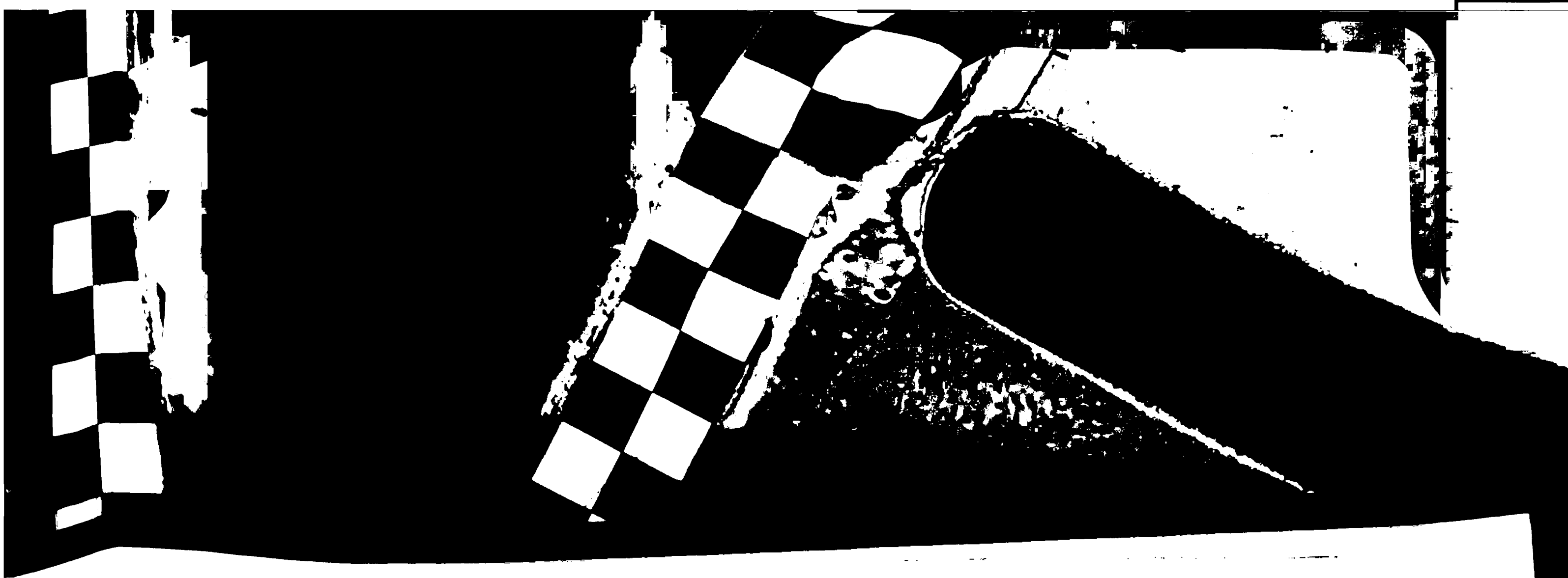

ABSTRACT

DIFFERENTIAL ADAPTIVITY IN THE JUDGMENTS OF CHILDREN

By Edward L. Palmer

It has been the position of this study that under certain conditions perceptual or cognitive items to be related judgmentally are referred to a set of expectancies. It was predicted that when pairs of such items differ either in simplicity-complexity (in the perceptual realm) or in relative familiarity (in the cognitive realm), and when Ss are induced in alternate conditions to use one or the other member of such pairs as the reference, or accommodating member, their judgments concerning the relationship between the pair of items will differ in terms of adaptivity, or accuracy. This predicted outcome was termed Differential Adaptivity (DA). Absence of this effect was termed Equivalent Adaptivity (EA).

It was further predicted that the judged relationship would be more accurate when either the more simple or the more familiar member of the pair of items served the accommodating function. Significant evidence of this predicted outcome was obtained at each of four grade levels, k, 2, 4, and 6, and under each of two conditions, in a task involving modified Muller-Lyer figures. For two additional experimental tasks, one perceptual and one cognitive, no such evidence was obtained.

Edward L. Palmer

The relation of DA and EA to Piaget's construct of reversibility was explored. It was concluded that in the event reversibility obtains, DA is very unlikely to obtain. Reversibility would very likely obtain in any instance of EA.

The relation of the constructs of the present study to Helson's Adaptation Level theory and to Witkin and others' notion of analytical vs. global modes of perceptual-intellectual functioning were considered. It was concluded that the constructs of the present study, in conjunction with the constructs of these other positions, might lead to further fruitful predictions. In particular, the constructs associated with DA might provide a beginning toward understanding the mechanism underlying analytical vs. global modes of perceptual-intellectual functioning.

DIFFERENTIAL ADAPTIVITY IN THE

JUDGMENTS OF CHILDREN

By

Edward L. Palmer

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

STATEMENT OF THE PROBLEM

Introduction

It is the position of the present study that under certain conditions perceptual or cognitive items to be related judgmentally are referred to a set of expectancies. When this is assumedly the case, and when the two members making up pairs of such items are presented in certain alternate conditions, judgments as to the relation between these items may differ, in a predictable direction, in terms of their relative accuracy. Certain predictions to this effect will be tested. The constructs and conditions involved in these predictions will be related to Piaget's construct of reversibility. In particular regard to concrete operational thought, reversibility is taken here to involve the reference of the perceptual or cognitive items which are to be related judgmentally to a logical grouping or system.[1]

The Problem

The theoretical position of this paper derives largely from the works of Piaget. Piaget (8) posits an isomorphism of process, or functioning, between biological and intellectual development.

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[1]It is merely a convenience to speak of a psycholgoical process as logical. The present notion of making reference to a logical system is intended to imply only that the argument the subject offers as a basis for his judgment may be stated in the form of a deduction. Moreover, since the subject may derive the premises on which his judgment, or conclusion, is based from a set of expectancies, reference to a logical grouping and reference to a set of expectancies are not viewed here as mutually exclusive processes.

According to him, organization and adaptation are the two basic invariants of functioning in the process of development. Only adaptation is of concern here. Adaptation is characterized by the invariant and inseparable functions of assimilation and accommodation. The process of adaptation involves the assimilation of the externally given into the individual's preexisting structure, and the accommodation of the preexisting structure to that which is being assimilated. In this view, increasing differentiation of both the biological and intellectual (cognitive) structures arises through successive equilibrations between assimilation and accommodation.

An ancedote by Robert S. Woodworth (16:469) provides an instructive example of assimilation and accommodation:

> A child on first seeing a squirrel called it a "funny kitty." The new was assimilated to the old--yet not completely since the new animal was "funny."

In Piaget's terms, it might be said that the child's preexisting cognitive concept of kitties partially accommodated his representation of the squirrel. Or, alternately stated, his representation of the squirrel was partially assimilated to his concept of kitties.

In the process of assimilation, that which is to be assimilated may be misrepresented, or distorted. On the other hand, the accommodating structure may undergo distortions or restructuring. For instance, in concept attainment, a new exemplar of a concept may be misrepresented in being assimilated, or, whether or not accurately represented, it may lead to a restructuring of the accommodating structure (of the S's notion or hypothesis concerning the concept, in this case).

The central problem of the present study relates to the possibility that for certain pairs of perceptual or of cognitive items which are to be related by a judgment, it may be possible in one condition to induce Ss to use member A of the pair as the standard, or reference member, to which member B is to be related, and, in a second condition, to induce Ss to use member B as the standard, or reference member,to which member A is to be related. It will be convenient to refer to the standard, or reference member as the accommodating member, and to refer to the member which is being related to it as the assimilated member. It is held that through the experimental induction, the reference member will have become articulated with, and thus a part of the preexisting structure prior to the assimilation to it of the second member. It is in this sense that the reference member is held to be the accommodating member. The central problem, on which the three main hypotheses of this study are based, is whether, given certain pairs of representations or concepts to be related by a judgment, the judged relation will be the same irrespective of which is the assimilated and which the accommodating member of the pair.

