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The applicability of Piaget's cognitive processes of assimilation and accommodation to the learning of verbal nonsense syllables (ten low association value consonant-vowel-consonant trigrams) was tested experimentally. Twenty-two undergraduates (ten female and 12 male) at the University of Michigan served as subjects. It was hypothesized that learning rate should be a function of the amount of cognitive adjustment the subject had to make to the stimulus material measured by changes in semantic differential ratings of the stimuli before and after they were learned. Results showed two groups of fast learners, one of which made significantly less changes than the slow learners, and one significantly more. Systematic directional shift on the evaluative, potency, and activity dimensions of the semantic differential were also found. The author feels that these findings lend considerable support for the applicability of Piaget's processes of assimilation and accommodation to the learning process and that identification and investigation of internal processes of this type will be necessary before the learning function of the human organism is understood. This paper comprises a report in "Development of Language Functions. A Research Program-Project." (DO)

The University of Michigan

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A Piagetian Approach to the Learning of Nonsense Material

by

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Abstract

The applicability of Piaget's cognitive processes of assimilation and accomodation to the learning of verbal nonsense syllables was tested experimentally. It was hypothesized that learning rate should be a function of the amount of cognitive adjustment S had to make to the stimulus material measured by changes in semantic differential ratings of the stimuli before and after they were learned. Results showed two groups of fast learners, one of which made significantly less changes than the slow learners, and one significantly more. Systematic directional shift on the evaluative, potency, and activity dimensions of the semantic differential were also found. The results are discussed in terms of a cognitive organismic theory of learning.

A Piagetian Approach to the Learning of Nonsense Material[1]

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Piaget views learning as a relation between the entire cognitive system of an individual and the material to be learned in the context of an organism adapting to its environment. In his theory of cognition (Piaget, 1952) he describes the adaptation process as two simultaneously occurring and interacting processes, assimilation and accomodation. Flavell summarizes these processes as follows:

> The process of changing elements in the milieu in such a way that they can become incorporated into the structure of the organism is called assimilation, i.e., the elements are assimilated into the system.
>
> Just as objects must be adjusted to the peculiar structure of the organism in any adaptational process, so also must the organism adjust itself to the idiosyncratic demands of the object ... The second aspect, the adjustment to the object, Piaget labels accomodation. (Flavell, 1963, p. 45).

These two interdependent processes can be involved whenever the organism adapts to an aspect of the environment, either internal or external, in such a way that he can reproduce that aspect at will and, at advanced stages of development, can perform cognitive operations upon it. (In fact, reproduction can be considered as the application of an identity operation to an aspect of the environment.) During the transition from an external environmental object to an internalized element of the subject's behavioral repertoire the object should undergo certain modifications as a prerequisite

for internalization (i.e., assimilation). At the same time the organism's cognitive structure should be somehow altered in order to allow the stimulus to become incorporated into it (i.e., accomodation).[2]

Piaget's description of the processes of assimilation and accomodation is far from precise. As a result it is not clear exactly how one would determine that such transformations in object and subject had in fact taken place. It is proposed in this paper that one way to deal with this problem might be through the concept of meaning. Although the definition of meaning itself is not by any means uncontroversial there is probably a fair amount of agreement that it is an organismic response. In the first place the meaning response to a stimulus consists of a large number of component responses of various kinds -- glandular, muscular, sensory, and ideational. Secondly the response has temporal depth since it is a function of many, if not all, past internal and external contexts in which the individual has responded to the given stimulus.

A Piagetian-type model would assert that integration into an ongoing cognitive structure is not only a result of learning, but indeed its very definition. Changes of meaning of the stimulus material during learning are not merely incidental to the learning process but rather are part of the process itself, reflecting assimilative and accomodative activities of the learner. Therefore a strong prediction from the model is that speed of learning will be in part a function of the number of changes which must be made in order for S to assimilate the material into his cognitive structure. It was also hypothesized that speed of learning would depend on the degree of differentiation of the stimulus material within this structure. Fast learners were expected to increase differentiation during the learning process to a greater degree than slow learners. In this study differentiation was measured in terms of placement on the three primary factors of Osgood's semantic differential, evaluative, potency, and activity (Osgood, Suci, and Tannenbaum, 1957). Finally it was suspected that certain systematic dire

tional shifts on these dimensions, especially on the activity dimension, might be consistent with a process theory of learning such as the one described above. These shifts are dealt with in greater length in the discussion section.

