solution has been absorbed by the agar of the medium.

It is possible that the myxamoebae trails are mechanical phenomena resulting from the decreasing moisture content of the agar at room temperature. However, the correlation of the density of the tracks with the richness of the medium suggests that they are composed of metabolic products. The fact that the myxamoebae from a strain of *D. discoideum* with nonmotile pseudoplasmodia leave tracks suggests that the production of trails by the individual myxamoebae may not be intimately associated with the mechanism of locomotion of the pseudoplasmodia.

References

1. BONNER, J. T. *Mycologia*, **45**, 235 (1953).
2. EMERSON, R. *Proc. Roy. Soc. (London)*, **B128**, 275 (1940).

Manuscript received August 3, 1953.

Conformity to Social Norms and Attraction to the Group[1]

Everett W. Bovard, Jr.[2]

Department of Psychology, University of Toronto, Canada

Previous theory and research in the area of small groups has suggested that the extent to which group members conform to the group norm or standard is a function of the extent to which they are attracted to the group. Such attraction is postulated as one of the major determinants of social conformity pressure in a recent formulation of the theory of group dynamics by Cartwright and Zander (*1*). Previous research by the writer has lent some support to this assumption (*2, 3*).

If this assumption were correct, it could be expected that the degree of conformity to social pressure shown in a population of small groups would be positively correlated, to an extent significantly different from zero, with the average attraction for the group shown in each unit. A precise test of this hypothesis in a population of 28 small groups was made possible by the use of instruments for the measurement of conformity and attraction to the group.

To measure conformity in each group, subjects were asked to estimate anonymously, as accurately as possible, the number of dots in a square containing 500 dots, within a 30-sec time limit. Each subject then read out his estimate[3] and the group average was computed and announced by the experimenter. Subjects were then asked to re-estimate the number of dots; again the time limit was 30 sec.

The amount of convergence on the norm in each group was measured by the extent to which the initial standard deviation of estimates of the number of dots was reduced by the announcement of the subjects' individual estimates and their average. Such a shrinkage in original dispersion of estimates with announcement of the group norm had been found in a previous experiment (*4*), and in the present study it was again found in all but 2 of the 23 groups used in the final computations. The absolute difference between first and second standard deviations was used as a conformity index for each group.

To measure attraction for the group, subjects were asked to rate their group as a whole on an 11-point scale ranging from minus five for extreme dislike, through zero for neutrality, to plus five for extreme liking. The assumption made here was that affect, here confined to a feeling of liking or dislike for a group, is a linear dimension ranging from an extreme negative pole through a neutral point to an extreme positive pole.

Reliability of the ratings from this scale had been previously determined to be 0.80 ($N=108$), and it was found to discriminate in the expected direction between 2 small group populations already presumed to differ in level of affect. The first of these populations was made up of 6 so-called stable groups, whose members had met together voluntarily for an average of 231 hr and were extremely likely to continue doing so. Total membership was 55. In the contrasting experimental population were 7 so-called temporary groups, whose members had met together for an average of 2.47 hr and were not likely to continue meeting voluntarily. Total membership was 53.

The average rating of their groups on the affect scale by members of the stable group population was +3.4, compared to +1.4 for the temporary group population. This difference yielded a critical ratio of 5.5, and the probability that it could have occurred by chance is less than 10^{-6}. In the present experiment, the average affect scale rating of each group by its members was used as an index of the attraction the group held for them.

The dots problem and the affect rating scale were administered to 28 classroom groups, discussion sections from an elementary psychology course, in the Easter, 1953, term at the University of Toronto. In half of these groups the dots problem was presented first, and in the other half the affect scale was presented first. Final computations were based on results from 23 groups, errors in procedure having eliminated consideration of the results from 5. These 23 groups ranged in size from 5 to 13 persons and included a total of 216.

A rank order correlation coefficient was computed between the extent of convergence on the norm in each group, measured in terms of the shrinkage of the original standard deviation, and the extent to which members liked their group, in terms of their ratings of it. The correlation obtained was −0.05 for the 23 groups, the group being the unit of correlation. The hypothesis originally suggested must therefore be re-

[1] This research was supported by grants from the Research in Humanities fund of the University of Toronto and from the Canadian Social Science Research Council.

[2] The assistance of Frank W. R. Taylor in statistical analysis of the data is gratefully acknowledged.

[3] In a previous experiment (*4*), the group was informed of individual estimates by the members, but not who had made each one.

jected as untenable. It does not appear from the present experiment, despite the reasonableness of the assumption, that attraction for the group is a determinant of social conformity.

References

1. CARTWRIGHT, D., and ZANDER, A. *Group Dynamics: Research and Theory.* Evanston, Ill.: Row, Peterson, 140, 1953.
2. BOVARD, E. W., JR. *J. Abnormal Social Psychol.*, **46**, 398 (1951).
3. ———. *Ibid.*, 521 (1951).
4. ———. *Science*, **117**, 361 (1953).

Manuscript received July 27, 1953.