It may be possible to rank the two members of pairs of such items on the basis of assumed familiarity in the cognitive realm, the extent to which instances of them may be articulated with a highly developed set of expectancies. In the perceptual realm, they may be ranked on the basis of simplicity-complexity, which may be a function of both the relative ease with which verdical representations of them may be formed, and the extent to which representations of them

may become articulated with a highly developed set of expectancies for like representations. Furthermore, it may be possible to rank the two judgments which have been obtained in the two alternate conditions of experimental induction in terms of their adaptivity. The more adaptive judgment is essentially the more accurate judgment, or, typically, the developmentally more advanced judgment.

It seems reasonable that members which are more simple or members which are more familiar will be more resistant to distortions leading to nonadaptive accommodations. Consequently, when either the more simple or the more familiar member of a pair is the accommodating member, the judged relation between the two members might be expected to be more adaptive. This study seeks to demonstrate such an effect. Ss are presented pairs of objects or pairs of instances of concepts in which member A is either more simple or more familiar than member B. An attempt is made to induce Ss to use A as the accommodating member in one condition, and B as the accommodating member in another. If there is a systematic difference in the adaptivity of the judged relations due to these variations in inductions, then the condition of Differential Adaptivity (DA) for the two judgments will be said to obtain. Where there is no such difference, so that the judged relation is the same in two such conditions, the condition of Equivalent Adaptivity (EA) will be said to obtain.

In a judgment concerning the relation between A and B, not only are A and B involved, but also the dimension of judgment. This dimension specifies the common property in terms of which the

members are to be related. The various values of the dimension of judgment, e.g., "larger," "equal," or "smaller," may be viewed as end states of an equilibration process. For example, at one level of development, and based upon one set of expectancies, the two items to be related may be judged "equal," without qualification. A kitty and a squirrel, for instance, might be judged equal, if the child's range of referents for the term "kitty" is sufficiently broad. At another level of development, with reference to a different set of expectancies, the child may wish to qualify his judgment to the effect that kitties and squirrels are in some respect equal. Thus to call a squirrel a "funny" kitty is to achieve a new level of equilibrium. In this view, many levels of equilibrium are possible. That is, there are many possible end states of the equilibration process. Moreover, these levels of equilibrium may range from less to more adaptive. DA may now be defined as the existence of differing levels of equilibrium resulting from an induced interchanging of the assimilatory and accommodatory functions for members of certain pairs of representations or concepts.

BACKGROUND OF THEORY AND RELATED RESEARCH

The Relation of Differential and Equivalent Adaptivity to Reversibility

Reversibility has been among the persistently explored constructs in Piaget's work. According to Piaget (4:272-273) reversibility is defined as

> . . . the permanent possibility of returning to the starting point of the operation in question. From a structural standpoint it can appear in either of two distinct and complementary forms. First, one can return to the starting point by canceling an operation which has already been performed--i.e., by inversion or negation. In this case, the product of the direct operation and its inverse is the null or identical operation. Secondly, one can return to the starting point by compensating a difference (in the logical sense of the term)--i.e., by *reciprocity*. In this case, the product of the two reciprocal operations is not a null operation, but an equivalence.

Piaget generalizes the concept of reversibility to a wide variety of adaptational forms. Flavell (2:233) observes that

> . . . Piaget is forever seeking subtle similarities among obvious differences when comparing various adaptational forms, e.g., structural and functional analogies between sensory-motor and representational cognition. This is also the case for the perception-intelligence comparison. Piaget describes such similarities in terms of the concept of *partial isomorphisms* between perceptual and intellectual (mostly concrete-operational) structures. That is, there are a number of perceptual phenomena which appear to be crude sketches or rough drafts of better structured intellectual phenomena to come.

Flavell continues". . . perceptual structures and operational structures in general relate in this way: the semireversibility of the one is partially isomorphic to the full reversibility in the other . . . ." (2:234) These two notions--reversibility and partial isomorphism--will

be explored as they relate to the constructs and the experimental tasks of the present study. The relationship of reversibility to DA and EA will be considered first.

Piaget has extensively explored the child's attainment of various constancies, and has interpreted their attainment in terms of the development of reversibility. Flavell succinctly summarizes the three-stage sequence Piaget has described with respect to the child's attainment of amount constancy:

> . . . (1) no conservation; (2) conflict between conservation and nonconservation, with perception and logic alternately getting the upper hand; and (3) a stable and logically certain conservation . . . . (2:312-313)

It will be maintained here that prior to attaining the third stage, the child often refers his representations of the objects in this task (pieces of clay are typically used) to a set of expectancies. In particular, he has come to expect longer objects, higher objects, or greater numbers of objects to contain more substance. Thus, even though he has agreed that two pieces have the same amount of clay, upon his perceiving that one piece has been made longer, or higher, or that it has been divided into a number of pieces, he will often hold that it now contains more clay. There seems clearly to be a deductive aspect to the child's argument. But his conclusion relies on the premise, for instance, that longer objects contain more substance. This premise derives from his reference of the task to a set of expectancies. It is not ordinarily possible for the child to verify this premise. In contrast, when he has attained the third stage, he refers his representations of the objects to a reversible,

additive logical grouping or system,[2] and deduces that since nothing has been added and nothing taken away, the amount of clay is the same. It is usually possible for the child to verify the premise expressed in this deduction.

It may now be seen that such constancies, once attained, are characterized both by Piaget's reversibility and by EA. In the case of reversibility, referring the members to an additive, logical system is held to result in maximum resistance to distortions, this reference effectively removing any effect on the judged relationship due to either assimilatory or accommodatory distortions. A case in point is that in the amount constancy task, the child at the third stage frequently maintains constancy while insisting that one of the pieces of clay appears to have changed in amount. There is a sense in which it may be said that the relations among the elements in a logical system characterized by reversibility remain unchanged irrespective of where one enters the system. Similarly, in the condition of EA, the judged degree of relationship between two representations or concepts is the same "irrespective of where one enters the system," i.e., irrespective of which member serves as the reference, or accommodating member. Reference to an additive, logical system characterized by reversibility may generally be expected to lead to EA. However, it is conceivable that EA may obtain in the absence of such reference.

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[2]The reader may reject the notion that one's representations are referred to a logical system, in favor of the view that exact constancy is attained through a series of reinforcements. For a discussion of these alternate positions, the reader is referred to Jan Smedslund, "The Acquisition of Conservation of Substance and Weight in Children," I. Introduction, Scand. J. Psychol. Vol. 2, 1961 (pp. 11-20).

The relation of reversibility to differential and equivalent adaptivity has been explored for both the perceptual and cognitive realms in general. It remains to consider the importance of reversibility for the particular three experimental tasks of the present study. This will be done in the section immediately following, wherein the nature of these tasks is presented. Briefly, reversibility is not a relevant factor in the first experiment, involving modified Muller-Lyer figures. It is potentially relevant in the second two experiments. Semireversibility, as interpreted here, is considered relevant in the Muller-Lyer experiment. The S may make reference to more--or to more accurate--expectancies by bringing cues from the visual field to bear on the judged length relation between the modified M-L figures. Or he might attempt to judge the relative lengths of the figures on the basis of a strategy. To the extent that these effects associated with semireversibility occur, the chances of detecting a significant DA effect as predicted will be diminished.

Theoretical Considerations in the Selection of the Experimental Tasks

The selection of experimental tasks was designed to explore the partial isomorphism of the processes underlying DA for the perceptual and cognitive realms. The theoretical bases for predicting DA with the perceptual and cognitive tasks are very similar.