Verbal nonsense material was used in the learning task for two reasons. First it provides some continuity with past work in human learning which traditionally uses verbal material; second, well established norms exist so that the material could be selected on the basis of pre-experimental meaningfulness, as measured by associative fluency. The design called for subjects (Ss) to rate low association value nonsense syllable trigrams on a semantic differential instrument (Osgood, Suci, and Tannenbaum, 1957) both before and after they learned to produce these syllables in a free recall situation. Comparison between the pre- and post-learning ratings provides most of the data for the study. Ss were also tested for recall of the syllables 24 hours and three weeks after the learning session.

Method

Subjects: Ss were 22 undergraduates at the University of Michigan, twelve males and ten females.

Materials: Nonsense syllables (NSs) - Ten low association value (AV) consonant-vowel-consonant trigrams were chosen from the Archer norms (Archer, 1960). AVs for the ten NSs ranged from 14-24% with a mean of 19.1. An attempt was made to choose syllables which were also low AV on the Glaze (1928) and Kreuger (1934) norms. Each vowel appeared twice in the ten NSs. In addition, as far as possible consonants appeared only once among the initial letters and once among the final letters of the NS set. Because of the lack of variation in low-AV NSs one consonant in the initial position, and two consonants in the final position were repeated.

The NSs were hand-printed in large capital letters with a black ink marker on sheets of 7 x 14 inch white cardboard. Four sets of stimuli were used in order to make the randomization process simpler and to control for the possibility that idiosyncratic printing on some words might cause Ss to attend selectively to these stimuli.

<u>Semantic Differential (SD)</u> - Twelve dimensions were selected such that each principal factor loaded heavily on four of the dimensions, while loading minimally on the remaining eight. Each dimension is listed in Table 1 with its loading on each of the three factors.

Insert Table 1 about here

Two random orderings of the twelve dimensions were used by all Ss, one for the pre-learning ratings and the other for ratings made after the NSs were learned. The rating scales for a particular NS were typed on a single 8 1/2 x 11 inch piece of paper. Each scale consisted of a line 4 1/4 inches long with vertical marks at each end and in the middle. No divisions were marked on the line other than the midpoint. At the top of each sheet was typed the NS to be rated on that page.

Two booklets were made up as follows: Booklet 1 contained instructions for the use of the SD and ten pages of scales, one for each NS. Booklet 2 contained ten blank pages for recording of responses during the learning task. There followed a page of additional SD instructions, giving a rationale for re-rating the NSs, followed by the second set of rating scales. Ss rated the NSs in the same order each time, although order of the rating scales for each NS was different in Booklet 2.

<u>Procedure</u>: Ss were seated in a regular classroom, given Booklet 1, and told to begin working after they had read the instructions. On the instructions the idea of the SD was explained and an example, using the word "forest" was given. They were then told:

> ...The more toward one end of the dimension you place your mark, the more you feel that particular characteristic applies to the stimulus you are rating.
>
> The stimuli you will be rating are not English words. You will be rating three-letter units which consist of a consonant, a vowel, and a second consonant. This task may sound strange to you. However, in the past subjects have been able to rate this kind of material in this manner.

While Ss were encouraged to work rapidly, there was no time limit set for the task. All Ss had finished after approximately 15 minutes.

After Booklet 1 was collected, Booklet 2 was handed out. Ss were instructed on the verbal learning task orally as follows:

> I am going to show you one at a time the ten stimuli you have just rated. You will see each syllable for five seconds. After you have seen all ten I will say "Recall". You will then have 30 seconds to write down as many syllables as you can remember in any order in the booklet provided. When I say "Stop" you will turn the page of the booklet so that a blank page is facing you. You will then see the syllables again, and will recall them again. This procedure will be repeated until you have attempted to recall the list of syllables ten times. After you turn the tenth page of your booklet you will read the instructions on the eleventh page and carry them out.

