which does not map into the sound system altogether, in contrast to our alphabet, which maps (at least in large part) into the level of phonemes. What is the critical feature of the difference between the Chinese logographic and the English alphabetic system which leads to reading difficulty? It could be the complete absence of sound mapping in Chinese; it could be the particular properties of the phoneme, rather than sound mapping per se; or it could be the irregularities of the grapheme to phoneme mapping in English.

We suspect that the phonemic representation contributes most heavily to reading difficulty. We and many others have found that children with reading backwardness have difficulty in "constructing" words from these isolated sounds. There is further evidence both from speech output (articulation) and input (perception) that the alphabetic unit or phoneme is unnatural or at least highly abstract (*11*).

If our suspicions are correct, then some unit intermediate between the morpheme and the phoneme—for example, the syllable—might be more suitable as a vehicle for introducing reading. An efficient orthography must satisfy only two requirements. It must be easy to learn and it must be productive in the sense that, after mastery, new words can be read without learning new symbols. Hence, the ultimate unworkability of the whole word method (*12*). The syllabary may meet these requirements (*13*). It has the advantage of pronounceableness (many phonemes cannot be pronounced in isolation) but still maintains its productivity or openendedness. It may therefore be a good step on the road toward learning to read alphabetic writing (*14*).

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References and Notes

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2. P. Katz and M. Deutsch, in *The Disadvantaged Child*, M. Deutsch and associates, Eds. (Basic Books, New York, 1967), p. 233.
3. J. C. Baratz and R. W. Shuy, *Teaching Black Children to Read* (Center for Applied Linguistics, Washington, D.C., 1969).
4. Because homeroom classes were not graded by school performance, we can take the children selected to be representative of children with reading problems in the second grade of the school.
5. Levels 1 to 4 are intended to be completed in the first grade. Level 3 (Primer) includes learning of words by sight and "developing skill in 'attacking' new words through phonics." Level 4 (Book I) includes "developing additional skills in 'word attack' including compound words, contractions and possessives." Levels 5 and 6 are expected to be completed in the second year and involve completion of Books II-1 and II-2, respectively. The above descriptions are taken from the description of reading levels in "Progress Reports" of the Philadelphia public elementary schools. The books referred to in the description of levels are in the Scott-Foresman Reading Series.
6. Our familiarity with the Chinese language consists of a few hours spent reading elementary books on reading Chinese. We consulted with two fluent speakers of Chinese. Certain constructions that did not translate literally into English were avoided, and some minimal liberties were taken in creating correspondences between Chinese and English.
7. The lettering for the stories and sentences was done by a Chinese member of the staff of the Library of Oriental Studies at the University of Pennsylvania. Although the written symbols appeared to us to differ significantly in some cases from the Xerox copies of individual symbols, the children had little difficulty in generalizing from one to the other.
8. The second stage test was composed of the following sentences in Chinese orthography: "Man has house. Small mother has one house. House has two books. Big father sees one small house. House has knife." The new element introduced for this test was the item "house."
9. One of the three stories was the mother-car story, which does not include all the symbols taught. It was: "Mother wants white car. Brother wants red car. Father gives mother white car. He doesn't (not) give brother red car. Brother says he wants red car. Father says, 'You use white car.' Brother doesn't (not) want white car; he doesn't (not) use car." The eight subjects made a mean of 3 errors (total of 23 errors) on this 40-item story. Seven timed subjects read it in a mean time of 1 minute and 43 seconds. The three comprehension questions were: (i) What did brother want? (ii) What will father let brother do? (iii) Who has the white car? A correct answer on each question is worth one point. Out of a possible total of 24 points, the eight subjects achieved 16.
10. Two of the children in the 24- to 33-day retest were tested without any practice or "warm-up." The remaining three were allowed to read one set of six sentences, with corrections, before proceeding to the retest. The practice set contained each character at least once.
11. A. Liberman, F. S. Cooper, D. P. Shankweiler, M. Studdert-Kennedy, *Psychol. Rev.* **74**, 431 (1967); H. Savin and T. Bever, *J. Verbal Learn. Verbal Behav.* **9**, 295 (1970).
12. J. S. Chall, *Learning to Read: The Great Debate* (McGraw-Hill, New York, 1967).
13. It is interesting to note that in Japan, where the written language consists of a syllabary (a much more "natural" transcription of the language), plus logographs, there is reported to be a very low rate of illiteracy [K. Makita, *Amer. J. Orthopsychiat.* **38**, 599 (1968)].
14. In a sense this experiment is simply a particularly clear demonstration of the fact that children with reading disability can learn many names of things in the visual world and can learn, to some extent, the connection between whole written words and their spoken equivalents ("look-say" method). The Chinese material may be easier because it is novel and because Chinese symbols are perhaps easier to discriminate visually than whole words written in English orthography. The point of the experiment is to highlight areas of competence and areas of specific difficulty in a type of reading disability commonly encountered in inner-city children, and to suggest new approaches to the problem.
15. Supported by NSF grant GB 8013 to one of us (P.R.). We thank the research office of the Philadelphia Board of Education and the staff of the Drew School for their cooperation; and H. Gleitman, L. Gleitman, E. Rozin, and H. Savin for their contribution to the formulation of the issues discussed and constructive comments on the manuscript.

