heterozygotes, and until it achieves its random frequency the population would present a nonrandom association. Once formed, incidentally, the two "couplings first" schemes are indistinguishable from one another, because, under the 2-by-2 contingency table, the two coupling or two repulsion types show equal deviation from expected, no matter which single linkage is responsible for the deficiency or excess. Similarly, the arguments do not depend on the assumption that *XL·XR* is the oldest combination. *XL-1·XR-2* may be substituted for *XL·XR* in any scheme; having a repulsion linkage ancestral means merely that the possible phylogenies consist of two "repulsions first" alternatives and one "couplings first" instead of the reverse.

The crucial point is, however, that only one of the possible phylogenies could have occurred, for, unlike point mutations, which presumably recur again and again in the species phylogeny, inversions are probably unique events. For one thing, spontaneous chromosome aberrations are much rarer than spontaneous mutations. In addition, the chances of repeating identical breaks necessary for an exact copy of an inversion are infinitesimal. It follows that only one kind of nonrandom association attributable to the historical process of building up the fourth linkage combination by crossing over is possible, either one in which the coupling types are deficient, the phylogeny having been "repulsions first," or else one in which the repulsion types are deficient, the phylogeny having been "couplings first." This means that at least one of the associations, the Blacksburg type or the Gatlinburg, is *not* the historical association. It must be a newly evolved, adaptive one, since natural selection, or at least selective migration, must be postulated in order to maintain a linkage association in the face of the randomizing tendency of recombination.

This demonstration achieves the other side of the coin of the typical evolution problem. Usually the adaptive trait is noticed, and the surmise is made that it resulted from selection for interacting loci, number and location unknown. Here the interacting loci are known to be linked, but the adaptive traits produced by their interaction are unknown. Some evidence exists, however, that in Blacksburg, at least, the X-chromosome association is involved in *D. robusta's* seasonal adaptations to the environment (*5*). It is also likely that selection for the associations has been accompanied by selection for chiasma suppression. The region between the right- and left-arm arrangements available for crossing over includes more than 20 percent of the X-chromosome euchromatin, yet less than 1 percent crossovers (*6*) are obtained (*7*).

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Effect of Verbalization on Reversal Shifts in Children

Abstract. Two questions were asked: (i) Would naming stimuli in a discrimination reversal influence the performance of 4- and 7-year-old children, and (ii) if so, would the influence be different for these two age groups? The results indicate a positive answer to the first question and an equivocal answer to the second.

There is considerable current interest among psychologists in the behavioral analysis of processes that mediate between the external stimulus and the overt response. One method developed for such analysis is the reversal-nonreversal shift technique (*1*), which was adapted in the following manner to the present research. Forty-eight nursery school children (mean age, 56 months) and 48 second-grade children (mean age, 91 months) were required to learn two successive discriminations. The stimuli, two-dimensional squares, varying in area (1 in.^{2} and 3 in.^{2}) and brightness (black and white), were presented in a portable discrimination apparatus which displayed two squares simultaneously. The child chose one of them by pressing a lever that pointed at his choice. A marble served as reinforcement. As illustrated in Fig. 1, the first discrimination presented one stimulus pair that differed simultaneously on two dimensions. The second discrimination presented this same pair with the reinforcement pattern reversed or another pair that also differed simultaneously on the same dimensions; the two pairs were presented in random alternation. Stimulus preferences were controlled by suitable counterbalancing.

The major experimental variable was the kind of verbal label the children were instructed to apply to the correct stimulus during the initial discrimination. These labels, which were always appropriate to the first discrimination, could be arranged to be descriptive of either the relevant or irrelevant dimension in the second discrimination. For example, if a child was trained to be a relevant verbalizer, he was presented with the reinforcement pattern illustrated in Fig. 1 and instructed to tell the experimenter, before making a choice, whether the large or the small one was correct. He soon learned to precede his choices with the appropriate label which, in this instance, would be "large." Since in the second discrimination "small" was the correct stimulus, the label referred to the dimension that was to become relevant. If a child was trained to be an irrelevant verbalizer, he was asked in the first discrimination to tell whether the white or the black one was correct. He would thus learn to say "black," which was descriptive of the dimension that was to become irrelevant. One-third of the children at each age level were randomly assigned to be relevant verbalizers, one-third to be irrelevant verbalizers, and the remainder to a no-verbalization group who learned with no verbal labels offered or required.

All groups learned the first discrimi-

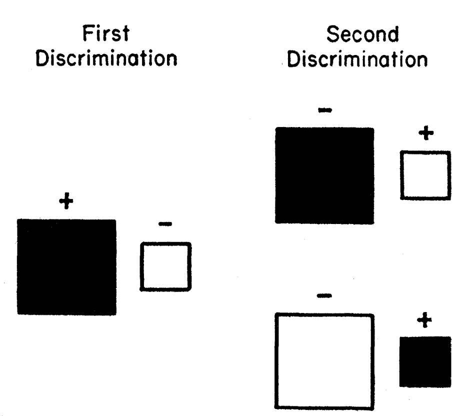

Fig. 1. Illustration of the experimental procedure showing one of the stimulus-reinforcement patterns used.