E then held up the stimulus cards one by one. Each card was shown for five seconds with a two second interval between each card. After the tenth card Ss were allowed 30 seconds for recall. This procedure was repeated ten times. On each trial the stimuli were presented in a different order.

After ten learning trials Ss read the instructions on re-rating the NSs. It was explained that they were being asked to rate them again to control for possible order effects in the first rating. They were told, "You need not attempt to make these ratings consistent with your previous ones. Simply rate the stimuli as they now appear to you." After Ss completed the second set of ratings they were dismissed.

Approximately 20 hours later Ss were asked to recall as many of the NSs as they could in a two-minute period. It was found that recall at this interval was nearly perfect. Therefore a second recall session was added after a period of three weeks.

Results

Directional Shifts on Evaluative, Potency and Activity Dimensions: For each S the signed scale values on the four SD scales for each of the three primary dimensions were summed across stimuli.[3] This was done for both "before" and "after" ratings. S's total directional shift on a given dimension was computed by subtracting his total "before" score from his total "after" score for that dimension. T-tests for paired observations showed a significant shift from "bad" to "good" on the evaluative dimension and from "passive" to

"active" on the activity dimension ($t(20) = 2.20$ and 2.16, respectively, $p < .025$.) The shift in potency did not approach significance.

Directional shifts were investigated separately for fast and slow learners. Fast learners (N = 11) produced the entire set of ten NSs in five trials or less, while slow learners (N = 10) required six or more trials. Fig. 1 shows mean scores on the three dimensions for fast and slow learners. Values are mean total evaluative, potency and activity scores per S per syllable. A negative sign indicates the good, strong, and active poles of the above dimensions, respectively. For the evaluative dimension only the effect of learning (before vs. after) was significant ($F(1,19) = 4.69$, $p < .05$). Post-hoc analysis (Scheffé 1959) showed that increase in goodness approached significance for the slow learners ($.05 < p < .10$), but was not significant for the fast learners. On the potency dimension only the interaction between the learning effect and learning speed was significant ($F(1,19) = 5.62$, $p < .05$). It can be seen that potency decreased for the slow learners, but increased for the fast learners. Post-hoc analysis showed that the decrease for the slow learners was significant ($p < .05$) while the increase for the fast learners was not ($p > .10$). Finally, on the activity dimension both the effect of learning and the interaction with learning speed were significant ($F(1,19) = 6.04$ and 4.85, respectively, $p < .05$). Again, post-hoc analysis showed that increase in activity was significant for slow learners ($p < .01$) but not for fast learners ($p > .10$).

Insert Figure 1 about here

Meaning changes and learning rate: Meaning changes were examined in two ways -- first simply as linear deviations along the dimensions of the SD, and second, as category shifts on the three factors, evaluative, potency, and activity, (i.e., good to bad). Both of these analyses disregarded directionality of the shift.

Linear absolute change in units of 1/16th of an inch was computed for each S by averaging the absolute value of the differences between the before and after rating on each of the twelve scales for all ten syllables. Average change was 6.41 for fast learners and

6.98 for slow learners. As predicted, fast learners shifted less than slow learners. However, the difference is not significant. Degree of change was highly related to mean distance of Ss initial rating from the midpoint of the scale averaged over all 120 dimensions (10 syllables, 12 dimensions per syllable). Pearson r = .86 for fast learners, and .87 for slow learners. Thus, the more extreme position on the rating scales S adopted before learning, regardless of direction from the midpoint, the greater the degree of change when "after" ratings are compared with "before" ratings.

At the factor level it is obvious from Fig. 1 that slow learners shift more than fast learners. For all three factors the shift is significant only for slow learners. It should be noted that this data was generated by summations over dimensions within a syllable, over syllables within a subject, and over subjects within a learning speed category, and that all these summations involve signed, not absolute differences. At any level differences equal in magnitude but opposite in sign cancel each other. Therefore it can be concluded that differences between the shifting behavior of fast and slow learners in terms of metric units is due to the direction, and not to the absolute value, of their shifts.

