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THE INFLUENCE OF CONTEXT AND PERCEPTUAL CONTRAST IN THE ASSESSMENT OF PIAGETIAN ABILITIES: A STUDY OF EVALUATION BY VIDEO PROCEDURES

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A STUDY OF EVALUATION BY VIDEO PROCEDURES

by

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Abstract

THE INFLUENCE OF CONTEXT AND PERCEPTUAL

CONTRAST IN THE ASSESSMENT OF PIAGETIAN ABILITIES

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by

Donald Edward White

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Two studies were performed to investigate the effects of contextual and perceptual variables upon performance by transitional children on two Piagetian tasks which evaluate structure at the concrete operational level. Context, or the situation which frames the task, was varied by means of a videotaped story in which the Piagetian task was used to trick or outwit a bully. In the first of the studies, the effect of this variable was examined on the conservation of continuous quantity (liquid) task among 96 second grade children. Changes from active to passive observer role which this contextual change introduced were also examined. Results indicated that superior performance was produced through the action of the contextual variable. Differences between active and passive observer role were not found to be of consequence.

The second study utilized 192 second grade children to examine the effects of context and perceptual contrast upon performance on both the conservation of continuous quantity (liquid) task and a class inclusion task used to measure additive classification (ie. a problem requiring the subject to determine whether there were more items in a superordinate set or in one of two presented subsets). Once again a significant effect was found for the contextual variable. The perceptual variable produced

the subject to determine whether there were more items in a superordinate set or in one of two presented subsets). Once again a significant effect was found for the contextual variable. The perceptual variable produced a significant effect upon the conservation task only, where increased perceptual contrast between pre- and post-transformation states was associated with better performance. This result was interpreted as tentative support for Piaget's recent position that stimulus changes in transformed materials should be viewed in terms of commutability and vicarious relationships, rather than relationships that are compensatory.

The major finding of the two studies was that variables existing apart from Piagetian structural concepts can produce spontaneous improvement of performance on a Piagetian task. These variables can arise from perceptual sources intrinsic to the Piagetian task and from contextual sources extrinsic to the task. In the case of the latter, performance may be influenced, regardless of whether the task involves a transformation of stimulus material. In the case of the former, the possibility of an effect beyond tasks featuring a physical transformation remains equivocal. The mechanism responsible for the enhancement of performance was said to be the inhibition or reduction in strength of the immediate response based strictly upon the more salient of the task dimensions, an effect which enables the use of dimensions less salient, as well, and thereby promotes operativity.

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Piagetian theory asserts that performance on intellectual tasks is governed by the action of internal regulatory mechanisms which operate upon the product of organism -- environment interactions. While this position recognizes environmental variables as consituting an influence with which these internal regulatory mechanisms must cope, it does not emphasize them as a source of variation in task performance. The stress, rather, has been placed upon the structural constraints on environmental influence.

In this paper the focus is shifted from the constraints of structure to the malleability of performance. The thesis is maintained that, at a given level of development, environmental variables can influence performance to a greater extent than is recognized by the Genevan school, and that this influence is both predictable and controllable. Issue is not taken with the notion of structure as a developmental concept. Instead, variables existing apart from Piagetian structural concepts are studied as additional factors which systematically influence performance and which require examination when inferences are drawn concerning the actualization of structure in behavior.

In recent years numerous studies have reported methods of producing spontaneous improvement in performance on Piagetian tasks. In most cases, performance change has been produced through methods which have, at some point, modified the requirements of these tasks (Zimiles, 1966; Winer, 1968; Whiteman and Piesach, 1970; Miller, Heldmeyer and Miller, 1975). In an alternate approach, White and Glick (1978) elicited enhanced conservation of

continuous quantity (liquid) through the manipulation of contextual, or situational, factors. While this procedure demonstrated the systematic facilitation of performance without evident change in either the requirements of the task or the abilities which the task is designed to tap, it left several questions unresolved concerning the nature of the stimulus variables responsible for the change in performance and the mechanism through which this change was produced. As these issues have remained unclear, so, too, has the relationship of this finding to those reported where other methods of inducing spontaneous change have been employed.

In order to enhance performance on a Piagetian task without the need for training, one must make it easier for the child, at his or her existing level of competence, to deal with the task. Doing so presumes, of course, that the child has become sufficiently mature to possess abilities which can be successfully employed for this purpose, if some courses of difficulty associated with the task are removed. This may be accomplished through modifications of features intrinsic to the task itself. Changes in the perceptual salience of stimulus cues utilized in the solution of the conservation task have been particularly effective in producing change in performance. Those which have increased the salience of cues overlooked by non-conservers have raised performance levels in number conservation (Peters, 1970; Whiteman and Piesach, 1970; Miller, Heldmeyer and Miller, 1975) and the conservation of mass (Whiteman and Piesach, 1970). Reductions in amount of transformed material have produced enhanced number conservation performance (Zimiles, 1966; Winer, 1975). Induced response sets, directing the subject's attention to appropriate cues, have been used to attain similar effects (Winer, 1968; Gelman, 1969). Change in conservation

performance, it appears, is quite attainable through change in the perceptual loading of the stimulus materials.

The basic premise of the White and Glick (1978) study was that the difficulty of the Piagetian task derives from factors extrinsic as well as those intrinsic to the task. It was proposed that performance might also be enhanced by means of a modification in the contextual demands which may accompany the presentation of the task.

In research where this has been attempted, Willoughby and Trachy (1971), Kahn and Garrison (1973) and Kahn and Reid (1975) found that children handled the number conservation task more effectively when it was presented as a choice between two rows of candies which they could take to eat. Willoughby and Trachy (1971), it should be pointed out, changed their instructions to avoid the use of words referring to amount, a variable believed by some (Braine, 1959; Braine and Shanks, 1965; Griffiths, Shantz and Sigel, 1967), though not by Piaget (1941/1965) to be a potential source of difficulty in the conservation task. In addition, Willoughby and Trachy used a less stringent criterion for conservation -- conserving judgments without justifications. Using the terms, "more" and "same," and seeking justifications, Baker and Sullivan (1970) achieved the same effect with an inequality number conservation task, as did Miller (1976) in a similar procedure that avoided these terms.

In these studies it is not likely that the candies, themselves, directed the child's attention to otherwise overlooked cues in the test stimuli. Rothenberg (1969 and Miller, Heldmeyer and Miller (1975) found that performance on number conservation tasks could not be improved by simply presenting high interest stimuli. The change that led the subjects

to approach the task in the appropriate manner evidently was the presentation of the materials as a choice among items to consume.

Silverman and Schneider (1968) used the same technique to obtain successful responding on a conservation of discontinuous quantity task, as did Bermudez, Prather, Berry and Tebbs (1974) on an analogous task involving continuous quantity. Both studies involved inequality conservation and avoided references to quantity, however. McGarrigle and Donaldson (1974) elicited number conservation by presenting the transformation as an accident caused by a misbehaving teddy bear. Murray (1977) has reported elicited conservation of mass in a procedure in which test stimuli (balls of clay) were attached to a bogus measuring machine, and subjects were asked whether the transformation would cause the machine to register a change in quantity. Despite the differences that exist among these studies, taken together they suggest that, given the right set of contextual factors, many children who would otherwise appear to be non-conserving can quite suddenly and quite competently display conservation.

White and Glick (1978) sought to elicit enhanced performance in the conservation of continuous quantity by utilizing a video presentation that incorporated the conservation task into a story involving a bit of trickery or deceptiveness. The theme of trickery was introduced to encourage the subject to become suspicious and, therefore, to discourage him or her from overlooking relevant task stimuli. The story, which depicted a child's efforts to cope with a bully, was designed to present the trickery in a familiar context which would facilitate comprehensibility. It was felt that if, in comparison with appropriate controls, this combination of story and trickery produced an elevated level of performance, a finding

of this nature would provide evidence of a new sort that an enhanced level of attainment can be produced through the manipulation of variables extrinsic to the conservation task.

The findings of the White and Glick (1978) study indicated that beneficial effects of context occurred among transitional children, those in the age range where the operations required for the conservation of continuous quantity are typically first developed (i.e., first and second graders). Among older subjects, the intrinsic demands of the task were sufficiently mastered to produce maximally successful performance without the need for the contextual manipulation. Among younger subjects, the conservation task was of sufficient difficulty (or the ability to comprehend trickery was so undeveloped) that the treatment was not effective in eliciting successful performance.

Although the findings were supportive of the White and Glick position concerning the power of contextual variables, they left several issues open. These include the nature of the stimulus variables responsible for the performance change and the mechanism through which the change in performance is induced. An examination of these issues and their implications follows.

The nature of the stimulus variables responsible for performance change. In the White and Glick study the contextual effect was limited to a video condition featuring the interaction of story and trickery variables. A story without trickery and trickery without a story were both ineffective in eliciting performance change. However, the manner in which these variables interact is clouded by a confounding factor.

The story presentations which were used to establish a familiar con-

text for the use of trickery involved a transformation that was made as part of a social interaction between two actors. That is, the liquid was poured by one actor for the benefit of the other, and the subject was asked about the quantities in the transformed state. The effect of the procedure was to place the subject into an uninvolved third-party role. In contrast, the transformation in the non-story conditions was made by a character who addressed the subject directly and asked him or her about the final quantities.

This difference is of importance in understanding the manner in which the trickery variable influenced performance. While it seems reasonable to presume that the trickery gained its effectiveness from the story context, this may not have been the case. One cannot rule out the possibility that either the effect of trickery alone, or the impact of the story x trickery interaction was evoked through the third party role of the subjects in the story, trickery condition.

