Developing sensitivity to correlated cues¹

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Children of two grade levels (second and third, and fifth and sixth) and college adults (N = 144) were presented random shapes of varying numbers of turns for tachistoscopic recognition. The relation between number of turns of the shapes and color of the shapes was either 1:1 or random. The children treated the correlated relation as a random pairing of cues. However, adults were sensitive to correlation; they showed significant improvement in their estimation of the shapes with correlated colors.

Brunswik (1956) speculated that children and adults are sensitive to the validity of stimuli and that they can use correlated cues to increase their perceptual accuracy. In addition, Piaget and Inhelder (1951) suggest that between the period of concrete operations (around 7-11 years) and formal operations (adolescence) the child comes to distinguish between chance events and associated events. The purpose of this study was to explore these speculations; in particular, to examine the ability of children and adults to use correlated cues to help them correctly categorize stimuli.

Two sets of stimuli were developed. Four colors (red, blue, yellow, and green) were randomly associated with four classes of stimuli (5-, 10-, 20-, and 40-turn random shapes) in one set, while in the other set only one color was associated with each class of stimuli. Specifically, in the second set of stimuli 5-turn random shapes were associated with red, 10-turn shapes with blue, 20-turn shapes with yellow, and 40-turn shapes with green.

Groups of children and adults were repeatedly presented (for tachistoscopic recognition) the sets of random or related stimuli. Each group received only one type of stimuli. If the subjects are sensitive to correlated cues, the estimation of cue-correlated stimuli should differentially improve over trials when compared with randomly related cues and stimuli. A developmental view might suggest that adults would profit more from experience than would children, so that we might find an interaction among age, correlated or random cues, and pre-post measurement.

Method

Subjects. Forty-eight introductory students from the University of Illinois, 48 second and third grade children, and 48 fifth and sixth grade children from the Chicago Public School System served as Ss in this study.² An equal number of Ss at each age level were unsystematically assigned to the experimental groups, with the restriction that the number of second and third grade, and fifth and sixth grade children should be equated within the age groupings and that the sexes should be balanced.

Stimulus materials. Twenty-four random shapes were constructed according to a procedure described in Munsinger and Kessen (1964). Each shape was a black figure on a white background. Transparent plastic tape was put over the entire slide to introduce appropriate background color. Preliminary investigations showed that the red, yellow, green, and blue tape used in this study did not differentially mask the shapes during tachistoscopic estimation. The four colors were easily distinguished.

Procedure. Six examples of four levels of complexity of random shapes (5, 10, 20, and 40 turns) were presented at 200 msec exposure duration to all Ss. The order of presentation of the 24 stimuli was randomized within blocks of eight shapes. The stimuli were presented in this randomized order; the order was reversed and then changed on subsequent presentations. The Ss were instructed to estimate (guess)³ the number of angles (points) contained in each shape. The children wrote the numbers 5, 10, 20, and 40 at the top of their answer sheets to help them remember the four possible responses. All Ss were asked to use only these four categories in responding; they were shown examples of each type of figure and were instructed to guess whenever they were not sure of the number of turns. The Ss received a four-page booklet with 24 lines on each page.

Each shape was projected tachistoscopically, by means of a Compur mechanical shutter monitored by a Tektronix oscilloscope, to the front wall of a room in which small groups of Ss were seated. All groups were told to pay particular attention to the relation between the shapes and colors because this relation would improve their estimation accuracy. The interval between presentations was approximately 10 sec. All Ss were shown the complete set of 24 figures four times.

The ability of Ss to estimate the number of turns of the shapes was assessed by calculation of transmitted information according to Garner's bivariate uncertainty analysis (Garner, 1962). A 4 by 4 confusion matrix was constructed with the four types of stimuli representing rows and the four possible responses representing columns. The six examples of each level of complexity (one trial of 24 shapes) were pooled for greater reliability. The contingent uncertainty of the first and last 24 presentations was computed separately and entered into a repeated measures analysis of variance as pre- and post-measurement.

Results and Discussion

Figure 1 shows a monotonic relation between grade in school and bits of transmitted information. This significant effect ($F = 48.9$, $df = 2/138$, $p < .001$) demon-

Fig. 1. The relation between grade in school and amount of transmitted information.

Fig. 2. The relation between grade in school and amount of transmitted information plotted separately for the linear and random contingent conditions.

Fig. 3. The relation between pre- and post-measurement and amount of information transmitted plotted separately for the three grade levels.

Fig. 4. The relation between pre- and post-measurement and amount of information transmitted plotted separately by linear and random contingent conditions.

strates that the ability to estimate number of turns of random shapes increases with age, a not surprising finding (Munsinger and Kessen, 1964, 1966a, 1966b). Estimation accuracy also increased from trial one to four ($F=21.3$, $df=1/138$, $p<.001$), suggesting some learning. Figure 2 shows a more interesting result. This significant interaction ($F=5.6$, $df=2/138$, $p<.01$) between the two types of relations (correlated and random) and age of Ss shows that only the adults were able to take advantage of the correlated cues. For both the second and third grade children and the fifth and sixth grade children there was no difference in estimation accuracy between the random and correlated sets of shapes. Children were *not* sensitive to the association of number of turns and color. For the fifth and sixth grade children the correlated condition is slightly below the random condition. However, the adults clearly estimated number of turns of the shapes more accurately when they contained correlated colors. Figure 3 ($F=7.8$, $df=2/138$, $p<.01$) shows that the difference between adults and children increased between the pre- and the post-measurement period. Figure 4 supports this finding, showing a significant ($F=7.3$, $df=1/138$, $p<.01$) interaction between the linear correlation and random conditions and the pre- and post-measurement periods.

The conclusion is that college adults are sensitive to a simple correlation among cues, but without better instructions, or much more experience, young children cannot use correlated cues to improve their estimation accuracy. The children's insensitivity to correlated cues may be due to the small amount of experience given. Alternatively, it may be that children are not able to integrate over time. If the latter notion is correct,

simultaneous presentation of several cue-correlated stimuli should produce much better performance among children. This simultaneous presentation would give the child the information all at once and not require him to integrate information over time. The present study required children to store and integrate a contingent relation. At present, it is impossible to know where the younger children are deficient; it may be memory overload; it may be inability to integrate contingencies over time; or it may be lack of understanding of the notion of contingency itself. Further work can examine these particular points. Simultaneous presentation of cue-correlated stimuli seems promising. A gradual building of the notion of correlation may also be a productive approach. Trial and error learning is inefficient; the children should probably be tutored.

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3. Words in parentheses were used with children.