It is also possible that meaning changes are significant for learning on the category level rather than on the metric level -- i.e., that change on a bipolar dimension is reflected mainly in a shift from active to passive or good to bad rather than a change from very active to less active. This notion is supported by the finding reported above that degree of metric shift is highly dependent on initial starting point. Category changes were computed in three ways. First, excluding the zero point as a separate category total number of changes from one pole to the other (i.e., active to passive, bad to good, etc.) were counted, and then averaged separately for the fast and slow groups. Second, zeros were included as separate categories, making the shift from zero to active, or good to zero a category change. This procedure is defensible on the grounds that Ss were often consistent on a zero rating before and after learning, indicating that they regarded zero as a separate category. The third method took into account the

degree of change by regarding a change which passed through the zero point as two changes, but a change which originated or terminated at the zero point as only one change. These three scoring methods are referred to as zero excluded, zero included, and linear, respectively.

Distributions of changes for fast and slow learners under the three scoring methods are shown in Fig. 2. While mean number of changes do not differ significantly for fast and slow learners in any of the three cases, the variance of the fast group is significantly greater than that of the slow group for all three methods ($F(10,9) = 4.81, 5.52,$ and 5.27, respectively, $p < .03, .02,$ and $.02$ by 2-tailed tests). Inspection of Fig. 2 reveals a possible bi-modality for fast learners in distributions A and C. Each of the three distributions for fast learners was divided at the mode of the slow distribution and variances were computed for each of the six resulting distributions. Comparisons of these variances with those for the corresponding slow distributions are shown in Table 2. Inspection of these data reveals that in all three distributions variance of the slow distribution corresponds more closely to that of the left-hand part of the distribution of fast learners (i.e., that of the fast learners who made few changes) than to that of the right-hand part.

Insert Fig. 2 about here

Insert Table 2 about here

Analysis of change frequency data indicates that Ss in the right-hand part of the fast distribution were in fact operating close to the chance level on either the pre-learning rating or the post-learning rating, or on both. For each S, the number of syllables on which he made 0, 1, 2, or 3 changes from before to after learning were tallied. Zero ratings were considered separate categories, as in distribution 2B of Fig. 2. These frequencies were then totaled separately for slow learners and the two

groups of fast learners. A distribution under the null hypothesis that Ss were responding by chance was derived using the assumption that the probability of switching a category under the null hypothesis that S made either or both of his ratings randomly is .50.[4] This assumption leads to a probability of $(1/2)^3$, or 1/8, of either 0 or 3 changes and the probability of $\binom{3}{1} \times (1/2)^3$, or 3/8, for 1 or 2 changes. Expected frequencies for each number of changes were derived using these probabilities and the total number of syllables for each group, and chi-square statistics were computed. Resulting chi-squares for the slow learners and the fast learners who made few changes are 70.01 and 90.05, respectively, with a value of 7.82 necessary for significance of the 5% level. Chi-square for the fast group who made many changes was 3.94, $p > .20$. When one S in this group who made a large number of zero ratings was removed, chi-square increased to 6.94, still below the 5% value. The error distribution for this S was close to that expected under a null probability of change of .67.

It was felt that a sufficient case existed for bi-modality in the fast distribution to warrant testing the means of the slow distributions against those of each part of the fast distributions. This was done for each of the three sets of distributions in Fig. 2. The resulting six ts, ranging from 3.29 to 3.80, were all significant ($p < .005$).

Category utilization and learning rate

Part of the task in assimilating material which is unfamiliar may be to differentiate it within a multi-dimensional meaning structure. Using Osgood's three primary bi-polar factors a stimulus can be characterized by one of eight different profiles if zero ratings are excluded -- good-strong-active, good-strong-passive, good-weak-active, and so on. If zero ratings are included 27 distinguishable profiles are possible. Number of different profiles used in pre-learning ratings are not related to the number of the first correct trial for either method of determining number of profiles ($r = -.06$ for the zero excluded method, $-.09$ for the zero included method). First correct trial was, however, related to number of profiles used in the post-learning ratings. Using only profiles which did not include zero ratings, $r = -.52$, $p = .01$. Two Ss had to be discarded

from this analysis since one had no profiles which did not contain zero ratings, and the other had only two. The remaining 19 Ss had a mean of 8.7 non-zero profiles.

When zero ratings were included in the profiles all Ss were included and each S's profile score was based on all ten profiles. Here $r = -.43$, $p = .025$.