Although the third party subject role has not been scrutinized as a vehicle to enhance conservation, it has come under investigation by individuals doing research in other areas with adults. Jones and Nisbett's (1972) analysis of attribution makes a rather important distinction between the behavior of active and passive observers. Active observers are defined by Jones and Nisbett (1972) as persons who are in some way interacting with the individuals whose actions they are observing. Passive observers are defined as observers who are not interacting in any way with the observed individuals. According to Jones and Nisbett (1972), active observers are more likely than passive observers to look to the personal qualities of the individuals they are observing to account for the sequence of actions that occurs before them in their observations. Passive observers,

on the other hand, are held more likely to attend to environmental factors in deriving their understanding of these events. It might also be pointed out that neither active nor passive observers are described as generally attributing as many occurrences to environmental causes as are the actors, themselves. This latter position, which has become somewhat controversial, has been corroborated by some researchers (Nisbett, Caputo, Legan and Marecek, 1973; Storms, 1973; West, Gunn and Chernicky, 1975) and disputed by others (Snyder, 1976; Monson and Snyder, 1977).

Jones and Nisbett's (1972) account of behavior among active and passive observers has received considerably less attention than their actor -- observer distinction, but has gained support from Miller and Norman's (1975) research on active and passive observers of behavior in competitive and cooperative situations. If this position is correct, it suggests that the rather high level of performance attained in the story, trickery condition of the White and Glick study may have been influenced by the observational role assigned to the subjects in this group.

The third-party role in the White and Glick study and Jones and Nisbett's passive observer role appear to be essentially the same. The more direct way of addressing the subject in White and Glick's non-story conditions may have created an observational role more similar to Jones and Nisbett's active observer. Since the inability of the video character to respond to the child created a situation that was less than a true observer -- actor interaction, the observational role in this condition might be better described as quasi-active. Not a true active observer role, it was, nonetheless, certainly the more active of the two found in this study.

Because of the differences in observer role that existed among the

experimental conditions, subjects in different conditions may have been predisposed to scrutinize different kinds of stimulus information to account for the events which occur in the task presentation. More sensitive to situational factors, the passive observers in the story, trickery condition may have more readily perceived the trickery of the video presentation as arising from sources external to the actor and, hence, from the lawful relationships which inhere in the manipulation of the experimental materials. Oriented more toward personal attribution, the active observers in the non-story, trickery condition may have attended more closely to the characteristics unique to the video character: the look in his eyes, the tone of his voice, etcetera. As a result, these subjects may have been less prone to attend to the logical nature of the transformation itself, and may have, consequently, been deterred from the production of sophisticated responses. Such an occurrence would create problems of interpretation by blurring the effects of the experimental variables, and by raising questions as to the recurrence of these effects in more standard settings where the observer role of the subject is typically more active. (This possibility will be investigated in the first of two proposed studies, to be described later.)

The mechanism through which performance change is induced. Although some researchers have sought to describe them in more molecular terms (Pascual-Leone and Smith, 1969; Anderson and Cuneo, 1978), the tasks that Piaget utilizes among children at the concrete operational level are generally held to attain their difficulty by requiring a response that is based upon two or more related dimensions. In the case of conservation, the logic of the task derives from the physical relationships which exist among the task materials and which vary in a coordinated manner when the

transformation is made. Successful performance requires sensitivity to all of the relevant changes that occur in the materials when they are transformed. Unfortunately the problems of this task may be compounded by a kind of deceptiveness derived from the unequal perceptual salience of the relevant dimensions and reflected in the common tendency among subjects who handle the task incorrectly to focus upon those that are perceptually more salient (typically height or length) when formulating their incorrect responses.

As long as the child has not developed the ability to decenter appropriately, a tendency to be attracted to certain dimensions can influence only the direction of his or her error. Later in development the the appropriate operations will enable the child to overcome any such tendencies. However, the child who is transitional in development with regard to the task may be able to respond operationally only under conditions which assist him or her in resisting these tendencies. As discussed previously, one way of introducing such conditions is through change in the perceptual qualities of the task. A change that would appear to be particularly important in this regard is the reduction in relative strength of the more salient perceptual dimension. One would presume that change of this sort would be produced by altering the level of perceptual contrast that exists among the stimulus dimensions of the task. In conservation, a transformation which induces lesser change in the more salient dimension might produce better performance than a transformation which induces a greater change.

This result has in fact been obtained by Melnick (1973), who reported that greater array length transformations on the number conservation task produced poorer conserving behavior than did smaller changes.

Unfortunately, attempts to achieve similar results in the conservation of continuous quantity (Miller and Heldmeyer, 1975; Gallagher and Reid, 1978) and the conservation of discontinuous quantity (Feigenbaum, 1963; Hooper, 1969; Koshinsky and Hall, 1973) have not been as successful.

It is possible that this lack of success may be the product of methodological problems. Variation of dimensional contrast in the conservation of quantity requires the use of one set of containers where the pre- and post-transformation diameter difference is slight, and one or more other sets where the diameter differences are greater (causing a sharper change in the height of the transformed material). But further dimensional specification may be required, in order to eliminate potential sources of error.

Container height could well be one such source requiring control. Preoperational children have imprecise concepts of quantity and fullness which confuse the relevance of liquid height and container height. In two studies (Bruner and Kenney, 1966; Siegler and Vargo, 1978), children at this point in development were presented with containers that were made to different heights and that were filled with different quantities of a liquid. When asked to respond to questions concerning the relative fullness of these containers (that is, the proportion of liquid to container height), these children responded as if the questions had been about relative liquid height. When using containers of varying heights in studying the conservation of continuous quantity, Craig, Love and Olim (1973) found that their non-conserving subjects expected the height of the liquid and the height of its container to be equally proportional in the glasses used to hold the liquid prior to and after the transformation. Liquids,

they felt, would rise higher in taller glasses. Given these sources of confusion, it would seem that, if differences in liquid height are to be used to measure perceptual contrast, the potentially contaminating variable of container height should be controlled.

Unfortunately, this is not reported as having been the case in any of the above studies. Glasses of varying heights were used in the work by Hooper (1969), Miller and Heldmeyer (1975) and Gallagher and Reid (1978). Glass dimensions were unspecified in the results reported by Feigenbaum (1963) and Koshinsky and Hall (1973). Had this variable been controlled, one would have hoped that the effect of perceptual contrast might have been evidenced on the conservation of continuous and discontinuous quantity tasks through superior performance in the low contrast conditions.

The contextual approach utilized by White and Glick (1978) presents an alternate means of getting the child to resist focusing upon only the more salient of the stimulus dimensions and to improve performance thereby. If this resistance involves the act of looking beyond the obvious appearance of things and attempting to discover realities underlying appearances, then parallels can be found between the trickery of the White and Glick approach and the requirements of the conservation task.

Trickery, as a social category, involves one person's influencing another by means of presenting a version of reality that is misleading. People aware of the possibility of a trick would be oriented toward analyzing surface appearances and, hence, toward understanding a truer version than what is presented as true. This being so, a vehicle is suggested through which performance would be enhanced on the conservation task, insofar as the latter similarly involves seeing through surface appearances and resisting the temptation to respond strictly on the basis of these

appearances.

The potential susceptibility of conservation performance to contextual and perceptual influence gives rise to questions regarding the generalizability of this phenomenon to performance on other Piagetian tasks. One issue, in particular, that is raised concerns the malleability of performance on tasks which do not depend upon the child's responsiveness to coordinated change in the physical dimensions of stimulus materials.

A task which is not based upon a physical transformation, but is derived, instead, from the pure logic of its premises is the class inclusion task used to measure additive classification. Additive classification refers to the relationship between a superoridnate set and its subsets, as measured in a comparison of the number of roses and the number of flowers in a bouquet (Inhelder and Piaget, 1964). Research in this area has recently been reviewed by Winer (1980).

Although purely logical in nature, the additive classification task, too, features potentially deceptive qualities which may add to its difficulty. Customarily, when individuals are presented with two sets of materials and are asked which of the two is "more," it is implied that a comparison is to be made among these sets, rather than among the classificatory relationships that they denote. A habitual tendency to respond in kind would be of minimal consequence for the performance of the preoperational child on this meausre. The youngster cannot decenter and is incapable of handling the task, in any event. For the mature individual, the appropriate operation would overcome this response tendency. If, for this task, there is a period during which the child is sufficiently mature to decenter, but is susceptible to habitually induced tendencies toward a comparison of subsets, this period of transition may be one which is

characterized by the kind of systematic variation in performance that was said to occur in conservation.

Work by several researchers bears upon this possibility. Wohlwill (1968) has suggested that the physical presence of items making up the stimulus subclasses in a class inclusion task (eg., pictures of dogs and horses in a task requiring a comparison between the numbers of dogs and animals) induces a "perceptual set" which encourages the young subject to focus upon these subclasses and discourages the proper subset comparison. Both Wohlwill (1968) and Winer and Kronberg (1974) have found that a verbal presentation in which the stimuli are not presented visually reduces this difficulty and produces better performance. However, findings by Jennings (1970) suggest that the results obtained by these researchers may be the product, not of perceptual, but of linguistic changes which the verbal presentation introduces.

