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The Quantifiable Effects of Different Photographic Stimuli on Apparent Visual Movement

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THE QUANTIFIABLE EFFECTS
OF DIFFERENT PHOTOGRAPHIC STIMULI
ON APPARENT VISUAL MOVEMENT

by

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INTRODUCTION

The phi phenomenon has been under investigation since Wertheimer (1912) experimentally manipulated the pause interval between the sequential flashing of two lights to achieve what he called optimal or phi phenomenon. The term, phi phenomenon, refers to the perception of motion induced by the rapid sequential flashing of spatially distinct, stationary light sources.

Kenkel (1913) investigated apparent motion and gave the term beta movement to the apparent motion of an object from one place to another. Korte (1915) compiled laws concerning beta movement. His fourth law states that as the duration of exposure (D) is increased, the interval between the end of the first stimulus and the beginning of the second (ISI) must be decreased to obtain optimal motion. Korte stated that once D and ISI are established they must be held constant for the perception of any degree of apparent motion. The sum of D and ISI defines the stimulus-onset asynchrony (SOA), or coincidence in time between the two exposures. The optimal SOA for motion is a monotonically decreasing function of D. Subsequent studies have confirmed Korte's fourth law (Kolers, 1964; Sgro, 1963).

Kahneman (1967) demonstrated that with brief exposure durations (up to 100-150 msec in many conditions) the experience is not of a stationary object that moves to a new location, but of a moving object. Wertheimer (1912) established the optimal interval between the sequential flashing of two lights at about 60 msec for the perception of movement. Recent research by Lyngen (1967) and Walraven (1968) used the duration time of 100 msec and interval time of 60 msec based on previous research. This research will incorporate these previously established beta movement times.

In addition to the factors of D, ISI, and SOA of beta movement, other factors have been discovered to influence phi and/or beta movement. Some of these factors are distance between stimuli, relative differences in intensity, form, wavelength differences, and factors influencing the subjects involved in the experiments (Graham, 1951). These factors have been reviewed by Hovland (1935), Fernberger (1941), and Aarons (1964). This experiment will investigate the effects of different photographic slides on phi phenomenon apparent speed.

The first investigator to report the use of meaningful material in apparent motion studies is DeSilva (1926) who investigated the role of (subjective) determinants in movement using drawings. Among his findings he specifies that meaningful objects are perceived as moving faster than unidimensional objects. Moreover, "...a meaningful, animate pattern gives a clearer perception of movement than an unmeaningful inanimate pattern." DeSilva's conclusions are somewhat ambiguous since he does not specify whether differentiated structure or greater meaning connotation is the factor contributing to decreased thresholds. Blug (1932) confirmed DeSilva's findings and reported "...apparent movement of the exposed objects. A horse appears to move in the direction suggested in the picture; a bird seems to beat its wings, etc... The apparent movement is especially pronounced when its direction coincides with that of the movement elicited by the brightness change." Krolik (1935) employed slides containing drawings of objects customarily experienced as mobile (car, balloon, ship, train, hand cart, elevator) or stationary in past experience (house, barn, log, beacon). Krolik found, under almost all conditions, allocation of movement unilaterally, in favor of the object experienced in the past as moving in the relevant direction. In the various studies by DeSilva, Blug and Krolik, the dependent variable was simply a verbal response about the perceived apparent motion.

Jones and Bruner (1954) studied the role of motion connotative factors using stick figures of a man and a nonsense figure. The figures were presented in phi phenomenon sequence placed equidistant but in opposite directions. The S was asked to report the relative speed and distance of movement of the two objects. After only one trial, 85% of the S's reported that the man appeared to move faster and farther. In the fourth experiment reported in the same paper, they presented the hypothesis; "...that where there is an option in the path of apparent movement, that path of movement will occur, other things being equal, that most conforms to an established expectancy." The basis for the presentation used in this experiment was supplied by Ternus (1938), who found that dots successively exposed as (1) spatially separated, (2) together, and (3) separated, could be optionally seen as "crossing over" or "bouncing off" each other. Although the results "tend to support the prediction" they failed to do this conclusively, i.e., the frequency differences fell short of statistical significance.

Kelly (1935) demonstrated to which extent the perception of apparent movement is influenced by previous experiences and by verbal suggestion. Of 400 elementary psychology students, approximately one-half reported seeing simple movement (two lights flashing) without any suggestion. Immediately after being told what to look for, seen movement was reported by 94% of the group. Of the 48% reporting a difference in the upward and downward speed of vertical movement, 32% reported a more rapid falling motion, and 16% a more rapid rising motion.

Comalli, Werner and Wapner (1957) demonstrated that autokinetic motion could be induced by meaning-induced sets of meaningful stimuli. The results indicated that directional dynamics of pictured objects influence the direction of autokinetic motion consonant with the direction of the dynamics in the stimulus figure.