Mean number of profiles used before and after learning by fast and slow learners are presented in Table 3. Fast learners did not use a greater number of profiles than slow learners before learning. However, they used a significantly greater number of profiles after learning than before. No such increase was found for the slow learners.

Insert Table 3 about here

Discussion

The major prediction of the present study was that processes involved in learning, assimilation and accomodation, would be reflected by meaning changes in Ss' responses to the material during the learning process. Specifically, it was expected that learning rate would depend on the number of changes necessary, and that fast learners would therefore make fewer meaning changes than slow learners. Results instead indicated that the fast learners fell into two groups, one which made significantly less changes than the slow learners, and one which made significantly more. In spite of the small number of Ss in each sub-distribution of fast learners there are several indications that the two populations are indeed different in several ways. The group which made a large number of changes assigned meaning categories randomly on one or both of its ratings. The group which made few changes resembled the slow group in the variance of its distribution of changes and in the non-random pattern of its meaning responses.

In terms of the theory those fast learners who made few changes started at an advanced stage of adaptation with respect to the material used in this experiment. Whether this was due to a stable attribute of these individuals, or to a S - stimulus interaction cannot be answered from the data of this study. It remains to be explained

in terms of the theory why Ss who made the greatest number of changes were fast learners. The most reasonable explanation is that they had no strong category committments for the stimulus material before learning, and therefore were random in their pre-learning ratings. This lack of committment in turn made meaning changes in the service of the adaptation process easier to make. Several authors have found that degree of polarity of rating on the SD (i.e., distance from the neutral point of the dimension) is sensitive to "amount" of meaning in the stimulus material manipulated by stimulus - situaation techniques (Kanungo and Lambert, 1963; Lambert and Jakobovits, 1960). If Ss considered the meaning categories of the SD irrelevant to the stimulus material before learning it might be expected that their pre-learning ratings were not very extreme. In fact, mean distance of their ratings from the neutral point was 5.37 scale units, while for the fast learners who made few changes mean distance was 8.68, and for the slow learners, 7.37.

Sex differences may also be involved in meaning change behavior for the fast learners. Four out of five of the Ss in the right-hand subdistributions of Fig. 2B and 2C are males. The four fast learners who made the greatest number of changes were males. Because of the small number of Ss more positive statements about sex differences will have to await further research.

A number of studies have found that Ss rate nonsense material more favorably on an evaluative scale after repeated presentation of the material than before (Becknell, Wilson, and Baird, 1963; Johnson, Thomson, and Frincke, 1960; Strassburger and Wertheimer, 1959; Zajonc, 1965). In one condition of his study Zajonc (1965), used Chinese characters as stimuli to establish that the effect was a function of exposure alone, and not production of the material by the S. Similarly, in this study a movement toward the "good" pole of the evaluative dimension was found when pre-learning and post-learning ratings were compared.

In the present study, which required production of the stimulus material, an increase in activity was also found. This increase can be interpreted as a reflection

of the fact that the material is now integrated into the behavioral system of the S. For Piaget, learning involves the internalization of schema for producing or reproducing a given response, rather than merely the formation of a structural memory trace containing the stimulus information. Piaget (1967) has presented evidence to indicate that the way in which a child recalls a given experience depends on the stage of cognitive development he has reached at the time of recall, and therefore the type of schema he is capable of utilizing at that time. Recall of the original stimulus material changes in predictable ways as the child progresses to the next cognitive stage even though the material is not presented again. Other investigators have proposed similar "active-organism" theories of learning (Neisser, 1967;[5] Werner and Kaplan, 1963). The finding that learned material increases in activity is entirely consistent with theories of this kind.

It was predicted that if rating of activity does reflect integration into a behavioral system then NSs recalled after three weeks should have been rated higher in activity after learning than those which were not recalled. Of 19 Ss who gave recall data, six recalled all ten NSs, and one recalled none. For the remaining twelve Ss, recalled NSs were significantly higher in activity on the post-learning ratings than unrecalled NSs ($t(11) = 2.53$, $p < .025$). Using the pre-learning ratings, the difference is not significant ($t(11) = 1.40$).