Using a counterbalanced repeated measures technique, Ahr and Youniss (1970) found that performance tended to become better as differences in subset size became smaller. However, the bulk of the variance which they obtained occurred between their extreme conditions, that is between the condition in which both subsets were equal in number of items and the condition in which one of the subsets contained all of the items. When the results obtained in these conditions are eliminated from their data, it becomes unclear whether differences in subset size influenced the performance of their subjects among the more intermediate conditions. Kalil, Youssif and Lerner (1974) have found that performance is better when subset size is equal than when it is not, but research by Brainerd and Kaszor (1974) suggests that this effect is, at least in part, an artifact of the wording of the task. Brainerd and Kaszor's (1974) findings indi-

cate that the presence of an equality (or an inequality) in the number of items contained in the subsets interacts with the wording of the class inclusion question (i.e., the use of the word "more" versus the word "same") to influence whether or not the child responds to the task in the appropriate manner. McGarrigle, Grieve and Hughes (1978) have reported that enhanced performance occurs when the wording of the class inclusion task does not direct the child's attention to the aspect of the task that is perceptually the most salient.

Although perceptual effects appear evident on the additive classification task, the covariation of linguistic factors in the above studies makes these effects difficult to interpret. However, in additive classification, as in conservation, there exists research in which potentially confounding linguistic effects seem rather minimal. Tatarsky (1974) obtained enhanced additive classification performance in a study involving wooden blocks. Each block was half unpainted and half painted with one of two colors. Using these materials, children were more successful in comparing the relative numbers of wooden blocks (the superordinate set) and blocks painted one of the colors (one subset). Wohlwill (1968) and Meadows (1977) uncovered a similar enhancement of performance when they included among the stimulus materials, extraneous items which increased the discriminability of the superordinate set. Meadows (1977) found, additionally, that better performance accompanied the use of smaller sets.

A generalization that might be drawn from the above data is that in additive classification and conservation alike, successful performance appears to be retarded when one intensifies the perceptual prominance of the dimension which comprises the focus of the preoperational response, and, conversely, that successful performance appears to be promoted when

one reduces the perceptual prominance of this dimension. In the former, as in the latter, perceptual contrast would seem to be of importance in this regard. In an additive classification probe in which subjects are presented with two subsets of a larger set, both containing materials, each unequal in number, and the subjects are asked whether the superordinate set or the larger subset "is more," one would expect impaired performance when the contrast in subset quantity is great, enhanced performance when the contrast is slight.

If conservation and additive classification performance can be viewed as comparably influenced by factors intrinsic to each of the two tasks, one might anticipate finding a common extrinsic manipulation which improves performance on each by restraining responses centered entirely upon the more prominant dimension of the task and by encouraging responses sensitive to additional dimensions relevant to its solution. The contextually induced changes in performance which were found on the conservation task might, therefore, be anticipated when a similar contextual manipulation is attempted on the class inclusion task.

Evidence of this possibility is found in a study performed by Siegel, McCabe Brand and Matthews (1978). Siegel et al. presented subjects with two sets of candy, each containing a different type, and told them that they could choose to eat either the candies or the variety of candies that they preferred. Greater numbers of children in this condition chose the superordinate set. Unfortunately, since this presentation also changed the wording of the task (eliminating the comparative terms, more, less and same), one cannot determine whether the contextual effect overcame or simply avoided the problems of linguistic confusion.

Since the above findings raise the possibility that, as in conserva-

tion, class inclusion performance may be facilitated through perceptual and contextual changes which influence the response-inducing properties of the task dimensions, the areas of conservation and additive classification provide excellent comparison tasks on which to examine the range of the perceptual and contextual effects and, by implication, the mechanisms through which these effects are produced. An effect that occurs in the former task, but not in the latter, would suggest its limitation to sources of confusion associated with a physical transformation of the sort required in conservation. One that occurs in additive classification as well as conservation would suggest an effect which mitigates confusion more generally associated with the use of stimulus materials in the evaluation of logical structures.

In order to examine these issues, two studies were performed. The goal of the first was to clarify the relationships that exist among the variables of trickery and observer role. The goals of the second were several. They included:

1. To verify the existence of the contextual effect.

2. To verify the existence of an effect for perceptual contrast.

3. To determine whether performance is influenced through the interaction of context and perceptual contrast.

4. To determine whether the conservation and additive classification tasks differ in sensitivity to the context and perceptual contrast variables.

With these goals in mind, the two studies were undertaken.

DESIGN

The research design consisted of two studies. A clarification of the White and Glick procedure, the first focused upon the conservation of continuous quantity (liquid) task. Its goal was to determine the extent to which the enhancement of performance obtained in the White and Glick study could be attributed to the impact of the story, trickery variable and the extent to which it could be attributed to the influence of observer role. The second was designed to determine whether the contextual variable found to be effective in the first study would produce similar results on both the conservation and class inclusion tasks at levels of high and low perceptual contrast. The studies proceeded as described below:

Study I

Method

Subjects. The subjects were 96 white, middle class, second grade children at a median age of 7 years, 6 months. Included were 49 boys and 47 girls.

Materials. A Panasonic NV 8310 video tape recorder and (black and white) playback monitor were used. The materials also included a pitcher and two glasses. As they appeared on the monitor, these glasses seemed capable of holding liquids to a height of $3^{1}/_{4}$ inches (8.26 cm.), and were $2^{5}/_{8}$ inches (6.67 cm.) in diameter. These were filled with a dark liquid to a height of $1^{13}/_{16}$ inches (4.62 cm.). There was an empty third glass with the same height dimension but a smaller diameter of $2^{1}/_{16}$ inches (6.18 cm.). When filled with the contents of one of the two other glasses,

it became filled to a height of 3 inches (7.62 cm.).[1]

Procedure. The children were seen in school. The materials were in a room where each of the subjects was taken and tested individually by the experiementer. The subjects were divided into four experimental groups, 24 in each. Assignment to groups was random, with the exception of a balancing for gender. No group had more than 13 of each sex.

Each group was tested for conservation by means of a different video presentation. The variables under investigation included observer role and the presence or absence of a story involving trickery (henceforth referred to as the trickery presentation). Their combination defines four conservation measures, each of which was utilized with a different group.

The conservation presentations are described in Appendix I. They consisted, in brief, of the following: The trickery conditions featured a story involving three characters, including a young girl, Jimmy Kool and a female (bully). The young girl was selling a soft drink and was allowed to give only a certain amount to each of her customers. The bully, however, demanded a glass filled with the drink to a higher level than she was given. After being threatened, the young girl got advice (seen but unheard) from Jimmy Kool and then met the bully's demand by

[1]The materials are described above as they were displayed to the subjects on the video monitor. Their true (off camera) dimensions were: Standard (wider) glass - $2\frac{13}{16}$ inches (7.15 cm.) high, $2\frac{7}{8}$ inches (7.30 cm.) in diameter, holding liquids to a pre-transformation height of $1\frac{1}{2}$ inches (3.81 cm.). Narrower glass - $2\frac{13}{16}$ inches (7.15 cm.) high, $2\frac{1}{4}$ inches (5.73 cm.) in diameter, ultimately holding liquid to a post-transformation height of $2\frac{1}{2}$ inches (6.35 cm.).

pouring the drink into a narrower glass.

The non-trickery conditions began with the young girl and Jimmy speaking. The girl then summoned a second girl (the bully in the trickery presentation) and performed the transformation for her.

In the versions featuring the active observer format, the characters repeatedly addressed the viewer. In the passive observer conditions, the interaction was restricted to the characters in the video presentations.

In each condition, the action ceased just after the transformation and, with the glasses displayed on the monitor in their post-transformation states, the subject was questioned for conservation by the experimenter. On all four measures, a successful response required the successive production of a correct judgment and an appropriate justification. The criteria for determining the appropriateness of justifications followed those utilized by Goodnow (1973). Justifications which were considered appropriate were those dealing with the compensatory relationships among the stimulus dimensions ("It comes up higher in a skinny glass."), the reversibility of the transformation ("She could pour it back, and it would be the same as before.") or the identity of the liquid, referring to addition/subtraction schemes ("She didn't add anything or take anything away, so it's still got to be the same."), and not referring to addition/subtraction schemes ("It was the same before she put it into the other glass, so it's still got to be the same.").

An analysis of justifications, by type, appears in Appendix V.

Results. Since the responses were scored as conserving or non-conserving, the non-continuous data which were obtained were analyzed by means of a chi-square augmented through Lancaster's partitioning procedure (Sutcliffe, 1957). In this procedure, as it was employed in the current

study, the main effects of the variables were calculated in a manner similar to standard chi-square methods. Partitions of the data were next performed and interactions were computed as chi-squares among residual variance. Computational formulas are shown in Appendix II. The data analysis approximated a 2 x 2 x 2 design and featured two factors which were fixed (trickery and observor role) and one which varied (pass, fail).

Table 1 shows the data of Study I, and Table 2 summarized the obtained effects. A significant main effect was found for context. As shown in Table 3, performance was better in the trickery conditions than in the non-trickery conditions. No other significant main or interaction effects were found. The contextual effect was, therefore, evidenced and clearly attributable to the presence of absence of trickery, irrespective of observer role.

Study II

Study II focused upon the variable found in Study I to be responsible for the contextual effect (trickery) and examined the comparative influence of this variable in the conservation and additive classification tasks at two levels of perceptual contrast.

Method

Subjects. The subjects were 192 white, middle class, second graders at a median age of 7 years, 6 months. These included 93 boys and 99 girls.

Materials. A Panasonic NV 8310 video tape recorder and (black and white) playback monitor were used. For the various combinations of task and perceptual contrast, the following materials were employed:

Conservation low contrast materials were identical to those used in Study I.

Conservation high contrast materials included the same two

wider glasses as in the low contrast condition. However, they were filled to a starting liquid height, as it appeared on the monitor, of only $^{7}/_{8}$ inches (2.21 cm.). The glass which ultimately held the transformed liquid was the same height as each of the other glasses used in the study, but had a narrower diameter (1 inch, 2.54 cm.) than its counterpart in Study I. As in the low contrast condition, the liquid rose to a height of 3 inches (7.62 cm.) in the narrower glass after the transformation.[1] Additive classification low contrast materials were miniature plastic toy animals: 20 horses and 16 cows. Additive classification high contrast materials featured the same number of horses (20) as in the low contrast condition and 4 cows.