Krampen and Toch (1960) examined the role of directional determinants and used for their study arrows and arrow-like figures. They asked, "How much like an arrow does an arrow have to look before its 'arrowness' becomes an effective determinant of perceived movement direction?" They used a three light presentation, in which the flashing of the center light followed the simultaneous flashing of the outer two lights. They found support for their hypothesis that the more an arrow-like figure looks like an arrow, the greater will be the perceived motion. Toch (1963) employed additional determinants in a study of perceived movement direction. The determinants used in the study were (1) fixation to one side of the stimulus, (2) movement connotations in the stimulus figures (meaning), and (3) identity (vs dissimilarity) of stimulus figures. He summarized that fixation, when combined with meaning, i.e., with stimuli figures having motion connotation, exercised a powerful effect on the perceived direction of motion, but when combined with identity, had little or no effect. Therefore the same perceptual determinants can have varying degrees of effectiveness, depending on how they are combined or controlled.

Lyngen (1967) studied the effects of past experience on the speed with which figures were seen to move. He used simple figures, plus figures of a stick man, jet plane, and sailboat. The S's perceived different figures as moving at significantly different speeds when presented in phi sequence. He had an independent group rank order the figures prior to testing and found a high correlation between the rank order of stimuli prior to testing and the rank order resulting from testing. His dependent variable was quantified by having each S match the horizontal speed of the blip on an oscilloscope to the speed at which the figure appeared to move.

Biel (1948) demonstrated that aircraft of differing types were perceived as moving at varying speeds depending on the S's familiarity with the performance characteristics of the aircraft. This is in agreement with Lyngen's results. Biel however, did not have a quantifiable dependent variable but used the common technique of simply having the S's report which seemed to move faster.

Walraven (1968) advancing the work of Lyngen found that the different orientations of the stimulus figures would produce differences in perceived speed. When he reversed the orientations of the stimulus objects, he found a reduction in the apparent speed of those stimulus objects perceived to be fastest in the normal orientation and an increase in the perceived speed of those objects perceived as slowest in the normal situation.

The present study was conducted to investigate not only speed connotative factors but also stimuli with certain aversive characteristics. It may be recalled that the literature shows investigation of distance between stimuli, relative differences in intensity of lights, form, wavelength differences and factors influencing the S's involved in the experiments. Meaningful objects and speed determinants have been investigated and examined along with modifying their orientations. The quantifiable effects of different photographic stimuli on phi phenomenon apparent speed using aversive stimuli with and without speed connotative factors, and using non-aversive stimuli with and without speed connotative factors was investigated in the present study. A deliberate attempt was made to find stimuli with the above mentioned characteristics. Four stimuli were selected that met the intended requirements. Three were in color and one in black and white. The photographic slides were (1) aversive, with no speed factors, in color; (2) aversive, with speed factors, black and white; (3) non-aversive, with no speed factors, in color; (4) non-aversive, with speed factors, in color.

The stimuli were selected that would impart the strongest meaning and directional factors to the perceiver. However, not all facets of all the stimuli were considered.

Previous research by the experimenter has indicated that aversive stimuli without speed connotative factors are perceived at slower speeds than non-aversive stimuli without speed connotative factors. The experimental hypotheses are: (1) that stimuli with aversive factors will be perceived as moving slower than stimuli without aversive factors; (2) that aversive stimuli without speed connotative structure will be perceived as moving slower than aversive stimuli with speed connotative factors; (3) that non-aversive stimuli without speed factors will be perceived as moving slower than non-aversive stimuli with speed factors; (4) that reversing the figure orientation from the normal left to right phi sequence will significantly reduce the overall perceived speed of the stimuli; and (5) that with figure reversal, speed connotative figures will be perceived as moving slower than non-speed connotative figures.

METHOD

Subjects

Eighty students enrolled in the 11th and 12th grades from Quincy High School, Quincy, Michigan, served as subjects.

Apparatus

The stimulus figures were: (Figure 1)

(1) The gaping mouth of a baboon -- aversive, no speed factors, in color.

(2) The face of a pretty girl -- non-aversive, no speed factors, in color.

(3) The hand of a primate -- aversive, speed factors, black and white.

(4) A man riding a motorcycle -- non-aversive, speed factors, in color.

The stimulus figures were selected because of the strong meaning variables they connoted. The meaning and speed connotative factors of the stimulus figures in this experiment were considered as most important variables for study.