30 December 1970

Potassium–Adenosine Triphosphate Complex: Values of and Uses for Its Formation Constant

A number of incorrect statements concerning the formation constant for $KATP^{3-}$ appeared recently (*1*). Among these are: "Our experiments . . . show these (previously published) values to be in error." and "Thus, our values for the formation constant are about 25 times larger than the previous estimates." These statements suggest that authors who have used the previously published (*2–4*) values for K_{f_I} to calculate the concentrations of $KATP^{3-}$, ATP^{4-}, and so forth at appropriate ionic strengths should do their work again using a number 25 times as great for K_f.

The authors provided a preprint of another paper (*5*) which contained more information about their measurements. They had measured the *p*H and the activity of K^+ in a number of aqueous solutions prepared by adding measured amounts of KOH solution to measured amounts of K_2ATP. For each solution it was then possible to calculate the concentrations of ATP^{4-}, $KATP^{3-}$, free K^+, and so forth from the relationship:

$$K_{f_0} = \frac{a_{KATP^{3-}}}{a_{K^+} \times a_{ATP^{4-}}} = \frac{c_{KATP^{3-}}}{c_{K^+} \times c_{ATP^{4-}}} \times \frac{f_{KATP^{3-}}}{f_{K^+} \times f_{ATP^{4-}}}$$

where a_y is the activity of the ion indicated, c_y is the concentration, and f_y the activity coefficient. Mohan and Rechnitz obtained values for K_{f_0} by assuming that the activity coefficients (f_y) of each ion were given by the equation:

$$-\log f_y = AZ_y^2 \left[\frac{I^{0.5}}{1 + I^{0.5}} - 0.3I\right]$$

Z_y is the charge on the ion y at the ionic strength I. This amounts to an algebraic extrapolation of K_{f_I}

$$K_{f_I} = \frac{c_{KATP^{3-}}}{c_{K^+} \times c_{ATP^{4-}}}$$

from the ionic strength of measurement to zero ionic strength. K_{f_0} obtained in this manner was quoted as

219 ± 23 and 218 ± 20 (*1*); and 222.4 ± 22.4 and 219.6 ± 24.1 (*5*) based on measurements with two different, commercially available, potassium ion–specific electrodes. To evaluate the applicability of this algebraic extrapolation, I calculated values for K_{f_I} for each of the measurements made above *p*H 9 (*5*, tables 1 and 2). The values obtained ranged from 162 to 74, the ionic strengths from 0.004 to 0.015, but most were in the range 0.011 to 0.015 with K_{f_I} in the range from 80 to 95. The logarithms of these experimental values for K_{f_I} were plotted against $I^{0.5}$. The resulting scatter diagram indicated convincingly that a graphic extrapolation using any reasonable function of $I^{0.5}$ was not possible. It was, however, clear that the value of K_{f_I} that should be used in the neighborhood of $I = 0.011$ to 0.015 was closer to 90 than it was to 220.