In the perceptual realm, it is held that the more simple member of a pair of representations may be more highly articulated than the more complex member. The degree to which such representations may be articulated refers to the extent to which highly confirmed expectancies

which have been developed through the individual's past experiences with like representations are brought to bear in his dealing with any particular such representation. It seems reasonable that a more accurate, highly confirmed set of expectancies will typically have been developed with respect to classes of more simple representations. Moreover, the more highly confirmed one's expectancies with respect to a particular representation, the more resistant to accommodatory distortions or restructuring this representation might be expected to be. On the other hand, when the less simple representation serves the accommodatory function, it may be relatively less resistant to accommodatory distortions. Just as it is held that the more accurate expectancies associated with the more simple representation are more likely to be brought to bear on the judged relationship when that representation serves the accommodating function, so it is held that the relatively inaccurate expectancies associated with the less familiar representation are more likely to be brought to bear when it serves the accommodating function. It is predicted that, in consequence, the adaptivity of the judged relationship between the two representations that define the experimental task will be greater when the more simple is the accommodating member.

In a partially isomorphic manner, in the cognitive realm, it is posited that the more familiar of the members is more readily articulated when it is the accommodating than when it is the assimilated member. For cognitive tasks, it is predicted that, in consequence, the adaptivity of the judged relationship between the two members will be greater when the more familiar is the accommodating member.

Experiment 1: The Muller-Lyer Task

The first of the three experiments designed to test the above predictions entails alternate presentations of modified Muller-Lyer (M-L) figures, as shown in Figure 1. Each of the four presentation figures may be said to give rise to a perceptual

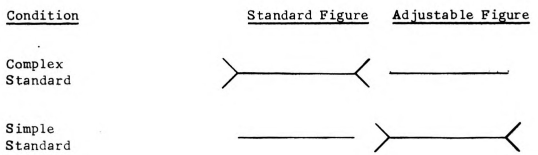

FIGURE 1. Alternate Conditions for Presenting the Modified Muller-Lyer Figures

representation. In each of the two conditions, the members of a pair of figures are presented simultaneously, one of which may be manipulated by the Ss. This form of presentation was devised in order to induce Ss to use the standard figure as the accommodating member, to which the adjustable must be assimilated. The presentation of one line segment with extending obliques, or feathers, and the other with no obliques is an attempt to operationalize the requirement that one figure be more complex and the other more simple. It is predicted that under these conditions DA will be demonstrated, in that there will be less departure from veridicality in the judged relationship between

the two figures in the Simple Standard (SS) than in the Complex Standard (CS) condition.

Experiment 2: The Amount Constancy Task

The second experiment entails alternate presentations of a slightly modified version of Piaget's amount constancy, or clay task. In the classical Piagetian presentation, after the child has agreed that two balls of clay have the same amount, one is rolled into the elongated form of a sausage. If the child maintains that they still have the same amount, he is said to have attained constancy of amount, or substance. In order to demonstrate DA as predicted for the perceptual realm with this task, the following conditions must be met: (1) it must be maintained that this is at least in part a perceptual task; (2) there must be a basis for maintaining that one representation is more complex and the other more simple; and (3) Ss must be induced to use the representation of one piece of clay as the accommodating member in one condition, and to use the other as the accommodating member in a second condition. To meet the first condition, Ss are sampled who may be expected to be at Piaget's second stage in the development of amount constancy, wherein perception and logic alternately are used as a basis of judgment (cf. p. 7). Flavell (2:299) notes that "For Piaget's subjects, conservation of matter seems to become common at 8-10 years of age . . . ." Ss for the present study are taken from the second grade of school, with an average age near eight. Piaget's analysis of the amount constancy task also provides a basis for ordering the representations of the pieces of clay in terms of simplicity-complexity. Lack of constancy has been held by Piaget and Inhelder (10) to result either from the child's centering upon the increased length of the sausage form, and thus responding that there is more clay in this form, or from his centering upon the decreased diameter in sausage form, and thus responding that there is less clay in this form. Attainment of the concept of constancy is taken to require decentering, or taking into account the simultaneous, compensating changes in length and diameter. Since there is no need to take these dimensions into account simultaneously in judging the amount of clay in the ball form, this form may be said to entail a less complex perceptual representation than the sausage form. Alternate conditions for presenting the Amount Constancy task were devised to induce Ss to use either the more simple or the more complex member as the accommodating member. In one condition, two sausages are presented. S is asked to hold one of the sausages, while E rolls the second into the form of a ball. S is expected to use the representation of the sausage he is holding, the form of which remains unchanged, as the reference, or accommodating member. In the second condition, S holds one of two balls, while E rolls the second into the form of a sausage. In this condition, S is expected to use the representation of the ball he is holding as the accommodating member. It is predicted that under these conditions DA will be demonstrated, in that the judged amount relationship between the two pieces of clay will be more adaptive when the representation of the ball is the accommodating member than when the representation of the sausage is the accommodating member.

Experiment 3: The Name-Size Task

The alternate conditions for the third--the Name-Size--task were selected to test for DA in the cognitive realm. In a "Name First" condition, Ss are asked to indicate, after being told that one of two boys their own age has a name and that the other has no name, whether they believe they know the relative sizes of the two boys. In the "Size First" condition, Ss must indicate whether from knowledge that one of two such boys is bigger and one littler, they believe they know which has a name and which has no name. The name-no name and the bigger-littler dimensions were chosen to meet the condition that one member be more familiar and the other less familiar. It seems reasonable that Ss will have had more occasion to apply the bigger-littler values than the name-no name values to boys their own age, and that therefore the size dimension is more familiar and the name dimension less familiar. It also seems reasonable that Ss will be induced to use as the reference, or accommodating dimension, that dimension which is presented first. A judgment indicating no relation between knowledge of name and knowledge of size values will be termed the more adaptive judgment. It is predicted that the judged relationship between the two dimensions will be more adaptive when the more familiar serves the accommodating function than when the less familiar serves this function.

The importance of reversibility in the experimental tasks may now be seen. Since it is not possible to deduce the relative lengths of the figures in the M-L task at any stage of development, reversibility is irrelevant to the first task. In the Amount Constancy and the Name-Size tasks, reversibility is important. To the extent that the sampling procedure for these tasks fails to exclude Ss who make reference to a logical system in responding, the chances of detecting a significant DA effect as predicted are diminished. The manner in which reversibility is possible for the Amount Constancy task was pointed out earlier. For the Name-Size task, reversibility is possible, and may result in either of at least two responses. With reference to Piaget's notion of nominal realism (7) the child might hold that the name is a real, qualitative part of the referent, failing to understand that it is merely an arbitrary, conventional label, and deduce that the boy with no name is smaller. On the other hand, the child might deduce that since the name is not a part of the referent, one cannot know the relative size of two boys, one with and one without a name. In either case, the reference to logic would diminish the chances of finding a significant DA effect.

Effects of Development on Differential Adaptivity

With development, the child may become more facile in interchanging spontaneously the members of pairs of representations or concepts, so as to minimize the likelihood that he may be induced experimentally to use one or the other as the accommodating member. Presumably, he learns with development to reframe such tasks, so as typically to use the more simple or the more familiar member as the reference, or accommodating member. This would increase the child's resistance to the induction to use one or the other member as the reference, or accommodating member, and would thus diminish the chances of DA occurring. Also, if the child brings either cues from the visual field or a strategy to bear in judging the relative lengths of the two figures, i.e., if semireversibility obtains, the chances of finding DA will be diminished. One might reasonably expect semireversibility to be more prevalent among older children. Following from this set of considerations, a subsidiary prediction for each of the three experimental tasks of this study is that the hypothesized DA effect will diminish with age.