A few words must be added concerning the quantities which were used in this study. The quantities of materials were chosen to present a constant 1 : 4 ration between the size of the smaller sets in the high and low contrast conditions on the additive classification task and also between the starting liquid heights in the high and low contrast conditions on the conservation task. Unfortunately, the pre-

[1]The materials are described above as they were displayed to the subjects on the video monitor. Their true (off camera) dimensions were: Standard (wider) glass - $2^{13}/_{16}$ inches (7.15 cm.) high, $2^{7}/_{8}$ inches (7.30 cm.) in diameter, holding liquids to pre-transformation height of $^{3}/_{8}$ inches (0.95 cm.). Narrower glass - $2^{13}/_{16}$ inches (7.15 cm.) high, $1^{1}/_{8}$ inches (2.86 cm.) in diameter, ultimately holding liquid to a post-transformation height of $2^{1}/_{2}$ inches (6.35 cm.).

cision of this relationship was lost when a constant distortion in liquid height was introduced through the transfer of recording format which was required for the editing of the video materials and through the use of a studio monitor having a picture quality that was different from the picture quality of the monitor which was used for testing subjects in the field. Although the 1 : 4 relationship remained in the additive classification task, it was changed to a ratio of slightly more than 1 : 2 on the conservation task.

Procedure. As in the previous study, the children were seen in school. The materials were in a room where each of the subjects was taken and tested individually by the experimenter. The subjects were divided into eight experimental groups, 24 in each. Assignment to groups was random, with the exception of a balancing for gender. No group had more than 13 boys or 14 girls.

Each group was tested for conservation or additive classification by means of a different video presentation. The variables investigated for each task included the presence or absence of a story involving trickery and the use of low or high contrast materials. Since in Study I no differences in performance were produced through changes in observer role, the active observer role was used exclusively in Study II. This role was chosen because it more closely resembled the standard Piagetian format, in that the subject was addressed by the participants.

The combination of variables which was used produced four conservation and four additive classification conditions. The trickery and non-trickery conservation presentations were identical to those of Study I, except that they were employed with the high contrast materials, as well as with the low contrast materials that were used in the first study. The

trickery and non-trickery conditions of the additive classification task featured the same three characters as in the conservation conditions, and they were analogous in design. They are described in detail in Appendix III.

The presentation used for the measurement of additive classification can be briefly summarized in the following manner: In the additive classification trickery condition, the young girl was distributing toy animals for the children in her class. The bully came by and insisted on taking as many toy animals as she wanted. The girl resisted, protesting that the bully was selfish and always grabbed as many as she could for herself, adding that this time she would not be allowed to get away with that. After being threatened, the girl spoke with Jimmy Kool (as before, with Jimmy seen but not heard by the viewer as he gave her advice) and then offered the bully a unique choice: the horses or the animals.

As in the conservation presentation, the non-trickery condition began with the young girl and Jimmy speaking to one another. The girl then summoned a second girl (the bully in the trickery presentation) and asked the additive classification, class inclusion question.

In all cases, when the action ceased the subject was questioned, with the monitor displaying the experimental materials as they appeared in the final scene. Judgements and justifications were sought. Acceptable justifications on this task were of only one kind -- those indicating the inclusive class relationship that exists between the whole set, animals, and the subset, horses ("The animals would be the horses and the cows." "The horses would be only that part of the animals.").

Results. The data of Study II, which are displayed in Table 5, were analyzed by means of Lancaster's chi-square partitioning procedure

(Stucliffe, 1957), with three factors fixed (task, context and perceptual contrast) and one varying (subject response). Computational formulas can be found in Appendix IV. Main and interaction effects are summarized in Table 6.

As in the first study, a significant main effect was found for context. Table 7 shows that, once again, the trickery condition produced better performance than did the non-trickery condition. No effect was found for perceptual contrast. As shown in Table 8, the success rate on the conservation task (63%) was greater than it was on the additive classification task (24%), a difference that was significant.

There was a significant interaction of task and perceptual contrast. As seen in Table 9, both tasks appear quite unexpectedly to have been influenced in opposite directions by the change from low to high contrast. It is possible that this may have been responsible for the failure to obtain a main effect for perceptual contrast, insofar as the reverse effects of perceptual contrast on the two tasks may have obscured the overall impact of this variable. What was particularly surprising was that on the conservation task, the higher level of perceptual contrast produced significantly stronger performance. The opposite had been anticipated.

To indicate that the perceptual variable influenced performance in any direction on the conservation task is to indicate that its influence was found on the task in which performance was generally better. On the additive classification task, performance was at a poorer level and did not indicate sensitivity to the impact of the perceptual variable.

One other significant interaction was evident, this between context and perceptual contrast. Table 8 shows that, relative to performance in

the trickery condition, performance in the non-trickery condition improved with increased perceptual contrast. As before, the effect of the perceptual variable appeared in one condition - in this case, the one featuring the non-trickery presentation. However, unlike the way in which the perceptual effect occurred across the two tasks, the effect of perceptual contrast appeared in the context which generally produced poorer performance, the non-trickery context. Here the implication is that maximum performance gain was attainable through the trickery variable alone, making the influence of the perceptual variable redundant in the trickery condition.

A significant context x task interaction was not found, indicating a consistent contextual effect across tasks. Nor was there a significant three-way interaction of context, contrast and task.

The unexpected finding of enhanced conservation performance in the low contrast condition required a reexamination of the explanations which the subjects gave to justify their conserving judgements. This was necessary in order to determine whether changes in sensitivity to these cues had been produced through any of the experimental manipulations. Since the mechanism for change in performance in the low and the high contrast conditions had been discussed in terms of change in the relative salience of the height and diameter dimensions of this task, it became important to determine whether the high contrast condition had somehow encouraged sensitivity to the less salient of these dimensions (as might be indicated by an increase in compensation explanations), or whether the subjects were responding to some property related to the continuity of the material from pre- to post-transformation states (as might be suggested through greater use of explanations based upon the identity of the stimulus material

or the reversibility of the transformation occurring within this material). Comparisons were made in the frequency of compensatory and identity/reversibility explanations in the high and low contrast conditions. In order to determine whether the mechanism responsible for the effect of perceptual contrast was a more general one, a comparison of these frequencies was also made between the story, trickery and no-story, non-trickery conditions.

Table 11 summarizes the effects of perceptual contrast and context upon the explanations which the subjects used. As can be seen in Table 12 and Table 13, while differences in context produced no differences in the subjects' explanations, the change in perceptual contrast did produce differences which were significant. Conservers in the high contrast condition (where performance was better) gave more explanations based upon identity or reversibility; conservers in the low contrast condition (where performance was poorer) gave more compensation explanations.

Overall, the occurrence of compensation justifications (75%) was relatively high.

DISCUSSION

The data demonstrate that, among transitional age children, performance on Piagetian tasks can be systematically influenced by sources of variation which, by Genevan standards, would have to be viewed as apart from the structures which these tasks have been designed to measure. These sources of variation have been found both intrinsic and extrinsic to the tasks, themselves. Appropriately tapped, they are capable of producing an immediate and spontaneous elevation in task performance over levels attained in standard task presentations.

Of the variables, context and perceptual contrast, as they were utilized in the current study, the former was particularly pervasive in its effects. The contextual variable improved performance, both where the task was based upon a physical transformation of stimulus materials (conservation) and where it was not (additive classification).

There is no reason within Piaget's theory, as it now stands, for a story involving trickery to have such an effect on a structural task. Yet the tasks used in the present study carry characteristics which do seem amenable to an influence of this kind. Of the variables, story and trickery, the warning implicit in the latter would seem capable of alerting the child to the chance that the task might be misleading. This quality may have inhibited the impulse to respond strictly on the basis of the more apparent properties of the task and encouraged responses based upon all the properties relevant to its solution. In conservation such responding would entail the withholding of quantity judgments based entirely upon the perceptually more salient height dimension and would allow consideration of accompanying changes. In additive classification, it would require overcoming the convention of comparing like classes and extending

the comparison to relationships that are inclusive. In both cases, the inhibition of the immediate response, combined with the encouragement of responses to additional relevant factors, appears to have been the mechanism through which the trickery of the story presentation produced superior levels of performance.

One cannot help but notice the similarity between the above mechanism and the analytic orientation set which Beilin (1969) believes is responsible for the improved conservation performance which results when the immediate, non-conserving response is inhibited through negative feedback. A comparison can also be made with Schwebel and Schwebel's (1974) finding that superior performance occurs when children are made to delay before giving their responses on conservation and additive classification tasks. Whether it is produced through feedback, encouraged by an imposed increase in response latency or sugested implicitly in the context of the task, inhibition of the immediate, incorrect response appears to be important for eliciting successfuly performance in the transitional child.

In conveying the sense of trickery, the role of the story appears critical. In the White and Glick (1978) study cited previously, neither trickery without the story, nor a similar story without trickery was sufficient for improving conservation performance over a no-story, non-trickery presentation. In comparison, a presentation featuring a story with trickery produced superior performance, relative to each of these three other conditions. It would seem that, in order to effectively warn the child to inhibit the immediate, less mature response, the trickery had to be embedded in a culturally appropriate, naturalistic setting.