It should also be clear that increases in ionic strength above 0.015 would be expected to cause a further decrease in the value of K_{f_I}, although present knowledge does not provide quantitative guidance for such extrapolation. The extrapolation equation used by Mohan and Rechnitz (*5*) gave values within a factor of two—not 25—of those published previously at higher ionic strengths.

The experiments of Mohan and Rechnitz have provided new evidence of the existence of $KATP^{3-}$ in aqueous solutions. Because their measurements were made at low ionic strengths they have been able to provide an estimate of the "thermodynamic" value of the formation constant, K_{f_0}, and thus one could estimate the standard free energy of formation of this ion. However, in most biological fluids the ionic strength is much higher than the range covered by their measurements or by any extrapolation method known to be applicable. Therefore, in practical situations one must use the "concentration" constant, K_{f_I}, measured as close to the desired ionic strength as possible. For $KATP^{3-}$, O'Sullivan and Perrin (*4*) reports $K_{f_{0.1}} = 14$ at 25°C, Melchior (*2*) reports $K_{f_{0.2}} = 10$ and $K_{f_{0.3}} = 7$, also at 25°C.

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Although Melchior does not dispute the numerical values for the formation constant of the $KATP^{3-}$ complex obtained in our study (*1, 2*), his critique implies that our values differ from earlier estimates because of effects of ionic strength and suggests that the earlier values are fully satisfactory for calculations in biological media. We cannot accept Melchior's contention, even his technical points, for the following reasons.

1) Contrary to Melchior's assertion, ours is not an extrapolation method. Rather we have made our measurements directly in a region of ionic strength where meaningful activity coefficients may be used. Thus, our method yields thermodynamic rather than conditional values.

2) Melchior does not take into account the effect of the supporting electrolyte used to control ionic strength in the earlier studies. As we have explicitly pointed out (*2*), an apparent lowering of the formation constant will be produced if the cation of the electrolyte associates with ATP. No additional cations are used in our study.

3) As Melchior himself points out, there is no reliable method for extrapolating our thermodynamic formation constant values to media of high ionic strength. A rough estimate has shown (*2*) that our value would still substantially exceed earlier values at 0.2*M* ionic strength, even if the leveling effect of the electrolyte cation is neglected.

Finally, we cannot support Melchior's suggestions that conditional values for formation constants should be used in biochemical calculations in preference to thermodynamic values. Indeed, we feel that the use of nonthermodynamic quantities is only justified as an expedient when rigorous values are not available. In those studies where electrolytes used to maintain ionic strength contain ions not even present in biological media, the validity of the resulting conditional constants is especially questionable.

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Skull from Spruce Swamp: Case of Cranial Dysraphism?

Included in Powell's report (*1*) on a possible case of aboriginal trephination was a photograph of the skull from Spruce Swamp Burial 1. On the basis of that photograph and on my experience as a neurosurgeon, I believe that the defect shown resulted from an encepholocele or meningoencepholocele. The cranial aperture exactly in the midline is a characteristic feature of these conditions. Through this hole, present at birth, meninges (membranous coverings of the brain) with or without rudimentary brain tissue herniated, and the protruding mass formed a bed in the soft infant bone. Brain pulsations were transmitted through the aperture and met against the bone edge, which caused the bone to "build up" at the edge that received most of the pulsations.

The skull may become "saucerized" also by benign tumors within it and growing out of it, or resting upon it, especially in young individuals. When this process is present exactly in the midline and an aperture is pierced through the skull at the bottom of the "saucer," a diagnosis of congenital cranial dysraphism seems mandatory.

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