It might also be expected that since the fast learners who made few changes were in some sense closer to having the material in an assimilated state they should shift less on the activity dimension than the fast learners who made many changes. And if this latter group responded randomly on the pre-learning ratings, their activity ratings should increase less than the slow group, which did not respond randomly. Magnitude of activity shift does follow this ordering -- for the three groups the shifts are +.77, -1.96, and -6.98 scale units, respectively. (A minus indicates a shift toward the active pole.) In contrast, for the evaluative ratings, shifts toward the good pole are approximately equal for the three groups (-3.09, -3.68, and -4.47 scale units, respectively.)

It is well known that degree of discriminability among the stimuli in a set is an important factor influencing rate of learning (Arnoult, 1957; Postman, 1963; Underwood, Runquist, and Schulz, 1959). If discriminability is low, learning is slow, and any procedure which increases inter-stimulus discriminability facilitates learning of the material. Previous work has defined discriminability in terms of formal properties of the stimulus such as identity of letters in a set of nonsense syllables or degree of alteration of visual patterns. In this study the same relationship was found between discriminability and rate of learning, but discriminability was a function of S's internal response to the stimulus. One interpretation of this finding is that Ss not only adapted to single stimuli, but to the entire stimulus set. The fast learners were those who assimilated the stimulus set in such a way as to accomodate to it most quickly and easily by increasing the degree of differentiation of their meaning responses.

The approach taken to learning in this study is fundamentally different from that normally adopted in research on human learning. Learning research traditionally deals with effects of stimulus and response parameters (especially the former) on various performance variables. Process variables are relatively unimportant to this research, the assumption being made that a structural "memory trace" is formed at the neural or intraneural level which is strengthened or duplicated by rehearsal of the stimulus material (Melton, 1963). Proactive and retroactive inhibition, although presumably describing interactions between traces, are considered more as descriptions of empirical phenomena than internal processes.

The present approach, on the other hand, assumes that there are internal processes, definable at the psychic level, which determine the development of S's ability to reproduce the stimulus material. This study investigates the applicability of Piaget's processes of assimilation and accomodation to the learning process, where internal changes in S's relationship to the stimulus material during learning is measured by means of the semantic differential. Considerable support for the applicability of these processes was found. This author feels that identification and investigation

of internal processes of this type will be necessary before the learning function of the human organism is understood.

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Footnotes

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2. Classical human learning theory differs from Piaget's because it is atomistic rather than organismic. It assumes that learning takes place through the construction of a structural memory trace, probably biochemical in nature. Each trace is for the most part independent of other traces.

3. One S reported that he had not made any effort to conform to the requirements of the experiment. His learning and SD data confirmed this and he was therefore excluded from the analysis.

4. Since with zero included each factor has three possible categories it might seem that this null probability should be .67. However, the zero category was used very infrequently -- in 5.9% of the "before" ratings and in 4.8% of the "after" ratings. Thus a probability of .50 is a fairly good approximation to the actual null probability.

5. Neisser states, "... one does not recall objects or responses simply because traces of them exist in the mind, but after an elaborate process of reconstruction .... In a sense, all learning is "response" learning; i.e., it is learning to carry out some coordinated series of acts." (1967, p. 285)

Table 1

Rotated Factor Loadings for Twelve Dimensions of Semantic Differential*

Dimension	Factor Loadings		
	Evaluative	Potency	Activity
good-bad	.88	.05	.09
beautiful-ugly	.86	.09	.01
sweet-sour	.83	-.14	-.09
light-dark	.69	-.13	.26
large-small	.06	.62	.34
strong-weak	.19	.62	.20
heavy-light	-.36	.62	-.11
thick-thin	-.06	.44	-.06
fast-slow	.01	.00	.70
active-passive	.14	.04	.59
hot-cold	-.04	-.06	.46
sharp-dull	.23	.07	.52

*From Osgood, Suci and Tannenbaum (1957), p. 37.

Table 2

Variances of Distributions of Meaning Changes for Slow Learners and Two Types of Fast Learners (See text for explanation.)