PROCEDURES

Experiment 1: The Muller-Lyer Task

An apparatus called the Adjustable Figures box, as described in Appendix B, was designed for presenting the Complex Standard and Simple Standard conditions of Figure 1 separately. In the CS condition, the complex figure was the fixed, or standard member, while the simple figure was adjustable. In the SS condition, the simple figure was the standard, and the complex adjustable. The two figures in each of these conditions were horizontally situated, with the standard figure always to the left of center and the adjustable figure always to the right of center, appearing immediately behind an eighty-by-twelve-inch viewing window. Through a suitable arrangement of pulleys, it was possible for Ss to pull one string and make both ends of the adjustable figure extend simultaneously, or to pull another and make both ends retract simultaneously. In both the CS and SS conditions, the standard figure was sixty-four millimeters long, while the adjustable was preset at either eighty or forty millimeters. When preset at eighty millimeters, the adjustment had to be made from long to short. That is, Ss had to pull the string which made the adjustable figure become shorter. When preset at forty millimeters, the adjustment had to be made from short to long. When set at the same length, the standard and adjustable figures were separated by sixty millimeters.

Sixty-four children from each of four grade levels, k, 2, 4, and 6, were randomly assigned to the experimental treatments. All Ss were taken from the elementary schools of a small midwestern community composed predominantly of middle-class families. There were four adjustment trials for each S. Long-to-short and short-to-long adjustments were alternated over these four trials. Half of the Ss performed two trials in the CS condition first followed by two trials in the SS condition. The other half performed two trials in the SS condition first followed by two trials in the CS condition. Within the CS first and the SS first conditions, half of the Ss began with a long-to-short adjustment, and the other half with a short-to-long adjustment. The Name-Size and the Amount Constancy tasks were interpolated, in that order, between the second and third trials of the Muller-Lyer task. The two main conditions of each of the three experimental tasks were balanced over the two main conditions of each of the other two experimental tasks.

The directions were uniform for all Ss as follows:

> Prior to trial one, each S was shown that the adjustable figure extended or retracted depending upon which string was pulled. These instructions were repeated for each trial: "Now pull on just this one string only. You will make this line (pointing to the adjustable figure) get longer (shorter). When it is just the same length as this one (pointing to the standard figure) stop pulling and let me know."

In scoring this task, the length in millimeters of the adjustable figure was recorded following each adjustment. Adjustment error could be derived from this measurement in terms of either signed or

absolute error, signed error indicating error with respect to the usual direction of the Muller-Lyer illusion, and absolute error indicating error without regard to the usual direction of the illusion. Absolute error is used in testing the predictions of the present study, since it is predicted only that there is less error of adjustment under the SS than under the CS condition. No prediction is made about the direction of this error with respect to the usual direction of the illusion. However, since signed error is shown in certain tables of Appendix A, the procedure for deriving signed error will be given here. The length of the standard figure was 64 mm. in both the SS and the CS conditions. If, in the SS condition, the complex figure was set longer than the simple figure, the error is negatively signed. If set shorter, the error is positively signed. If, in the CS condition, the simple figure was set longer than the complex figure, error is positively signed. If the simple figure was set shorter in this condition, the error is negatively signed.

For each grade level, under each of two control conditions, a mean, $\bar{d}$, will be calculated, expressing the magnitude of the DA effect.[3] In calculating $\bar{d}$, first the average absolute error or adjustment is found for each S on trials one and two, along with the average absolute error of adjustment for each S on trials three and four. Then a difference score is obtained for each S, representing the difference between his average error of adjustment on the first two trials and

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[3]The reader who may not be familiar with $\bar{d}$, and with the application to it of the statistic t, is referred to Wilfred J. Dixon and Frank J. Massey, Jr., Introduction to Statistical Analysis, New York: McGraw-Hill, 1957, pp. 124-127.

his average error of adjustment on the second two trials. The average of these difference scores is $\bar{d}$. At each grade level, two values of $\bar{d}$ are obtained, one for each of two control conditions. In one scoring procedure, for one of these control conditions, $\bar{d}$ represents the average of the difference scores taking Complex Standard trials first minus Simple Standard trials (CS 1st procedure). In the other scoring procedure, for the second control condition, $\bar{d}$ represents the average difference taking Simple Standard trials first minus Complex Standard trials (SS 1st procedure). For each of these two scoring procedures, $\bar{d}$ will be signed. If there is less error in the SS than in the CS condition as predicted, then in the CS 1st procedure the value of $\bar{d}$ will be positive, while in the SS 1st procedure $\bar{d}$ will be negative.

Experiment 2: The Amount Constancy Task

The objects used in the Amount Constancy task were pieces of clay about four centimeters in diameter in ball form and about two centimeters in diameter in sausage form. The procedures were uniform for the Ss in each of two experimental conditions. In a Simple to Complex (S to C) condition, two balls were presented. After S had agreed that both had the same amount, and that, therefore, neither had more and neither had less, S was given one piece to hold, while E rolled the other into the form of a sausage. In a Complex to Simple (C to S) condition, the procedure was the same, except that two sausages were presented, then one was rolled into the form of a ball. In both conditions, Ss were then asked: "Do the two pieces now have the same amount of clay, or does one piece have more clay?"

A "Same" response, indicating amount constancy, is scored as more adaptive, and a "More" response as less adaptive.

While DA is predicted for the second-grade level only (cf. p. 12) Ss from k, 4, and 6 performed the task also. This procedure served the purpose of providing uniform interpolated activities between the first and second pairs of trials on the M-L task.

Experiment 3: The Name-Size Task

The two main experimental conditions for the Name-Size task were Name First and Size First. Each S performed in only one of these conditions. In the Name First condition, the name and no-name values were presented side by side on separate cards, as a part of the longer phrases shown in Figure 2. In the Size First condition, the bigger-littler values were similarly presented. One phrase appeared on each of four 3" by 5" plain file cards, in primary type.

Condition	Phrases Presented	
Name First	BOY WHO HAS A NAME	BOY WHO HAS NO NAME
Size First	BOY WHO IS BIGGER	BOY WHO IS LITTLER

FIGURE 2. Two Main Conditions for Presenting the Phrases Used in The Name-Size Task

A second, larger plain file card was placed beneath each of these cards when it was presented. Ss were told that each bigger card had a drawing of a different boy on it. These bigger cards were actually left blank, since Ss had no occasion actually to see the alleged drawings.

The standard form of presentation for this task was as follows:

> S was presented one of the two pairs of cards, and told that on each of the bottom cards appeared a drawing of a different boy. In order to insure that no Ss believed the boy with no name to be an unnamed baby, these boys were said to be of the same age and grade as S. Then, depending upon the condition, S was told either that one boy had a name and one had no name, or that one was bigger and the other littler. To insure that S knew which was which, E pointed to the phrases and read them to S. S was then asked whether he could or could not tell which boy was bigger and which was littler (or which was named and which was not named) from what he already knew. To control for a possible set effect, the order for presenting the two values of the dimension involved in this final question was alternated.

A "No" response, indicating no relation between knowledge of the values of one dimension and knowledge of the values of the other, is scored as a more adaptive judgment, while a "Yes" response is scored as less adaptive.