The use of naturalistic settings in eliciting intellectually mature

levels of thinking comprises a basic activity of the Cole, Gay, Glick and Sharp (1971) approach to measurement of intellectual ability among different population groups. Directed primarily toward non-Western populations which test poorly in most standard Western evaluation procedures, this approach has been used to augment the study of intellectual ability through an examination of the ways in which performance on intellectual tasks is influenced by the situations in which these tasks occur (Cole, Gay, Glick and Sharp, 1971; Cole and Scribner, 1974). In the enhanced performance that was achieved among American middle class subjects, the results of the current study attest to the viability of using this approach for studying the test behavior of domestic populations, as well.

A more general use of the Cole et al. approach among other population groups and for other intellectual measures carries two requirements: that one develop notions of what abilities are involved in the solution processes of the intellectual tasks under investigation and that one uncover situations which, in the everyday functioning of the subject population, are likely to call out the requisite skills. By embedding the task in the framework of an everyday situation which might call out task-relevant solutions, one might expect to promote the utilization of the requisite skills with regard to the task and, by so doing, to elicit levels of performance which may exceed those obtained in more standard task presentations, where such investigation is not initiated. Attention to such factors would seem to offer the benefit of more effectively revealing the upper levels of accomplishment which the subject population is potentially capable of attaining on the intellectual task.

The perceptual contrast of a task is a characteristic which necessarily inheres in the task, itself. The conservation and additive classification

tasks require some level of perceptual contrast to create an obstacle that the child's cognitive abilities must work against in the production of an operational response. While Piaget never fully specifies what this level might actually be, in writing about conservation, he does state that, at an intermediate stage of "inarticulated intuition" some liquid transformations:

> are believed to change the whole while others, between glasses that are just slightly different, induce the subject to suppose that the whole is conserved. (Piaget, 1947/1976, p. 140)

The implication is clear that once the "slightly different" point is passed, there is no reason why any given change in perceptual contrast should produce an accompanying change in performance.

The position advanced in the current study posits, on the other hand, that, since any change in the perceptual loadings of the relevant stimulus cues would affect the relative salience of these cues and, by so doing, would influence the ease with which the less salient of the relevant cues would be included in formulating a response, the influence of perceptual change would be more continuous. It was presumed that, at the appropriate age, even at perceptual levels beyond those which one could reasonably call "slightly different," changes in contrast would influence the success rate attained on the measurement task.

The occurrence of such an effect on the conservation task supports the position that, for transitional children, much of the difficulty of this task derives from the relative salience of the task's stimulus dimensions. This position disputes the Genevan claim that, beyond the special case of transformations which produce "slightly different" stimulus configurations, the effects of contrast are governed by those operations which have been constructed by the child. It is more supportive

of non-Piagetians (Suchman and Trabasso, 1966; Titchener, 1966; Odum, 1978) who have reported that certain perceptual dimensions are capable of influencing the young child's problem-solving abilities by capturing and diverting his or her attention from other relevant stimulus cues. In this view, perceptual salience exerts a much greater and more generalized influence upon the child's task performance.

While the presence of the perceptual effect on the conservation task was in keeping with the premise of the current study regarding the influence of perceptual contrast, the direction of this effect was directly opposite to that which was anticipated. It was assumed that, since small changes in the diameter of a cylindrical container produce proportionally larger changes in its capacity, an increase in the radius difference between the pre-transformation and the post-transformation glasses would produce a much larger difference in the more salient dimension of pre- and post-transformation liquid height and would, consequently, deter successful performance. The reverse finding suggests a need for reexamining how perceptual salience operates on this task.

Examining the methodology of the study reveals one rather unique quality which may account for this result. In the present study, and only in the present study, variation in perceptual contrast was produced by using identical pairs of starting (standard) glasses in both the high and low contrast conditions and by filling the high contrast pair to a lower initial liquid level. This produced a post-transformation liquid height in the very narrow (high contrast) glass which was equal to the corresponding post-transformation height in the moderately narrow (low contrast) glass. The rationale for doing this was that, with the task stimuli presented in such a manner, a decrement in performance in the

high contrast condition would be directly attributable to the more pronounced difference between starting and final liquid height in this condition, a property reflecting the more extreme compensatory relationships which were introduced.

The results suggest that this method produced important perceptual changes based upon something other than the relationship between pre- and post-transformation liquid height. One might speculate that the locus of such perceptual changes would lie in the configuration of the transformed material. Trabasso (1975) has pointed out that young children have a tendency to reduce comparative evaluations to descriptive ones. The child who disregards the starting levels of the liquids and responds to the conservation question as if he or she were being asked to see whether one glass has "a lot," is apt to respond, not to the transformation, but rather, to the final state of the liquid, as if it were static. One could surmise that, for such a child, while the height might be the more salient dimension, at any given post-transformation liquid height, where the difference between height and diameter is great, the diameter dimension might more readily be recognized as a compensating factor than where the difference between height and diameter is small. Since the final heights of the liquids in the high and low contrast conditions were the same (as were the heights of the glasses), the increased narrowness of the glass in the high contrast condition might have directed attention to the diameter and may have, thus, encouraged the conserving response.

According to this view, the narrower diameter of the high contrast container may have produced conserving behavior by provoking a compensatory response. While attempts to specify empirically the relationship

between compensation and conservation have not provided entirely clear results, the two variables have been shown, in a general sense, to covary (Larsen and Flavell, 1970; Gelman and Weinberg, 1972), although not necessarily causally (Brainerd, 1976). In special procedures involving some alteration of the conservation paradigm, non-conserving subjects have been found capable of shifting their attention from the more salient height dimension in making quantity judgments (Halford, 1970; Miller, 1973; Sheppard, 1973). It is a plausible conclusion that, for two identical post-transformation heights, the one accompanied by a diameter dimension which differs more greatly from the height might be the one which more effectively stimulates the child to make use of that dimension in evaluating quantity and to conserve.

There is an alternate explanation which deals less directly with the compensatory height and diameter relationships among the task stimuli and which, instead, emphasizes the distribution of material prior to and after the transformation. In a fairly recent modification of his theory, Piaget (1977) has proposed that conservation is based upon the following two principles:

1. A change in the form of an object or collection is understood as being the result of simple changes in the position of the components.

2. In any change what is added at the terminal point has been removed or subtracted from the starting point. (p. 355)

He describes the second as involving "commutability", insofar as it "expresses the identity of a component despite desplacements", and the first as representing "vicarious relationships", or the "invariance of the whole irrespective of internal arrangements" (p. 355).

In this newer explanation, conservation is derived from the ability

to extract the invariant that exists within the task. Compensation is not a principle of conservation but, rather, an inference derived from the extended identity concept upon which conservation is based.

In the current study perceptual contrast had been cast in terms of the changing height and diameter relations of the liquid containers. If commutability, not compensation, is to be considered the more essential organizing principle of the task, then perceptual contrast may have been measured improperly. In the latter case, contrast would not necessarily be increased by increasing the pre- and post-transformation height differences. It would require, instead, that one maximize the deformity of the liquid. This would be accomplished by pouring from a liquid configuration in which the height and diameter measurements are very similar into one in which these measurements are very dissimilar (or the reverse). In this view, transferring liquid from a low, wide configuration into a tall, thin configuration would produce less perceptual contrast than would a transformation into the tall, thin configuration from a configuration that is more even in its dimensions. The clear implication is that, in the current study, the high and low contrast conditions may have been conceptualized inappropriately. The high contrast transformation may have, indeed, produced a more extreme compensatory relationship, but, more importantly, it also resulted in a less extreme change in the shape of the liquid. If this had been viewed as constituting a low contrast criterion, the obtained results would have been as expected.

While both explanations are plausible, evidence favoring one of them can be found in the explanations which the subjects used to justify their conserving judgments. One might speculate that, if the high contrast condition had encouraged a compensatory response, as suggested in the first

explanation, a greater number of compensation justifications might be found among the conservers in this condition. If, on the other hand, the high contrast condition has facilitated the use of commutability-based operations, one might expect to find more justifications referring to the identity or reversibility of the liquid in the high contrast groups. The presence of significantly more identity/reversibility justifications in the high contrast condition favors the Geneval argument.[1] However, this evidence should be viewed as only tentative. The Piagetian position holds that, if a child can use any of the accepted conservation justifications, he or she should be capable of using each of the others, as well. Consequently, it is difficult to say that the justification verbalized by the child is the one that was used in formulating the conserving response. Goodnow (1973) has demonstrated that the nature of the justification is influenced by the nature of the conservation probe. One investigator (Brainerd, 1973) has even suggested that justifications are too biased a measure to be fruitfully used at all. Additionally, it should be noted that the results were so characterized by compensatory justifications that even in the high contrast conditions, identity/reversibility justifications occurred in less than half the cases. It would seem that other kinds of supportive data would be needed to more fully resolve the issue of perceptual contrast on the conservation task.

Although evidence can be found in the perceptual contrast x task interaction to indicate that, relative to conservation, additive classification performance was more influenced in the anticipated direction by

[1]The Genevan argument is strengthened by the fact that all such justifications which were obtained were, in fact, identity based.

perceptual contrast, the failure to obtain a main effect for the perceptual variable on the additive classification task brings with it another set of problems. One might conclude that the more purely logical basis of this task makes it less vulnerable to a perceptual change of the sort induced in the current study. However, past evidence, cited earlier, indicates otherwise. Furthermore, on other kinds of Piagetian classification tasks, which, like the additive classification measure, have been characterized as requiring knowledge of a primarily logical variety (Inhelder and Piaget, 1964), the perceptual salience of stimulus dimensions has exerted a particularly strong influence upon performance (Overton and Jordon, 1971; Parker and Day, 1971; Odum, Astor and Cunningham, 1976). A more likely explanation is that some other factor operated to diminish the potential effect of the perceptual variable.