	Scoring Procedure		
	Excluding zero	Including zero	Linear
Fast learners -- many changes	3.50	7.40	16.40
Fast learners -- few changes	3.98	3.26	13.88
Slow learners	4.24	4.00	13.64

Table 3

Mean Number of Profiles Used Before and After Learning by Fast and Slow Learners

	Scoring Procedure			
	Excluding Zero		Including Zero	
	Before	After	Before	After
Fast learners	4.22	5.22**	5.36	6.09*
Slow learners	4.40	4.20	5.00	5.10

*$.05 < p < .10$ for difference between before and after.

**$p < .025$ for difference between before and after.

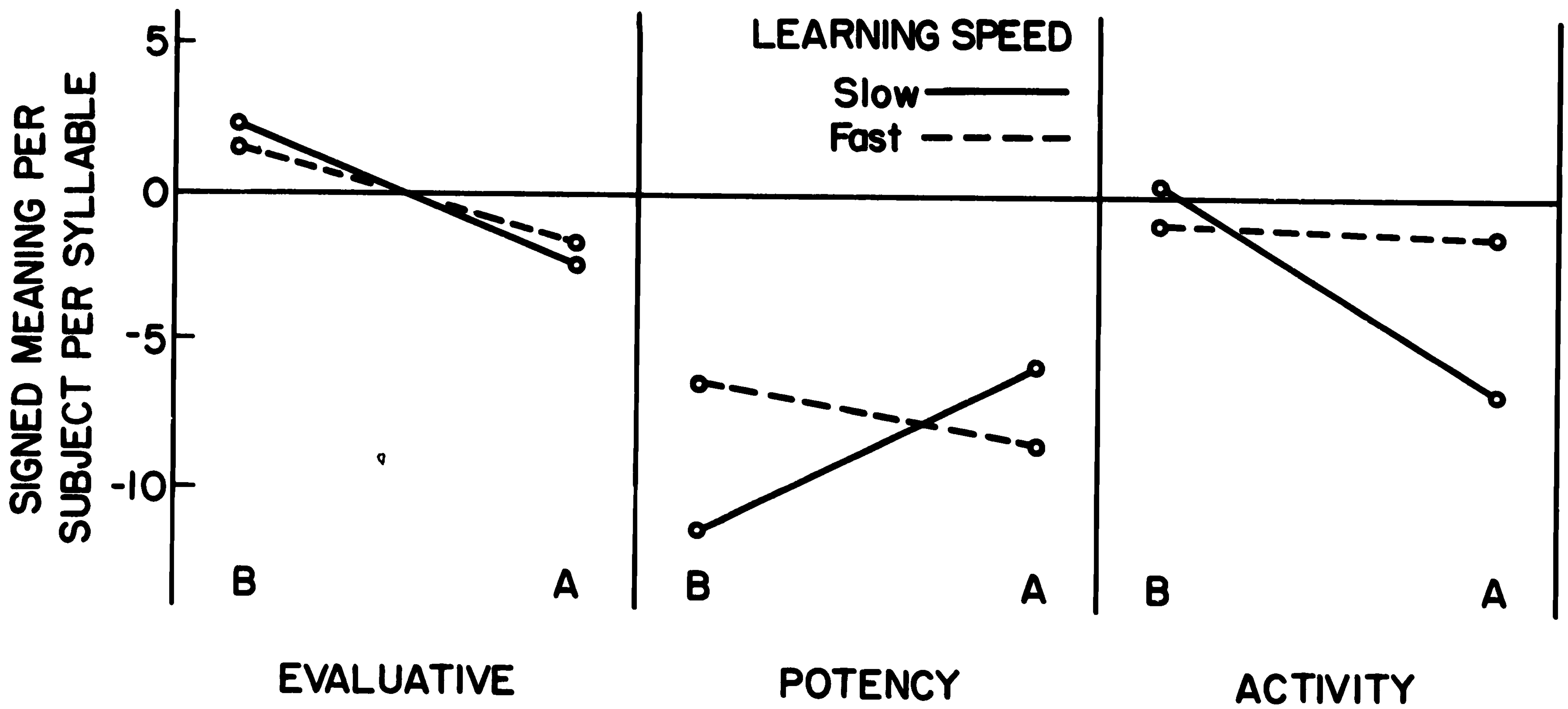

Fig. 1. Average meaning responses before and after learning on evaluative, potency, and activity dimensions for fast and slow learners. A negative sign indicates the good, strong, and active poles of these dimensions, respectively.