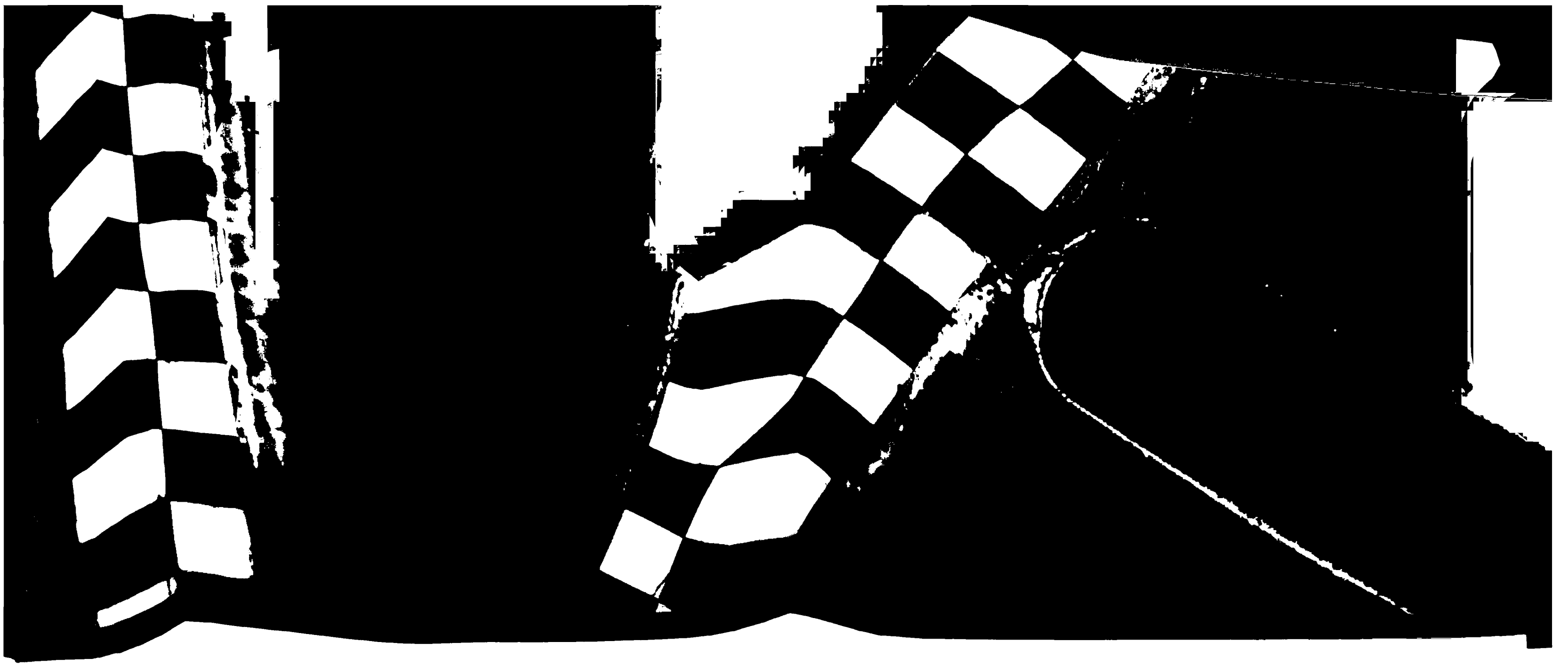
HYPOTHESES

Experiment 1: The Muller-Lyer Task

The first two hypotheses are concerned with the predicted DA effect in the M-L task. As indicated in the Procedures section, the value of $\bar{d}$ represents the extent to which DA obtains. The sign of $\bar{d}$ represents the direction of DA. For the control condition in which CS trials precede SS trials, $\bar{d}$ represents the average of the difference scores obtained by subtracting absolute error of adjustment on SS trials from absolute error of adjustment on CS trials (CS 1st scoring procedure). If DA obtains, and in the predicted direction, $\bar{d}$ will be positive in the CS 1st procedure.

> H_1: For the CS 1st procedure, and at each of the four grade levels tested,it is hypothesized that $\bar{d}$ is significantly greater than zero.

For the control condition in which SS trials precede CS trials, $\bar{d}$ represents the average of the difference scores obtained by subtracting error of adjustment on CS trials from error of adjustment on SS trials (SS 1st scoring procedure). If DA obtains, and in the predicted direction, $\bar{d}$ will be negative in the SS 1st procedure.



H_2: For the SS 1st procedure, and at each of the four grade levels tested, it is hypothesized that $\bar{d}$ is significantly less than zero.

The first subsidiary hypothesis is also concerned with the M-L task. It deals with the prediction that DA diminishes with increased age. Since $\bar{d}$ is an index of the extent to which DA obtains, the value of $\bar{d}$ will be nearer to zero in both the CS 1st and SS 1st scoring procedures if this prediction holds.

H_3: For each of the two scoring procedures, CS 1st and SS 1st, $\bar{d}$ for kindergarteners will be significantly different than $\bar{d}$ for sixth graders, with the value of $\bar{d}$ closer to zero at the sixth-grade level.

Experiment 2: The Amount Constancy Task

The next main hypothesis is concerned with the predicted DA effect in the Amount Constancy task.

H_4: For second-grade Ss, it is hypothesized that the proportion of adaptive (amount constancy) judgments in the C to S condition will be significantly less than the proportion of adaptive judgments in the S to C condition.

The second subsidiary hypothesis concerns the Amount Constancy task. The second and sixth-grade levels were selected in order to compare Ss representing approximately the second and third stages (cf. p. 7), respectively, in the development of amount constancy.

H_5: The difference between the proportions of adaptive judgments under the C to S and the S to C conditions at the sixth-grade level will be significantly less than the difference between these proportions at the second-grade level.

Experiment 3: The Name-Size Task

The third main hypothesis is concerned with the predicted DA effect in the Name-Size task.

> H_6: It is hypothesized that for each grade level tested, the proportion of adaptive (no relation) judgments in the Name First condition will be significantly less than the proportion of adaptive judgments in the Size First condition.

The third subsidiary hypothesis concerns the Name-Size task. The comparison is made between kindergarteners and sixth graders, in order to maximize the age difference within the age range tested.

> H_7: It is hypothesized that the difference between the proportions of adaptive judgments under the Name First and the Size First conditions at the sixth-grade level is significantly less than that at the second-grade level.

RESULTS

Table 1 presents the results of one-tailed t tests on the means for the eight sets of difference scores to be compared. For both the CS 1st and the SS 1st procedures, the mean difference, $\bar{d}$, is significantly different from zero at each grade level. Since all differences are in the predicted direction, indicating less error under the SS condition, all the results confirm H_1 and H_2.

It is worth noting the effect that an increment in motor performance over trials would have on the obtained difference scores. In the CS 1st procedure a gradual increment due to motor practice effects would tend to result in relatively less error under the SS treatment, and to make for a mean difference in the same direction as that due to the DA effect. However, in the SS 1st procedure such an increment would tend to result in relatively less error under the CS condition, an effect which would diminish the chances of detecting a significant DA effect. It is particularly noteworthy that the DA effect is, nevertheless, significant in this latter procedure.

TABLE I

COMPARISON OF DIFFERENCE SCORES FOR ABSOLUTE ERROR OF ADJUSTMENT UNDER COMPLEX STANDARD AND SIMPLE STANDARD CONDITIONS OF THE MULLER-LYER TASK[a]

Complex Standard First Procedure

	Grade Level			
	K	2	4	6
$\bar{d}$	4.98	3.13	3.84	1.77
S_d^2	17.91	19.16	16.76	18.48
$\underline{t}$	6.66	4.04	5.29	2.29
N	32	32	32	32

Simple Standard First Procedure

	Grade Level			
	K	2	4	6
$\bar{d}$	-3.34	-2.89	-1.91	-2.88
S_d^2	20.61	16.19	19.14	20.65
$\underline{t}$	4.29	4.07	2.47	3.58
N	32	32	32	32

[a]In the CS 1st procedure, $\underline{t}$ = 2.29 is significant at the .05 level, using a one-tailed test. All other values of $\underline{t}$ are significant at the .01 level, using a one-tailed test.

Table II presents the data relevant to the second major hypothesis, concerning amout constancy. At each grade level, thirty-two Ss performed on each of the two conditions, C to S and S to C. Each cell of the table shows the proportion of adaptive judgments out of thirty-two. Only the second-grade results are pertinent to this

TABLE II

PROPORTION OF ADAPTIVE JUDGMENTS IN THE AMOUNT CONSTANCY TASK BY GRADE LEVEL

	Grade Level			
Condition	K	2	4	6
Complex to Simple	.19	.66	.94	1.00
Simple to Complex	.06	.75	.86	.97

hypothesis. No statistical test of the significance of these results was performed. Examination of the results indicates no significantly greater proportion of adaptive judgments in the S to C than in the C to S condition. The second major hypothesis, H_4, is not confirmed.