The Tetrakaidecahedron as the Basis for the Computation of Cell Volume and Density

Donald Thomas Chalkley

Department of Biology,
University of Notre Dame, Notre Dame, Indiana

Studies by various authors (*1–6*) on the shape of central cells in compact tissues have shown that the average number of cell surfaces closely approaches the number 14 characteristic of the Archimedean tetrakaidecahedron or 14-hedron. Despite the fact that the pattern of cell faces is only infrequently identical with the arrangement of hexagonal and cubic faces definitive of the orthic form of this polyhedron (*1*) its shape may still be useful as a basis for volume determination since ". . . this is the form about which the observed shapes hover . . . it may properly be regarded as the typical shape of cells in masses. There is no rival uniform pattern" (*3*).

In sectioned tissues composed of essentially isodiametric cells randomly arranged in the plane of section the only readily measured dimension is the mean chord. It has been found (*7*) that this parameter is equal to 4 volume/surface for any solid and to π area/perimeter for any plane figure. From the data given by Matzke (*5*) it can be determined that the surface of the orthic 14-hedron of side s is $6s^2 + 8 \times 2.598s^2$, or $26.78s^2$, while the volume is $(6s^2 \times 1.414s + 8 \times 2.598s^2 \times 1.225s)$ 1/3, or $11.32s^2$. The mean chord is then equal to $1.69s$ and $s^3 = 0.207c^3$. Substituting this last equation in the original volume equation we obtain a second in which $v = 2.34c^3$.

From data available for regular polyhedra it can be shown that volume is equal to $2.91c^3$ in the 8-hedron, $2.36c^3$ in the 12-hedron, and $2.12c^3$ in the 20-hedron. It is apparent that in the range between 12 and 16 faces, regarded as most frequent in compact tissues (*1*), the average volume of orthoid cells will not vary greatly from $2.34c^3$.

A test of the applicability of this formula to cell volume measurements was made on a section of amphibian liver. Camera lucida drawings of cells in the hepatic plates were superimposed on a pattern of equiangular radiating lines, and the intercepts of these lines by the cell cross sections were measured as

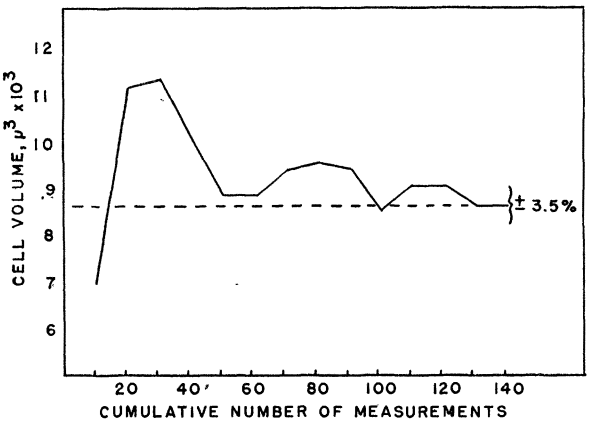

FIG. 1. Cumulative estimates of amphibian liver plate cell volume from successive measurements of the length of the mean cell chord. After 100 measurements fluctuations do not exceed ± 3.5% of the final value.

chords. Cumulative estimates of the volume of the average cell as the number of chord measurements increased are shown in Fig. 1. At the final mean chord value of 15.5 μ the volume was 8730 μ³. Cell volume can also be determined in this tissue by multiplying the average volume of the essentially spherical nuclei by one plus the cytoplasm/nucleus ratio as determined by the multiple pointer method (*8*). Fluctuations between successive cumulative estimates of the ratio became and remained less than ± 2% of the terminal value of 4.73 after 1800 pointer hits had been registered. Similar fluctuations in estimates of the average diameter of the nucleus never exceeded 1.5% of the terminal value of 14.6 μ in 100 measurements. The volume obtained by this method was 9340 μ³. The volumes obtained by the two methods differ from their mean by less than ± 4%.

If the orthic 14-hedron is cut by a plane perpendicular to any edge the surface of the polyhedron intercepts a hexagonal section of the plane (*5*) in which the area a is $5.66s^2$ and the average width $w = 2.77s$. Substituting $s = 0.361w$ in the area formula it becomes $a = 0.737w^2$ (for a regular hexagon $a = 0.746w^2$) and and a right prism of height w has the volume $0.737w^3$. The orthic 14-hedron has a maximum height of $1.08w$ and a volume of $11.316s^3$ or $0.532w^3$ so that its volume differs from that of a right prism of identical central cross section and height by $0.264w^3$. Alteration of the length of the edges of the 14-hedron perpendicular to a hexagonal right cross section produces squamous and columnar 14-hedra in which $v = w^3$ $(0.737\ l/w - 0.264)$ where l/w is the length/width ratio at values greater than 0.722. At lower values of l/w the tetrahedral caps of the 14-hedron would be deformed.

This formula was tested on the same group of amphibian liver plate cells used as a test of the mean chord method. The average width of 50 cells was 26.3 μ. Assuming that the cells are orthic and have a l/w ratio of 1.08, their average volume is 8620 μ³ (compare with the volumes obtained above).

In leaf palisade epithelium the cumulative estimates