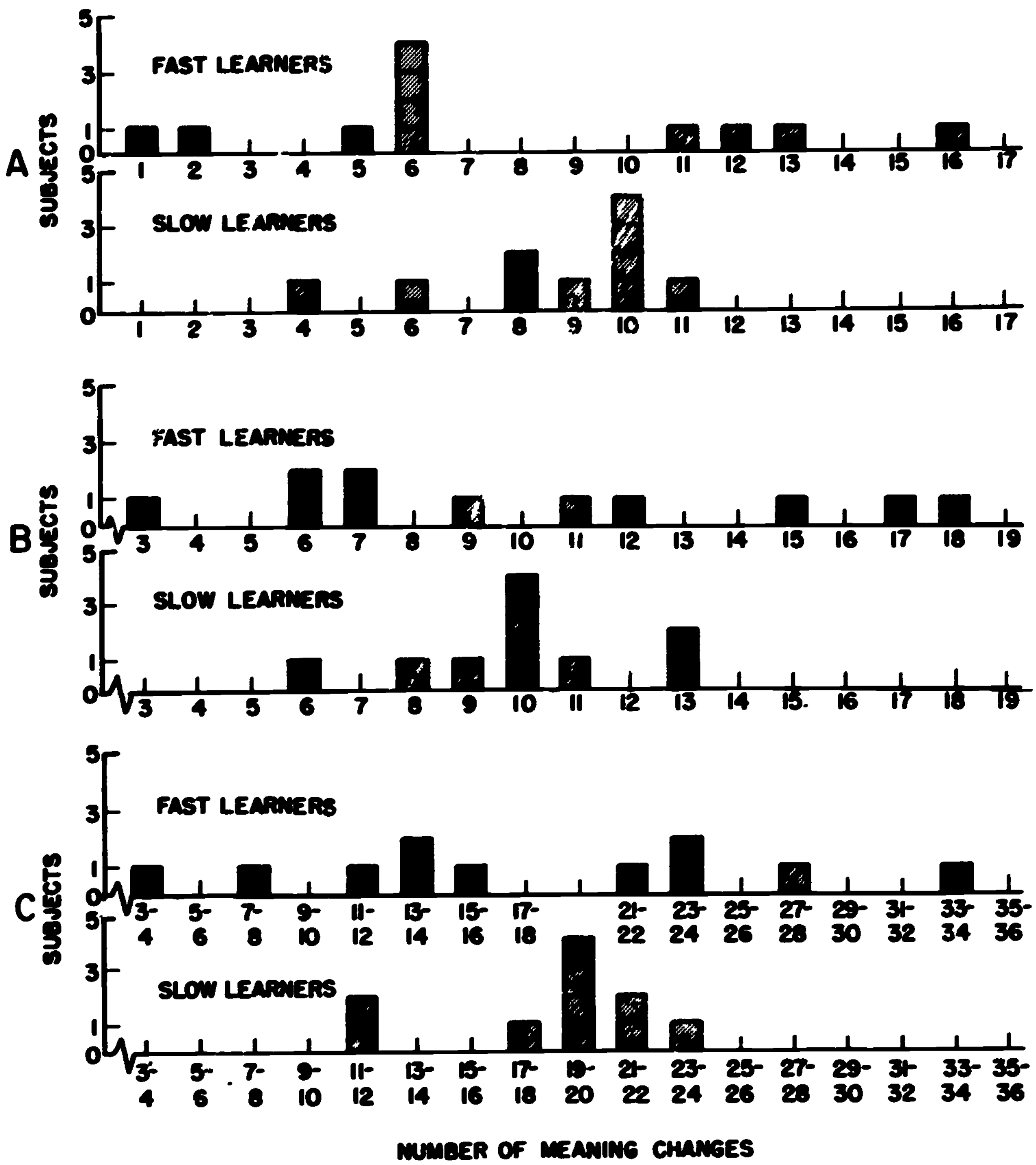

Fig. 2. Distributions of meaning category changes for fast and slow learners for three methods of scoring changes: A, excluding zero values; B, including zero values; and C, linear. (See text for explanation of these procedures.)