Table III presents the data relevant to the third major hypothesis, concerning the name-size relation. At each grade level, thirty-two Ss performed on each of the two conditions, Name First and Size First. Each cell shows the proportion of adaptive judgments, i.e., judgments indicating no relation between knowledge of the name values and knowledge of the size values, out of thirty-two judgments.

TABLE III

PROPORTION OF ADAPTIVE JUDGMENTS IN THE NAME-SIZE TASK BY GRADE LEVEL

	Grade Level			
Condition	K	2	4	6
Name First	.28	.44	.41	.56
Size First	.31	.38	.41	.69

No statistical tests of the significance of these results were performed, since examination of the table clearly indicates that there is not a significantly greater proportion of adaptive judgments in the Size First than in the Name First condition at any grade level. Thus the third major hypothesis, H_6, is not confirmed.

Accompanying each main hypothesis was the subsidiary hypothesis to the effect that the DA effect diminishes with increased age. Since no significant DA effect was found for the Amount Constancy or for the Name-Size task, analysis of the subsidiary hypotheses for these tasks is redundant. For both the SS 1st and the CS 1st procedures of the M-L task, a one-tailed t test of the significance of the difference between $\bar{d}$ for the kindergarteners and $\bar{d}$ for the sixth graders was performed in order to test H_3. The 3.21 mm. difference obtained in the predicted direction for the CS 1st procedure is significant at the .01 level. For the SS 1st procedure, the 0.49 mm. difference in the predicted direction is not significant.

Certain further results tangential to the hypotheses of the present study are included in Appendix A. Certain of these tables give the results of the M-L task in terms of absolute error, and others in terms of signed error. A positive error is an error in the usual direction of the illusion, and a negative error an error in the reverse direction. Tables A and B show the differences by trial and by grade level between the CS and the SS conditions, in terms of absolute error and signed error, respectively. Tables C and D show the mean absolute and signed error, respectively, with a cell for each condition of the M-L task. Table E presents separate results for males and females on the M-L tasks. None of these results is critical in the interpretation of the main hypotheses.

DISCUSSION

Interpretation of the Results

It is concluded that Differential Adaptivity has been demonstrated in the perceptual realm, with the modified Muller-Lyer task, according to the conditions and constructs from which it was predicted. Such a demonstration was not effected with the Amount Constancy or the Name-Size task.

Evidence for the hypotheses that DA diminishes with increased age in the M-L task was quite clear in one control condition, but did not attain significance in a second such condition. That some evidence of this developmental tendency was obtained is encouraging in two respects. First, this evidence tends to validate the constructs associated with DA, in that it indicates that these constructs, in conjunction with certain additional constructs, lead to fruitful predictions. Secondly, this evidence tends to validate these additional constructs. In particular, it supports those constructs associated with Piaget's semireversibility.

The exploration of cross-relating theoretical linkages between the present and still further theoretical positions might well prove fruitful. Several possible lines of such exploration will be considered after the results for the Amount Constancy and the Name-Size tasks have been discussed.

Tables II and III show a clear developmental trend toward more adaptive judgments for both the Amount Constancy and the Name-Size tasks. However, the predicted DA effect did not occur with either task. In the Name-Size task, Ss who indicated that they could know the size values from knowledge of the name values were asked how they could know this. None expressed a premise to the effect that the name is a part of the referent. Even older Ss could merely reiterate their judgment by a comment such as: "Well, the boy who has no name will be littler." Whereas in the Amount Constancy task many older Ss spontaneously commented to the effect that nothing had been added and nothing taken away, none said that nothing had been added and nothing taken away in the Name-Size task. Nevertheless, the developmental tendency was toward reversibility in both tasks, supporting Piaget's findings.

Through a more refined basis for selecting Ss in the Amount Constancy task, it might be possible to demonstrate DA. An attempt was made to test the requirement that second-grade SS were responding perceptually, and thus, assumedly, on the basis of having referred their representations of the pieces of clay to a set of expectancies. E asked several Ss whether, in order to tell if there was still the same or a different amount of clay after the shape of one piece had been altered, they had to look at the pieces of clay. Some Ss said they did not have to look. Had this test been introduced sufficiently early in the course of the experiment, only those Ss who said they did have to look would have been retained in the sample.

There are two further considerations which might need to be taken into account in any further attempts to test for DA. Both have to do with inducing Ss to interchange the assimilatory and accommodatory functions for a pair of representations or concepts. The first is that various methods for making the inductions need to be tried. Secondly, assuming that such inductions may be possible in the cognitive realm, the conditions in which they might be effective need further exploration. One line for such exploration which might prove fruitful is to limit the time S has to make the judgment after being presented with that member of a pair of items which is to be assimilated. The reason for expecting this factor to have an effect is related to the seemingly reasonable assumption, as stated previously, that Ss may learn spontaneously to reorder the assimilatory and accommodatory functions, such that the more simple or the more familiar member is typically used as the reference, or accommodating member. Calling for an immediate judgment might be expected to reduce the chances that Ss could "reframe" the task in this manner.

Consideration of Differential Adaptivity in Relation to Other Theoretical Areas

In the background of Theory and Research section above, the present study was related to certain theoretically relevant constructs of Piaget. The present section will consider the possible relations between the constructs of this study and those of certain other theoretical areas.

Witkin and others (14) have recently studied effects alternately termed field independence vs. field dependence and analytical vs. global modes of perceptual-intellectual functioning. Witkin (13:26-27) interprets such studies as indicating that

> . . . a tendency to experience in more analytical or less analytical fashion characterizes a person's intellectual activity as much as his perception. There is now considerable evidence that children and adults with a relatively more analytical way of perceiving do significantly better at intellectual tasks in which essential elements must be isolated from the context in which they are presented and recombined into new relationships.

In the present Muller-Lyer task, the line segment in the complex figure must be isolated from the context of the extended obliques in order for a more accurate judgment as to the relative lengths of the complex and simple figures to be made. The results of the present study indicate that Ss may be induced to respond more or less analytically depending upon the mode for presenting the essential elements of the task. Moreover, the present study has attempted to specify the conditions and constructs according to which such more or less analytical judgments may be predicted. Further studies relating the present study to those studies in the tradition of field independence and dependence might be expected to indicate that field independence often entails a "reframing" of the task, as discussed earlier. Consequently, Ss who are more field independent might be expected to be more resistant to the induction to use one or the other member of pairs of figures as the reference, or accommodating member. Considering DA as an individual difference variable, greater field independence might be predicted to be associated with less DA. Confirmation of this

prediction would help to validate the constructs associated with DA. Moreover, it would have the implication for the field dependence-independence tradition of providing a beginning toward the study of the mechanisms underlying analytical vs. global modes of functioning.

It may be asked whether Differential Adaptivity is not a special instance of adaptation level effects as Helson has characterized them. Helson (In Koch, p. 575) has stated his position so generally that such would seem to be the case. He states:

> In so far as past stimulation influences present behavior and there is interaction between focal and contextual stimuli, we are justified in including such interactions among AL effects.

Such a broad basis for inclusion seems unwarranted in the absence of cross-relating linkages among the theoretical bases for positing such effects. The presently posited interchangeability of the assimilatory and accommodatory functions in the process of articulating and relating representational or conceptual structures has no clear counterpart in adaptation level theory. Neither do the summative effects to which Helson applies his weighted log mean formula have a clear counterpart in the present study. It might well be a fruitful undertaking, although beyond the scope of the present study, to attempt to apply Helson's formula in the case where the relative familiarity of the items presented is established by controlling the relative number of presentations of the members of a pair of items before calling for a judgment as to the degree of relationship between them. This may well be an avenue toward providing cross-relating theoretical linkages. It may also be the case that the present view of DA can be liberated

from the consideration of only pairs of single, represented objects or of concepts to consideration of series of objects by analyzing its relationship to Helson's adaptation level theory.

