a booklet by one person to another." In reporting their data BB&M have decomposed the chains into their pairwise components (thereby eliminating the possibility of studying sequential effects). They concentrate instead on studying biases in the generation of from-to pairs.

BB&M reported a significant tendency for persons to pass messages to targets of the same nationality, gender and program of study. Their analysis of data on housing propinquity, however, led them to the conclusion that proximity effects were small.

Reanalysis of the Propinquity Data

TABLE 1

PROPINQUITY DATA

Distance between rooms of initiator and receiver	Number of transactions
Roommate	7
Same Unit	20
Same Floor	18
Same Building	35
Different Building	6

(Source: BB&M, Table 4)

Table 1 shows the "propinquity data" as reported in BB&M's Table 4, BB&M in referring to this table reported that, "The model transaction occurred between two persons who occupied the same building but lived on different floors, indicating that physical proximity played only a minor role in determining the pattern of responses." They went on to argue that, "the absence of a strong proximity effect," in contrast to the findings of other studies, was fortunate because it left the main determinants of response patterns unmarred "by internal inconsistency."

The only trouble with that conclusion is that it is wrong. BB&M made no attempt to calculate expectations of the several kinds of transactions. Instead, they apparently relied on their intuitions to tell them that the "model transaction" was indicative of something less than a "strong" proximity effect.

From information given in the paper we can determine the approximate likelihood of roommates, unit mates and so on being chosen. There are, it is reported, two dormitories. Each is divided into rooms, units and floors. In each case, a unit contains three double and four single rooms and houses ten persons. One dormitory has four units or 40 students per floor and contains three floors. Thus it houses 120 persons. The other, larger, dormitory has six units (60 persons) per floor and has eight floors that house 480 persons. Together, then, these buildings house 600 students.

Since we were given no information on occupancy, we must assume full occupancy (or random vacancies) to calculate expected friendship choices under the assumption of random selection by residence. We assume, then, 600 occupants. Collectively, they could generate (600 (599) = 359400 choices.

Now in any unit there are three double rooms, so there could be (3) (2) = 6 directed lines linking roommates. In the smaller dorm there are 12 units that together could produce (12) (6) = 72 roommate → roommate choices. In the larger dorm there are 48 units that could generate (48) (6) = 288 such roommate choices. Together the two dorms could generate 72 + 288 = 360 possible roommate choices. So, all roommate → roommate choices constitute the proportion, $\frac{360}{359400}$ = .001 of all the possible selections of friends in this center.

Exactly the same sort of reasoning has been used to determine the expected proportions of random choices for each of the other classes. They are shown in Table 2. And it turns out that roommates, unit mates and floor mates are all overrepresented, while people on other floors and those in the other dormitory are underrepresented.

Table 2

PROPINQUITY DATA

Distance	Proportions Observed	Proportions Expected	Difference	Z	Poisson Prob.
Roommate	.081	.001	.080	-	$\lesssim 0$
Same Unit	.232	.014	.218	-	$\lesssim 0$
Same Floor	.209	.076	.133	4.65	
Same Building	.407	.588	-.181	3.41	
Different Building	.070	.320	-.250	4.97	

The significance of the differences between observed and expected proportions in Table 2 has been calculated using the normal approximation to the binomial. This is appropriate for the larger expectations (Same Floor, Same Building and Different Building) but is probably not adequate for the extremely small expectations generated in the categories of Same Room and Same Unit. As a further check, therefore, the Poisson probabilities were calculated for those two categories. The Poisson approximation to the binomial distribution may be used whereever n is reasonably large (86 here) and the probability of an event is extremely small (.001 and .014 respectively here). In any case the Poisson probabilities indicate that both of these differences are significant at any level of significance one might care to specify. With n = 86 and an expected proportion of .001 any frequency greater than 4 will occur with a probability approaching zero quite closely. (The probability of observing exactly 7 roommate choices under these conditions, for example, is estimated by the Poisson approximately to be .00000000000633 !)

These differences are so large that they suggest that the propinquity effect overshadows all the other results. These students exhibit an overwhelming tendency to select as friends those who are housed close to them and to avoid those who are distant.

One is left wondering how rooms are assigned in the center. May individuals choose rooms and/or roommates? Are rooms assigned by national origin? By program of study? Obviously, they are assigned by gender, but it isn't clear whether housing segregation by gender inhibits the formation of heterosexual friendships or if such segregation is simply one manifestation of a stable and general tendency to avoid developing strong cross-gender ties.[3] We would have to know a good deal more about this center to begin to answer these questions directly.

Summary and Conclusions

In summary, reanalysis of the BB&M data on residential propinquity showed it has a profoundly significant impact on passing messages. Friends are not chosen, as BB&M suggested, without reference to their physical proximity. Instead, physical proximity seems to be the overriding factor in friendship choice

among these students. Whether this is due to biases in room assignments or to the effects of propinquity in breaking down interpersonal distance is unknown and unknowable without further data.

The basic problem in the BB&M analysis stems from their reliance on an intuitive judgment about expectations in the study of social networks. Safety, it would seem, requires that actual expectations be calculated before conclusions can be drawn.

Footnotes:

1. The author wishes to express his gratitude to Peter Killworth for his detailed and helpful review of an earlier draft of this paper.
2. A chooser, for example, would be unlikely to return a packet to the person who chose him or her although such a symmetrical choice is not prohibited by the rules of the experiment.
3. Since we know something about room assignments by gender, it is possible to compute expected male-male and female-female choices, given the observed tendency to choose friends according to residential propinquity. Under this propinquity assumption, Peter Killworth has computed the expected proportion of female-female choices to be .823 and male-male choices to be .848. In both cases the observed proportion is .86. Their standard errors are .058 and .054 respectively, yielding normal deviates of .64 and .18. Neither is significant, which suggests that the observed tendency for same gender choices may be seen as a simple function of housing propinquity.

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