There is a strong possibility that this other factor was structural development. In the design of the study the intent was to utilize two tasks for which the subjects would be simultaneously at transitional points in development. As Miller (1978) has pointed out, it is at such points that performance is unstable and susceptible to experimental manipulation. Transitional periods have generally appeared to last between one and two years. In the White and Glick (1978) study, the contextual effect was spread among two transitional grade levels (first and second), although its presence was evident in comparison to performance in a greater number of control conditions at the older of the two grades.

Although variation exists in the age data comparing additive classification performance with performance on other concrete operational tasks (Winer, 1980), past findings tend to suggest that conservation of continuous quantity and additive classification are mastered at age levels close

enough for one to expect to encounter developmental overlap in their transitional periods. Wohlwill (1968) has reported moderate correlations in performance in each of the two areas. Some of Piaget's (1941/1965) data and data by Smedslund (1964) suggest that the development of the two is concurrent. Other Genevan findings (Inhelder and Piaget, 1964) and data presented by Almy and Dimitrovsky (1975) indicate a slightly earlier mastery of the conservation of continuous quantity task. Sigel, Roeper and Hooper (1966) and Inhelder (1977) have reported that training in classification skills can lead to improvement in conservation performance. Given the length of the transitional period and given the general, though imprecisely related, nature of the above findings (an imprecision which, in itself, is suggestive of concurrent transition), it seemed reasonable to anticipate tapping a point at which the degree of transition would be sufficient on both tasks for the two to be concurrently influenced by the contextual and perceptual variables. Evidently this was done with some, but not complete, success.

The relatively poor performance, overall, on the additive classification task suggests that it may have been caught at a developmentally early point in transition and that the potential for performance change was less than optimum. For the contextual variable, it was sufficient. For perceptual contrast, as this variable was employed in the study, it was not.

The above stands in sharp contrast to the conservation task, where both context and perceptual contrast were so effective that each was capable of maximizing the performance gain, and each was, in essence, interchangeable with the other as a facilitator of performance. On this task the subjects do appear to have been at the developmental level most appropriate for

the kinds of manipulations which were initiated. It is an unresolved issue whether at a more advanced point in development a similarly robust effect might likewise occur on the additive classification task.

The current use of structural development as a factor influencing the amount of change which can be induced through perceptual and contextual manipulation is reminiscent of Flavell and Wohlwill's (1969) model, wherein competence is described as appearing initially in restricted settings and only gradually becoming functional in the variety of situations to which it is potentially applicable. Yet it remains an unanswered question whether the contextual and the perceptual manipulations can be said to have succeeded where they did by enabling the child to achieve success through the use of competencies at less advanced levels of development, or because they made it possible for the child to utilize developmentally advanced abilities which were present but less readily available to him or her under other conditions of context and perceptual contrast. This question belies the more basic issue of whether to consider among the criterial attributes of Piagetian competencies, qualities which are, themselves, non-structural, in the Piagetian sense, or whether, as the Flavell and Wohlwill (1969) position would seem to sugest, to view them as representing a set of intervening variables which influence performance but remain distinct in function from the operations upon which the tasks are based.

The systematic performance changes that were induced through the use of non-structural variables which promote responsiveness to less salient stimulus dimensions attests to the influence of these variables. Yet

Piagetian theory allows little room for them. They are relegated to a "figurative" status (Piaget, 1971) and are considered meaningful only to the extent that the individual is capable of acting upon them. It is the ability to act upon these figurative variables internally -- to transform them -- that defines, for Piaget, the more essential, operative aspect of thinking. Piaget (1971) writes:

> Any state can be understood only as the result of certain transformations or as the point of departure for other transformations. In other words, to my way of thinking, the essential aspect of thought is its operative and not its figurative aspects. (p. 14)

The apparent systematic, mutually related nature of operations is what leads to the notion of a structure held together through a set of internally regulated interrelationships. In another of his writings, Piaget (1968/1970) states:

> A structure is a system of transformations. Inasmuch as it is a system and not a mere collection of elements and their properties, these transformations involve laws: the structure is preserved and enriched by the interplay of its transformational laws which never yield results external to the system nor employ elements that are external to it. (p. 5)

In principle, then, by looking at particular operations, one should be able to diagnose the stage specific characteristics of the child and anticipate the developmental accomplishments which lie ahead for him or her. In practice, it does not appear that one would actually be capable of freeing one's assessment procedures from the influence of those variables which Piaget calls figurative and, as a consequence, that one would find it possible to observe operations without having to account for these other variables, as well.

In a review of perceptual effects, Miller (1978) suggests that measurement practicies be broadened to enable these effects to be accounted for in the evaluation process. She writes:

> Instead of attempting to strip away all obstacles to the expression of the logical structure, it would be more fruitful to examine them as part of the assessment procedure. Assessment should produce a description of the steps a child takes in translating his knowledge into behavior. (p. 142)

The present findings indicate that Miller's words ought not be limited to the perceptual issues which she addresses, but should be extended to issues of a contextual nature, as well. However, contextual variables cannot be examined without encountering new difficulties. As Jenkins (1974) has pointed out, context is an essentially boundless concept, potentially expanding onto successively broader domains. Furthermore, as inquiry moves into such domains, it necessarily encounters variables arising from sources increasingly separate from the cognitive variables under investigation. Such a research direction entails, in the words of several writers, a kind of "experimental anthropology" (Cole, Gay, Glick and Sharp, 1971, p. 18), involving the examination of culturally based "rules and repertoires, rituals and tricks of the trade" (Goodnow, 1972, p. 83) to uncover the "pyschological reality" (Pylyshyn, 1972, p. 551) of "ecologically valid problems" (Jenkins, 1974, p. 793). It means dealing with factors extrinsic to the Piagetian task, so that the manner of presenting the task, too, comes under investigation.

The recognition and control of non-structural variables might not directly improve existing epistemological concepts, but it could clarify our understanding of those activities in which these concepts become manifest. To illustrate the point, it will be recalled that, in the current study, conservation performance exceeded additive classification performance, but not in the low contrast condition. Perceptual contrast influenced performance, but not in the story context. In these cases, specification of the non-structural variable resulted in a more complex

finding, and one which provided a more precise analysis of the behavior under examination.

Variation in performance on Piagetian tasks has been studied primarily in relation to the operations which these tasks are said to measure. The current findings suggest that the scope of the variables which have been investigated in this regard requires broadening to a consideration of their perceptual and contextual characteristics, as well. Examination of such factors holds promise for increased understanding of the means by which success rates on these tasks can be influenced, and for new insight regarding the nature of those factors responsible for the performance which one encounters in the evaluation of cognitive structure.

APPENDIX

Segment 1C: Passive observer[1] -- trickery context. This segment featured a story in which an emphasis was placed upon the potential deceptiveness of the transformation. The subjects remained unacknowledged by the story characters.

The segment began with pictures of Jimmy, a twelve-year-old boy, carrying a basketball outside a building and joined by two friends (girls). Latin music was played in the background as an adult male, sounding very street wise, and a female read alternate parts of the following script:

> The adventures of Jimmy Kool!
> Jimmy Kool and the Kool Aid!
> Jimmy Kool sure was cool.
> Watch him closely.
> Don't be fooled.

A story then followed in which Wanda, a rather small girl, was selling Kool Aid. A pitcher and two glasses were on the table in front of her. The glasses were about two-thirds filled with a dark liquid. The tape was paused, and the subject was asked by the experimenter to verify that the heights of the liquid were the same.

Debbie, a larger girl, indicated that she wanted some Kool Aid, but that she wanted hers, pointing to the top of the glasses, "this high." When Wanda insisted that her father said she "shouldn't put any more into the glasses," Debbie repeated her demand, and warned that she would be back later for a completely filled glass, "or else!"

With the tape paused in this state, the child was asked by the experimenter three questions for comprehension of plot ("What was Wanda selling?

[1]Passive refers to observer role, as described by Jones and Nisbett (1972).

What did Debbie want? Why couldn't Wanda give it to her?") If the child failed to answer any of these questions correctly, the segment was shown again and the tape stopped right after each of the points at which the action provided the answer. The question was asked again, making sure that the subject answered correctly.

After Debbie departed, Wanda was joined by Jimmy. Hearing of her predicament, Jimmy got another glass and said, "Use this glass when Debbie comes back." At this point, the audio faded as the characters kept talking. A superimposed male adult voice then read:

> Jimmy Kool sure is wise
> Watch him now.
> Debbie's gonna be surprised!

In the final scene, Debbie returned to the Kool Aid stand. Wanda put the narrow glass down, poured the Kool Aid into it from one of the two wider glasses on display and asked Debbie, "Do you think you're getting more?" The action was then stopped, as the camera remained fixed on the glasses. At this point, with the glasses in their final state, the experimenter, following a standard protocol, questioned the child.

In the questioning for conservation, the successive production of a conserving judgment and an appropriate justification was considered an indication of conservation. A justification was considered appropriate if it referred to the reversibility of the transformation, the unchanged identity of the liquid or the compensatory relationships among the stimulus dimensions.

A control for the effect of a story implying trickery in a presentation requiring a passive observer role was designed as follows:

Segment 2C: Passive observer -- non-trickery context. In this sequence an attempt was made to eliminate the suspicion arousing aspects of the story and to maintain the passive observer role.

In the introduction, Jimmy was seen standing next to the two girls. An adult male and an adult female read:

> The Jimmy Kool Show.
> Jimmy Kool is smart.
> Watch him.