The Relation of Empirical Data and Generalizations
from Other Studies to the Present Muller-Lyer Task

There is an extensive body of literature relating to the Muller-Lyer illusion. Consideration of this literature suggests that a number of other explanatory principles need to be evaluated in interpreting the results of the M-L task of this study as instances of DA. It will become clear that several aspects of the M-L task as presented in this study tend to preclude the straightforward comparison of the present results with previous empirical findings with the illusion.

Certain effects associated with Piaget's "law of relative centrations" (see Vurpillot;12) would seem to be operative in the present experiment. The effect of centering is among the effects Piaget has described with respect to certain geometric illusions. This effect consists in an overestimation of that element which is fixated. A special instance is the error of the standard, which consists in an overestimation of the figure which serves as the standard of reference (Vulpillot, p. 407). Piaget's particular method for presenting the M-L figures--the constant presentation of a reference figure along with a variable series of comparison figures--is taken by him to result in a relatively greater duration of fixation of the standard figure, and a consequent overestimation of it. In the present experimental procedure, however, both figures are constantly visible during the presentation, with an adjustable figure replacing the typical Piagetian series

of variable figures. Since these two procedures do differ, one can only speculate as to the relation of his findings and interpretations to the present task. It seems likely that the adjustable figure receives more fixations, since S must give considerable attention to it as he makes the adjustment; however, this is not known to be the case. Moreover, it is not known whether fixating a line whose length is adjustable results in the same effect as fixating one which is not. In any case, overestimation of the length of the adjustable figure in the CS condition of the present experiment would result in its being set shorter than otherwise, and would consequently tend to diminish the usual illusion effect. Overestimation of the adjustable figure in the SS condition would tend to increase the usual illusion effect. Taken jointly, these outcomes would have tended to diminish the chances of detecting the significant DA effect which was found.

Drawing upon a different set of considerations and findings, there may be an alternate basis to that posited in the present study for expecting the SS condition to result in less error than the CS condition. If sound, this alternate explanation would tend to increase the chances of finding a differential effect. This alternate position is based upon the assumption that any tendency to increase the number or duration of fixations of the complex figure might make for a more accurate representation of it, and, consequently, for a more accurate judgment of the relative lengths of the two figures. Since the M-L task as presented here, in both the CS and SS conditions, is presented with unrestricted time limits for the adjustment, it seems unlikely that the complex figure will be fixated for any much different duration

in either condition. Nevertheless, there is some basis for expecting that it might be so fixated which needs to be taken into account. Vernon (11:165) discusses a number of instances in which ". . . it seems that an observer's perception of the field, or of any particular aspect of it, may be made more accurate in so far as his attention is directed toward it." Vernon (11:158) discusses an additional general perceptual phenomenon which may be relevant here: "We tend to overlook anything relatively uninteresting and unimportant, unless it moves or changes in some way." Also pertinent is Berlyne's (1) finding that certain Ss spent significantly more time looking at the more complex figure from among a large number of pairs of figures, where each pair was presented separately. Both because it moves and because it is more complex, the complex figure in the SS condition seems likely to receive relatively more fixations than the simple figure. Given as an assumption that this would be the case, it remains to consider any empirical findings which might indicate that this assumed increase in the number and duration of fixations would make for a more accurate judgment of the relative lengths of the modified M-L figures of the present study. Any improvement over trials in the judged relation between the M-L figures as classically presented might be interpreted as evidence of this outcome. Noelting (5) studied the effects of practice on the Muller-Lyer illusion. The difficulty of generalizing from Noelting's to the present study should be emphasized. His form of presentation differs in several respects from that of the present study: (1) he used both feathers and arrows; (2) he used the classical method of adjustment, wherein the two figures form one continuous line segment;

and (3) he called for twenty continuous trials, without interruption. Noelting's data show a progressive decrease in the illusion over a series of twenty trials for an eight-year-old group and for a nine-to-ten-year-old group. Younger groups five to seven years old show no statistically clear change in the illusion over twenty trials. Indeed, for his particular sample, the results show a possible slight progressive increase. It is noteworthy that for the two older groups mentioned above, there is no clear tendency for the decrease in the illusion to become asympototic within the twenty-trial series. That is, improvement continues throughout the twenty trials. Noelting's findings seem to suggest (1) that there may be an interaction between age and improvement over trials within the age range tested (roughly, six to thirteen) in the present study, and (2) that it may not be reasonable to expect a great deal of improvement in the relatively brief duration of the four trials of the present study. It does not seem reasonable to conclude from these results that the effect of practice in the present study would be sufficiently greater in the SS than in the CS condition to lead to the significant differential effect found at all grade levels in the present study.

Certain data from the present study give a more direct test of this possible alternate explanation. If in the SS condition S attends for a greater duration to the adjustable, complex figure, and if so attending decreases the error in the judged relations between the two figures, then, according to the alternate explanation, there should be a significant negative correlation between adjustment in seconds and error of adjustment in millimeters. Since adjustment time was recorded

for all Ss on all trials, a test of this outcome is possible. The correlation coefficients between mean error of adjustment on the first two trials of the SS condition and mean adjustment time on these trials, for grades k, 2, 4, and 6, respectively, are 0.24, -0.10, -0.07, and -0.13. Each r is based on N=32. One-tailed tests of significance show that none of these correlations attains significance at the .05 level. The results do not support the alternate basis for explaining the significant DA results obtained in the present study.

Conclusion

It is concluded from the results of the present study that the constructs associated with Differential Adaptivity merit further exploration. Two main courses of exploration need to be pursued. First, further attempts to demonstrate this effect with tasks other than the Muller-Lyer task, with which it was demonstrated in the present study, need to be devised. Such further demonstrations would give additional support to the validity of the constructs according to which DA was predicted. Secondly, consideration has been given to other areas of theoretical exploration whose constructs, in conjunction with those of the present study, might lead to further fruitful predictions. Evidence for such further predictions would tend not only to validate the constructs of the present study, but also to extend and further validate the constructs of these other theoretical areas.

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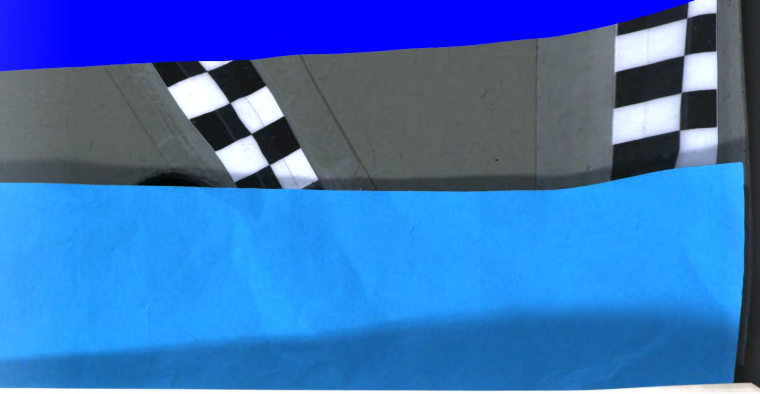

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APPENDIX A

TABLE A

ABSOLUTE ERROR DIFFERENCES BY TRIAL AND BY GRADE LEVEL OF THE DIFFERENCE BETWEEN THE COMPLEX STANDARD AND THE SIMPLE STANDARD CONDITIONS OF THE MULLER-LYER TASK[a]

		Grade Level			
Trial	Standard Figure	k	2	4	6
1	Complex	11.88	8.78	8.31	6.81
	Simple	6.41	5.35	5.34	6.44
	Difference	5.47	3.44	2.97	0.38
2	Complex	6.28	7.09	7.66	5.13
	Simple	4.66	5.13	4.28	3.47
	Difference	1.63	1.97	3.38	1.66
3	Complex	9.68	7.75	6.41	7.22
	Simple	5.84	4.47	4.66	5.22
	Difference	3.84	3.29	1.75	2.01
4	Complex	8.28	8.59	7.03	7.81
	Simple	5.47	5.16	3.59	3.84
	Difference	2.81	3.44	3.44	3.97

[a]Each difference is based on N=32.