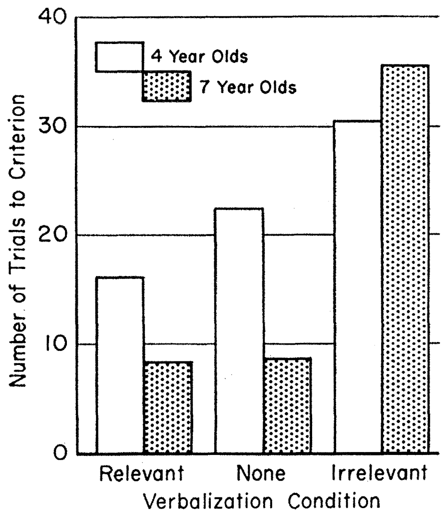

Fig. 2. Effect of verbalization on the acquisition of a reversal shift for 4- and 7-year-old children.

nation to a criterion of nine out of ten successive correct responses, after which the second discrimination was immediately presented without any further instruction or ostensible break in the procedure.

Previous research has found that when no verbalization is required, young children perform a reversal shift more slowly than older children (*2*). This finding is confirmed by the difference between the 4- and 7-year-old, no-verbalization groups of the present study ($p < .05$). To account for these developmental differences it has been suggested that older children are more likely than younger children to make covert mediating responses that facilitate such shifts (*1, 2*).

One likely mediating mechanism is language. The results shown in Fig. 2 lend considerable support to this hypothesis. For both ages combined, relevant labels facilitated and irrelevant labels retarded the shift. These differences, as assessed by analysis of variance, were highly significant ($p < .005$). Apparently, spoken labels that refer to conceptual dimensions *can* mediate a reversal shift in children.

Having demonstrated that their own spoken words are an effective source of stimulation for children and that the experimental procedure employed is sensitive to this effect, it is appropriate to raise questions about possible differences in responsiveness associated with age. Luria (*3*), a Soviet psychologist, has proposed that in the early stages of child development speech is merely a means of communication; not until about 5 years of age does it become a regulator of actions. According to his thesis the effects of verbalization in our experiment should be different for the two age levels. While the results in Fig. 2 suggest that they are different, the implied statistical interaction falls short of significance ($.05 < p < .10$). Consequently, definitive conclusions must await further research. There are, however, some interesting relationships suggested, if not confirmed by these data. For the 7-year-olds, relevant verbalization was no better than no verbalization. This result is consistent with the hypothesis that at this age level children are likely spontaneously to supply relevant mediators and, therefore, need no help from the outside. For the 4-year-olds, relevant verbalization did show a positive influence. This influence was so small, however, that it only decreased slightly rather than eliminated the difference between the ages.

Irrelevant verbalization interfered with the performance of both age groups. The effect for the younger children was again in the right direction but rather weak. For the older children the interference due to irrelevant verbalization was potent, as would be expected if they were particularly sensitive to their own words.

In general, the analysis by age indicates that, at both age levels, the behavior of the children was regulated by their verbalizations. Although no statistically significant evidence indicated that the extent of the regulation was different for the two age groups, this possibility must still be considered (*4*).

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Electron Diffraction from Coals

Abstract. Electron diffraction patterns have been obtained for coals of different rank by transmission through ultrathin sections 500 to 2000 angstroms thick. Analysis of these patterns for the distribution of atoms in coals by Debye radial distribution functions should furnish information complementary to that derived from x-ray studies, considering the differences in wavelength of the radiation involved and the different mechanisms governing the diffraction.

Because fast electrons have much shorter wavelengths than x-rays and their diffraction is proportional to the potential within the crystal (or molecule) rather than to the electron density of the atoms, electron diffraction is a powerful tool in solid-state studies. Heretofore, attempts to obtain electron diffraction patterns of coal have not been successful. Mackowsky and Nemetschek (*1*) reported that finely divided coal preparations graphitized upon exposure to an electron beam. Westrik (*2*) reported a diffraction pattern from a bituminous coal showing a distinct hexagonal crystallinity; the *a* spacing of the hexagonal lattice was 5.2 A compared with 2.46 A of graphite. The pattern was most likely produced by impurities either already present in the coal or introduced during preparation (*3*).

Electron diffraction patterns can be obtained by reflection from the surface of solid specimens. The reflection pattern of an anthracite is shown in Fig. 1*a*. The pattern reveals clearly the usual (002), (10), and (11) (*4*) reflections of aromatic molecules as shown in the densitometer tracing (Fig. 1*b*). Electrons do not penetrate more than several hundred angstroms, and the surface of the specimen is not uniform on the scale of depth of penetration; therefore, the electrons pass through excrescences on the surface. The process has much more the character of transmission than reflection. However, in this method the geometry of the scattering portion of the sample is undefined, and the distance from specimen to plate is uncertain because the diffraction patterns obtained are limited to scattering angles of a few degrees. In addition to these uncertainties, obtaining diffraction patterns from coal surfaces is extremely difficult —that is, it is a hit-or-miss process.

Well-defined electron diffraction patterns can be obtained by using uniform sections sufficiently thin to permit trans-