Following the introduction, Jimmy was seen talking to Wanda (with no audio) and giving her a glass. Simultaneously an adult male voice read, "Watch Jimmy be smart."

In a final scene featuring Wanda and Debbie, Wanda was shown with the stimulus materials. The subject was asked by the experimenter to verify the equality of the liquid heights in the glasses. Wanda called Debbie over to her and said, "Watch this, Debbie!" Wanda next made the transformation, saying, "If I took this glass (pointing to the untouched glass), and I gave you that one (pointing to the transformed liquid), do you think you would be getting more?"

The child was next asked by the experimenter whether or not Debbie would be getting the same/more, and justifications were sought.

A story presentation to control for the potentially facilitative effects of the passive observer role is described below:

Segment 3C: Active observer -- trickery context. This segment featured a trickery story presentation with the actors addressing the subject directly. It matched the passive observer conservation trickery presentation, except for the following changes:

After the introduction and prior to the start of the action, Jimmy

and Wanda faced the camera and said, (Wanda) "We have something to show you." (Jimmy) "Watch closely, or you are going to be in for a surprise!"

The story next proceeded as in the passive observer -- trickery context (segment 1C).

In the final moments of the story, as she was about to make the transformation for Debbie, Wanda turned to the camera, pointing to the camera as she did, and she said, "Do you know what will happen? Watch what I am going to do for Debbie. Don't you be fooled!"

Wanda then made the transformation (with Debbie off camera) and said, "I am going to give this glass to Debbie. Do you think she's going to be getting more?"

With the monitor showing the glasses in the final state, the child was questioned as in the passive observer -- trickery condition (segment 1C).

A final taped segment served as a control for the effect of the passive observer role in a presentation not implying trickery.

Segment 4C: Active observer -- non-trickery context. In this segment the suspicion arousing aspects were absent, with no story, but with the active observer role.

After the more neutral introduction of the passive observer -- non-trickery context (segment 2C) and prior to the start of the action, Jimmy and Wanda faced the camera and said, (Wanda) "We have something to show you." (Jimmy) "Watch closely."

The segment next proceeded as in the passive observer -- non-trickery context.

In the final moments of the segment, as she was about to make the

transformation for Debbie, Wanda turned to the camera, pointing to the camera as she did, and she said, "Do you know what will happen? Watch what I am going to do for Debbie."

Wanda made the transformation (with Debbie off camera) and said, "If I took this glass (pointing to the untouched glass), and if I gave Debbie that one (pointing to the transformed liquid), do you think she would be getting more?"

With the camera fixed on the liquids in their final states, the child was questioned as in the passive observer -- non-trickery condition (segment 2C).

II Partitioning of Chi-Square for Study I

Source	
AB	$\sum^{b} \overline{\lfloor (O_{ij} - E_{ij})^2 / E_{ij} \rfloor}$
AC	$\sum^{c} \overline{\lfloor (O_{ik} - E_{ik})^2 / E_{ik} \rfloor}$
AD	$\sum^{d} \overline{\lfloor (O_{il} - E_{il})^2 E_{il} \rfloor}$
ABC	$\sum^{b} \sum^{c} \overline{\lfloor (O_{ijk} - E_{ijk})^2 / E_{ijk} \rfloor} - (AB + AC)$

df = 1 (all cases).

A = subject response (pass/fail).

B = context.

C = observer role.

O = observed frequency.

E = expected frequency.

(For further elaboration, see Sutcliffe, 1957.)

Yates correction (McNemar, 1962) utilized where any expected cell frequency fell between five and ten.

III Additive Classification Presentations

Segment IA: Active observer -- trickery context. As in the analogous conservation segment (segment 3C), a story was featured in which an emphasis was placed upon the potential deceptiveness of the class inclusion question. The subject was addressed by the characters.

The introduction was identical to that of the conservation, trickery context presentations (segments 1C and 3C) except that the line "Jimmy Kool and the Kool Aid," was replaced by the words, "Jimmy Kool and the animal toys!"

After the introduction and prior to the start of the action, Jimmy and Wanda faced the camera and said (Wanda) "We have something to show you." (Jimmy) "Watch closely, or you are going to be in for a surprise!"

In the story which followed, Wanda was in charge of giving out toy animals at school for children to play with. On a table in front of her were sets of miniature horses and miniature cows. The horses comprised the larger set (see Design). The tape was paused, and the child was asked by the experimenter to identify each of the sets.

Returning to the story, Wanda offered Debbie "some animals to play with," but balked when Debbie demanded to be allowed to pick "as many as I want." Wanda stated, "I know you, Debbie. You're selfish. You always try to get as much as you can for yourself. The teacher said I shouldn't let anybody get away with that!" Debbie repeated her demand and warned that she would be back later to pick "as many as I want, or else!"

As in the conservation story, the tape was paused, and the child was questioned for comprehension of plot (What was Wanda giving out? What did Debbie want to do? Why didn't Wanda let her?"). If the child

failed to answer any of these questions correctly, the segment was shown again and the tape stopped right after each of the points at which the action provided the answer. The question was asked again making sure that the subject answered correctly.

After Debbie left, Wanda went to Jimmy, who advised her, "I know what you can do. Tell Debbie this when she comes back." At this point the audio faded and, as Jimmy and Wanda kept talking, a male voice read:

> Jimmy Kool sure is wise,
> Watch him now.
> Debbie's gonna be surprised!

When Debbie returned later, Wanda turned to the camera, pointing to the camera as she did, and she said, "Do you know what will happen? Listen to what I am going to tell Debbie. Don't you be fooled!"

With the camera focusing on the materials, Wanda continued, "I am going to tell Debbie that she can have the horses or she can have the animals. Which one do you think will give her more?"

As the materials continued to be shown on the monitor, the experimenter next asked the subject, "Which would be more for Debbie to have, the horses or the animals?" The child was then asked to justify his or her answer. The successive production of a correct judgment and an appropriate justification was considered an indication of an adequate additive classification response. A justification was considered appropriate if it indicated a recognition of the class inclusive relationships of the materials.

A control condition for the effect of a story presentation implying trickery is described below:

Segment 2A: Active observer -- non-trickery context. In this seg-

ment the suspicion arousing aspects were absent, with no story, but with the active observer role.

The introduction was identical to that of the conservation, non-trickery context presentations (segments 2C and 4C) except that the line, "Jimmy Kool and the Kool Aid," was replaced by the words, "Jimmy Kool and the animal toys!"

After the introduction and prior to the start of the action, Jimmy and Wanda faced the camera and said, (Wanda) "We have something to show you." (Jimmy) "Watch closely."

Jimmy was next seen talking with Wanda (with no audio). Simultaneously an adult male voice read, "Watch Jimmy be smart."

In the final scene Wanda was shown with the stimulus materials. The tape was paused, and the child was asked by the experimenter to identify each of the sets. As the action resumed, Wanda called Debbie over to her and turned to the camera, pointing to the camera as she did, and she said, "Do you know what will happen? Listen to what I am going to ask Debbie."

With the camera focusing on the materials, Wanda continued, "If I told Debbie she could have the horses or she could have the cows, which do you think would give her more?" With the camera fixed on the materials, the child was questioned for additive classification as in the active observer -- trickery context (segment 1A).

IV Partitioning of Chi-Square for Study II

Source	
AB	$\sum^{b} \left[(O_{ij} - E_{ij})^2 / E_{ij} \right]$
AC	$\sum^{c} \left[(O_{ik} - E_{ik})^2 / E_{ik} \right]$
AD	$\sum^{d} \left[(O_{il} - E_{il})^2 / E_{il} \right]$
ABC	$\sum^{b} \sum^{c} \left[(O_{ijk} - E_{ijk})^2 / E_{ijk} \right] - (AB + AC)$
ABD	$\sum^{b} \sum^{d} \left[(O_{ijl} - E_{ijl})^2 / E_{ijl} \right] - (AB + AD)$
ACD	$\sum^{c} \sum^{d} \left[(O_{ikl} - E_{ikl})^2 / E_{ikl} \right] - (AC + AD)$
ABCD	$\sum^{b} \sum^{d} \sum^{c} \left[(O_{ijkl} - E_{ijkl})^2 / E_{ijkl} \right] - (AB + AC + AD + ABC)$

df = 1 (all cases).

A = subject response (pass/fail).

B = context.

C = perceptual contrast.

D = task.

O = observed frequency.

E = expected frequency.

(For further elaboration, see Sutcliffe, 1957.)

Yates correction (McNemar, 1962) utilized where any expected cell frequency fell between five and ten.

V Evaluation Probe

The current study carries a particular need for examining the processes involved in the predicted effects. This need originates through two design characteristics: the manipulated variables and the video medium. Its existence underscores the importance of considering justifications used by the subjects, along with their judgments (rather than judgments, alone) in determining the presence or absence of operational thinking.

Since the systematic variation of both the contextual and perceptual variables represented a departure from standard Piagetian practice, consideration had to be given to the means by which the subjects arrived at their answers, in order to evaluation their comparability. At the onset it was not certain that the manipulation of either variable would not also produce some cue through which the subjects could arrive at the correct judgment without engaging the normally required operations. Such an occurrence would have invalidated the findings concerning the effects of the manipulated variables. Examination of the subjects' justifications was required to ensure their operational character.

The video medium also placed several constraints upon the study. It featured the inherent problem of being a two dimensional medium depicting three dimensional objects and, in conservation, a transformation among these objects. In past studies involving film testing of Piagetian tasks, this problem had not been insurmountable, as performance had been found to correlate highly with more standard Piagetian measures (O'Bryan and Boersma, 1972; Wheatley, 1975). However, that testing was designed for group format, precluding exmination of justifications.