TABLE B

SIGNED ERROR DIFFERENCES BY TRIAL AND BY GRADE LEVEL OF THE DIFFERENCE BETWEEN THE COMPLEX STANDARD AND THE SIMPLE STANDARD CONDITIONS OF THE MULLER-LYER TASK[a]

Trial	Standard Figure	Grade Level k	2	4	6
1	Complex	10.75	7.78	7.56	4.88
	Simple	2.16	-2.46	1.28	0.63
	Difference	8.59	10.42	6.28	4.25
2	Complex	8.78	6.03	4.78	4.77
	Simple	1.84	-1.63	1.78	1.03
	Difference	6.94	7.66	3.00	3.74
3	Complex	9.68	7.13	5.09	6.91
	Simple	-1.97	0.72	-1.16	-0.31
	Difference	11.65	6.41	6.25	6.22
4	Complex	8.16	8.41	6.05	7.19
	Simple	-1.91	-0.60	0.34	1.28
	Difference	10.07	9.01	5.71	5.91

[a]Each difference is based on N=32.

TABLE C

MEAN ABSOLUTE ERROR FOR EACH CONDITION OF THE MULLER-LYER TASK[a]

		Trial 1						Trial 2			
		k	2	4	6			k	2	4	6
SS1st	L-S	8.87	6.00	4.62	5.12	SS1st	L-S	5.31	4.81	3.00	4.19
	S-L	3.94	4.69	6.06	7.75		S-L	4.00	5.44	5.56	2.75
CS1st	L-S	8.75	8.87	8.12	8.37	CS1st	L-S	7.37	8.37	8.62	5.81
	S-L	15.00	8.69	8.50	5.25		S-L	11.44	5.81	6.69	5.75
		Trial 3						Trial 4			
SS2nd	L-S	5.87	4.12	4.94	5.87	SS2nd	L-S	5.50	5.44	3.31	4.06
	S-L	5.80	4.81	4.37	4.56		S-L	5.44	4.87	3.87	3.62
CS2nd	L-S	7.25	8.56	5.62	9.75	CS2nd	L-S	7.50	9.37	8.06	6.87
	S-L	12.10	6.94	7.19	4.69		S-L	9.06	7.81	6.00	8.75

[a]Each mean based on N=16.

TABLE D

TABLE D

MEAN SIGNED ERROR FOR EACH CONDITION OF THE MULLER-LYER TASK[a]

		Trial 1 k	Trial 1 2	Trial 1 4	Trial 1 6			Trial 2 k	Trial 2 2	Trial 2 4	Trial 2 6
SS1st	L-S	4.87	-3.10	0.62	-4.87	SS1st	L-S	3.31	-4.19	-0.50	0.31
	S-L	-0.56	0.56	1.94	6.12		S-L	0.37	2.56	4.06	1.75
CS1st	L-S	6.50	6.87	8.12	7.50	CS1st	L-S	6.12	7.50	8.25	4.94
	S-L	15.00	8.69	7.00	2.25		S-L	11.44	4.56	5.81	4.62
		Trial 3						Trial 4			
SS2nd	L-S	-0.87	-0.87	-3.81	-4.37	SS2nd	L-S	-1.25	-3.06	-1.94	1.31
	S-L	-3.06	2.31	1.50	4.06		S-L	-2.56	1.87	2.62	1.25
CS2nd	L-S	7.25	8.31	5.37	9.75	CS2nd	L-S	7.25	8.87	7.19	6.87
	S-L	12.10	5.94	4.81	4.06		S-L	9.06	6.94	5.00	7.50

[a]Each mean based on N=16.

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l
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TABLE E

ABSOLUTE ERROR MEANS FOR MALES AND FEMALES ON THE MULLER-LYER TASKS[a]

Simple Standard First

	k		2		4		6	
	M	F	M	F	M	F	M	F
$\bar{X}$	5.57	5.21	5.12	5.08	4.97	4.66	5.67	4.54
N	14	14	12	12	16	16	12	12

Complex Standard First

	k		2		4		6	
	M	F	M	F	M	F	M	F
$\bar{X}$	9.13	11.80	8.33	7.00	7.29	8.33	7.61	5.77
N	15	15	12	12	12	12	14	14

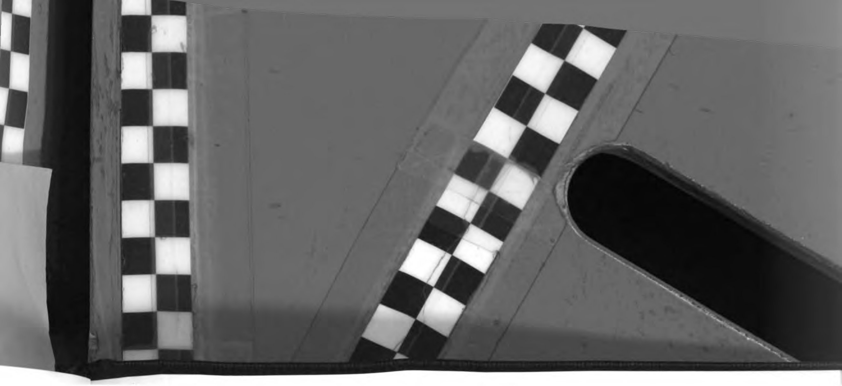
[a]Each pair of means represents the largest possible random sample of equal numbers of males and females who received equivalent treatment on all balancing conditions. Each score is the average of one long-to-short and one short-to-long adjustment.

APPENDIX B

THE ADJUSTABLE FIGURES BOX

This appendix presents a description of the Adjustable Figures box developed for the presentation of the modified Muller-Lyer task.

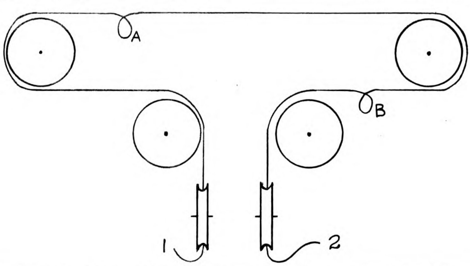
Mounted on the front of a suitable box frame was a removable front panel of 3/8" plywood 36" long by 18" high, in which a 12" long by 8" high viewing window had been cut. Mounted on the rear of this panel were two aluminum channels, situated horizontally about 12" a-part, one above, and one below the viewing window. Three panes of 3/16" transparent plastic were inserted so as to be supported by these channels, while free to slide readily along them. In order for one of the Muller-Lyer figures to be adjustable in length, one-half of the figure was mounted on one of these sliding panels, and the other half on another. These portions of the figure were made of black plastic tape. These portions were partially superimposed, so as to appear to be a single, continuous line segment. Sliding the two panels apart simultaneously caused the line segment to extend in length at both ends simultaneously. Sliding the two panels together simultaneously caused the line segment to retract at both ends simultaneously. This adjustable figure was so situated as to appear to the right of center in the viewing window. The fixed Muller-Lyer figure, also made of black plastic tape, was mounted on the third plastic panel, so as to appear horizontally to the left of center in the viewing window. This panel was taped into place so that it did not slide between the channels.



A system of pulleys was placed inside the box frame on which the plywood front panel was mounted, making it possible for a subject to pull on one string which protruded through the front panel and make the adjustable figure extend in length, or to pull a second string and make this figure retract. Diagram 1 shows the pulley system.

DIAGRAM 1

PULLEY SYSTEM FOR THE ADJUSTABLE FIGURES BOX



Loop A was attached to one of the sliding plastic panels, and loop B to the other. Pulling string end 1 caused the two loops to move outward simultaneously. While pulling string end 2 caused both loops to move inward simultaneously. And this effect,of course, caused the adjustable line segment to extend or to retract at both ends simultaneously.

This box may be adapted for presenting a variety of figures and forms.