Another problem concerned the inability to make adjustments in the

liquid height in the conservation task. This created a deviation from Piaget's methods among children who, after closely inspecting the liquids in the two glasses, pronounced them to be unequal prior to the transformation. In the White and Glick (1978) study, this problem was surmounted by telling the subjects who made the initial inequality judgments that the television must be malfunctioning and by adjusting the height control in the back of the monitor.

The above solution was not possible in the current study, where a height adjustment would have produced a contaminating effect upon perceptual contrast among the variables. Cognizant that, in the White and Glick study, very few subjects did initially judge the pre-transformation heights unequal and that extensive questioning among these few subjects showed little difference in their ability to conserve (with accompanying indications of appropriate operational logic), the decision was made to keep the question regarding initial liquid height, but to forego the monitor height adjustment among individuals who judged these heights unequal, while relying more fully upon the post-transformation probe to determine the absence or presence of conservation. At worst, it was felt that this procedure might slightly reduce the sensitivity of the measure to the conserving response, retarding the effects of the experimental variables, rather than promoting false positives.

In all, six of the 96 subjects in the first study and four of the 96 (conservation condition) subjects in the second study described the initial states of the liquids as unequal. Their numbers are shown in parenthesis in Table I and Table II alongside the totals showing the overall distribution of results.

Although it did not seem so to the experimenter, there may have

been a slight difference in the low contrast liquid heights, since all six of these subjects in Study I -- which employed the low contrast condition exclusively -- indicated that the glass on the left started with more liquid. This may have had its fortunate consequences, insofar as it was the (perceived lower) liquid of the glass on the right that was transformed into the higher, narrower state. As a result, potentially thorny logical inequality conservation responses were precluded.

Overall, two subjects among this group of six produced conserving responses, with appropriate justifications, in a manner as if they had, in fact, judged the liquids equal in the first place. Four were non-conservers, reversing the direction of their inequality responses after the pouring, and justifying their answers inadequately.

A similar patterin occurred in Study II. Three of the four who described the initial states as unequal were in the low contrast condition. The only non-conserver in this group was among those in the low contrast condition, again favoring the glass on the left (and again precluding the inequality conservation response). In their judgments and justifications, two of the three conservers spoke as if they had initially considered the starting liquid heights the same. One took cognizance of her initial inequality judgment, but then indicated that it had been "just a little bit different" at first, and that, after the transformation it "looked a lot different," although it "really was just the same as before," with an accompanying explanation attributing the change in appearance to the narrowness of the post-transformation glass.

On the basis of these results, and in light of the relatively even distribution of individuals who had judged the initial states to be unequal, it appears doubtful that the failure to insist upon pre-transformation

equality judgments among all the subjects introduced any systematic bias into the study.

The evaluation probe also includ-d an investigation of the type of justification used by conservers. This was necessary to uncover the nature of the logic responsible for the effects observed in Study II. However, the critical discriminations required in the categorization of justifications presented potential reliability problems. To explore these, a second, independent rater was used to judge a smaple of 50 conservation protocols, randomly chosen from the data of Study II. Virtual complete agreement was obtained in the response ratings.

The distribution of justifications featured two striking characteristics: a lack of reversibility responses and a high rate of compensation explanations. Both seem atributable to qualities of the video medium. Because of its fixed, essentially unchangeable sequence of action, one could suggest a reveral of the tranformation as a theoretical possibility, but not as an available option. In such a circumstance, the appeal of this explanation, relative to other available justifications, could well have been diminished, and the response so influenced.

Regarding the high rate of compensatory responses, the casting of explanations in terms of height and diameter relations may have been encouraged by the two-dimensional nature of the medium, an influence which may have been particularly strong in the low contrast condition, where commutability relationships were less apparent.

The video medium presented fewer difficulties for the additive classification task. Each of 16 pretested subjects had been able to discern the larger set when the materials in the low contrast condition were shown on the monitor. Since no physical transformation was involved in this

task, little more was required in establishing that its perceptual qualities were likely to be distinguishable.

Acceptable justifications on this task were of only one kind -- those indicating the inclusive class relationship that exists between the whole set, animals, and the subset, horses. As in conservation, a reliability test was performed by a second, independent rater, using 50 randomly selected and additive classification protocols. Disagreement occurred in the rating of one response, with the independent rater categorizing an additional subject as passing in the high contrast, non-trickery condition.

None of the subjects exhibited any trouble in the probe for identification of sets that preceeded the class inclusion question.

TABLES

Table 1

Number of Passing Subjects in
Each of the Conditions of Study I

		Pass		Fail	
Passive	Story Trickery	20	(1)*	4	(1)
Observer	No Story Non-trickery	9	(0)	15	(2)
Active	Story Trickery	18	(0)	6	(0)
Observer	No Story Non-trickery	8	(1)	16	(1)

*Totals in parenthesis indicate numbers who initially perceived the starting quantities in the comparison glasses to be unequal. (See Appendix V.)

Table 2

Main and Interaction Effects of Study I

Source of Variance	χ^2	p
Context	18.8	.001
Observer Role		n.s.
Context x Observer Role		n.s.

Table 3

Effect of Context upon Number of Passing Subjects

Context	Pass	Fail
Trickery	38 (1)*	10 (1)
Non-trickery	17 (1)	31 (3)

$\chi^2(1) = 18.8, p < .001$

Table 4

Effect of Observer Role Upon Number of Passing Subjects

Observer Role	Pass	Fail
Passive	29 (1)	19 (3)
Active	26 (1)	22 (1)

n.s.

*Totals in parenthesis indicate numbers who initially perceived the starting quantities in the comparison glasses of the liquid conservation task to be unequal. (See Appendix V.)

Table 5

Number of Passing Subjects in
Each of the Conditions of Study II

			Pass	Fail
Liquid Conservation	Story Trickery (active)	Low Contrast	17 (2)*	7 (0)
		High Contrast	19 (0)	5 (0)
	No story Non-trickery (active)	Low Contrast	6 (0)	18 (1)
		High Contrast	18 (1)	6 (0)
Additive Classification	Story Trickery (active)	Low Contrast	11	13
		High Contrast	6	18
	No story Non-trickery (active)	Low Contrast	3	21
		High Contrast	3	21

*Totals in parenthesis indicate numbers who initially perceived the starting quantities in the comparison glasses to be unequal. (See Appendix V.)

Table 6

Main and Interaction Effects of Study II

Source of Variance	χ^2	p
Context	11.2	.001
Perceptual Contrast		n.s.
Task	29.1	.001
Context x Perceputal Contrast	4.89	.05
Context x Task		n.s.
Task x Perceptual Contrast	7.89	.01
Context x Perceptual Contrast x Task		n.s.

Table 7

Effect of Context upon Number of Passing Subjects

Context	Pass	Fail
Trickery	53 (2)*	43 (0)
Non-trickery	30 (1)	66 (1)

$\chi^2(1) = 11.2$, $p < .001$.

Table 8

Differences between Tasks in Number of Passing Subjects

Task	Pass	Fail
Conservation	60 (3)	36 (1)
Additive Classification	23	73

$\chi^2(1) = 29.1$, $p < .001$.

*Totals in parentheses indicate numbers who initially perceived the starting quantities in the comparison glasses of the liquid conservation task to be unequal. (See Appendix V.)

Table 9

Effect of Perceptual Contrast x Task Interaction upon Number of Passing Subjects[1]

Conservation			Additive Classification		
Perceptual Contrast[2]	Pass	Fail	Perceptual Contrast[3]	Pass	Fail
Low	23 (2)*	25 (1)	Low	14	34
High	37 (1)	11 (0)	High	9	39

[1]Task x perceptual contrast interaction: $\chi^2(1) = 7.89$, $p < .01$.

[2]Effect of perceptual contrast on conservation task: $\chi^2(1) = 8.71$, $p < .01$.

[3]Effect of perceptual contrast on additive classification task: n.s.

*Totals in parentheses indicate numbers who initially perceived the starting quantities in the comparison glasses to be unequal. (See Appendix V.)

Table 10

Effect of Perceptual Contrast x Context Interaction upon Number of Passing Subjects[1]

Trickery			Non-Trickery		
Perceptual Contrast[2]	Pass	Fail	Perceptual Contrast[3]	Pass	Fail
Low	28 (2)*	20 (0)	Low	9 (0)	39 (1)
High	25 (0)	23 (0)	High	21 (1)	27 (0)

[1]Context x perceptual contrast interaction: χ^2 (1) = 4.89, $p < .05$.

[2]Effect of perceptual contrast in trickery context: n.s.

[3]Effect of perceptual contrast in non-trickery context: χ^2 (1) = 6.89, $p < .01$.

*Totals in parentheses indicate numbers who initially perceived the staring quantities in the comparison glasses to be unequal. (See Appendix V.)

Table 11

Effect of Context and Perceptual Contrast upon the Occurrence of Compensation vs. Identity/Reversibility Conservation Explanations

Source of Variance	χ^2	p
Context		n.s.
Perceptual Contrast	4.31	.05

Table 12

Effect of Context Upon Use of
Compensation vs. Identity/Reversibility Explanations

Context	Compensation	Identity/ Reversibility*
Trickery	29	7**
Non-trickery	16	8

n.s.

Table 13

Effect of Perceptual Contrast Upon Use of
Compensation vs. Identity/Reversibility Explanations

Perceptual Contrast	Compensation	Identity/ Reversibility*
Low	21	2
High	24	13**

χ^2 (1) = 4.31, $p < .05$.

*All the responses in this category were identity responses. No reversibility responses were obtained.

**Includes 2 responses justified through reference to addition/subtraction schemes.

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