The stimulus figures were mounted on the ends of the cylindrical canisters, supplied as component parts of a phi phenomenon presentation device manufactured by Psychological Instruments, Inc. One of the four canisters was eliminated, and the remaining three canisters were placed horizontally. The front of each canister was made of translucent plastic, and measured 2-1/2" in diameter. A masking device was inserted over the round canisters reducing

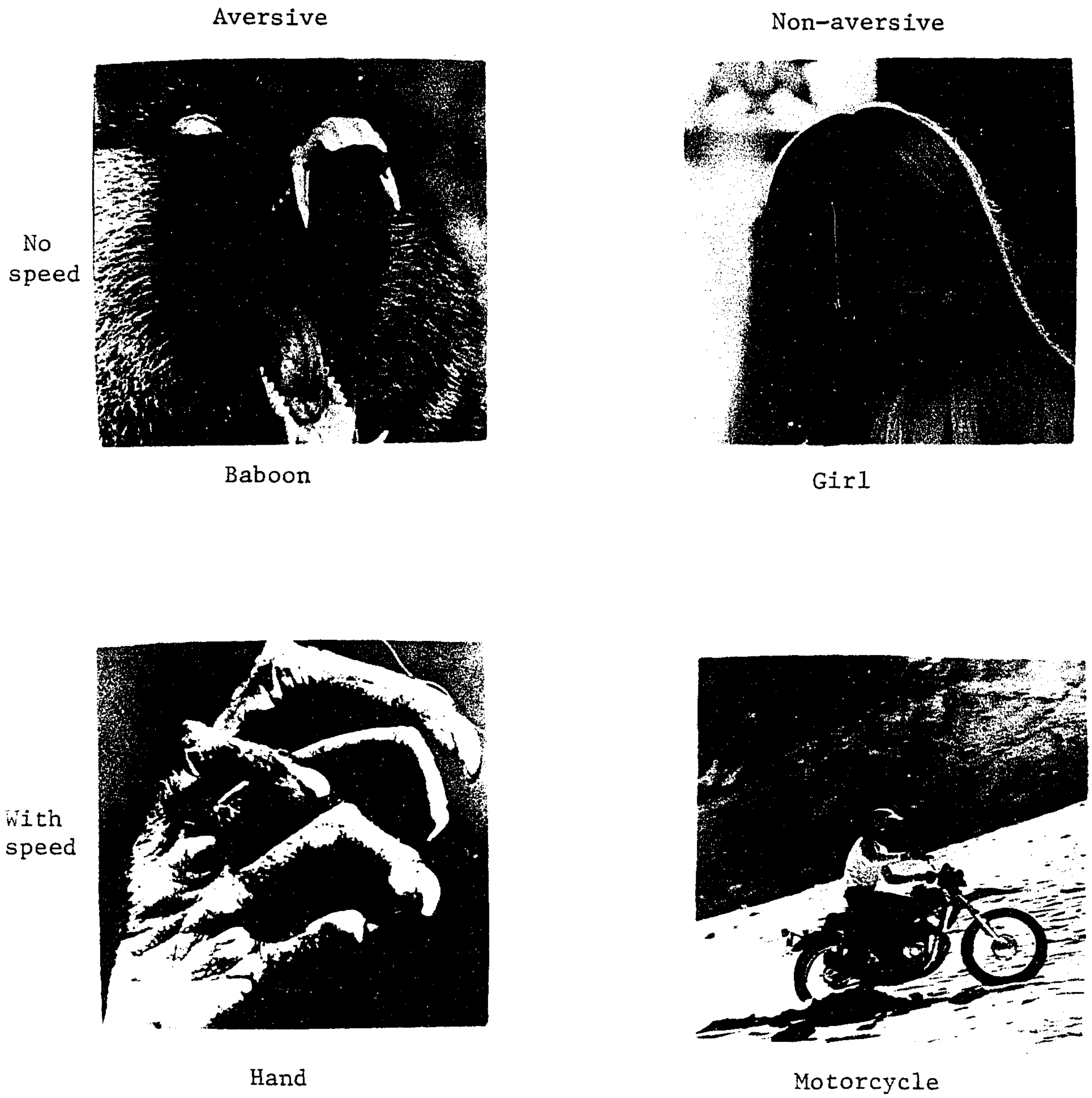

Figure 1

Stimulus figures: shown in phi sequence orientation.

the 2-1/2" circle faces to 2-1/4" squares. Each canister contained a light, the flashing, duration, and intensity of the lights being controlled from a separate panel. The three canisters were placed equidistant from another such that the total distance from the outside edges of the first and third canisters was 12". The centers of all canister faces were 8-1/2" from the surface of the table on which the apparatus was mounted. The duration of each flash was set at 100 msec with 60 msec delay between flashes. Recycling time, from the disappearance of the third flash to reappearance of the first, was 220 msec. Flash sequence was from left to right, abc.

The response measure incorporated an RCA WO-56A 6" oscilloscope which was modified by the insertion of a two-stage potentiometer allowing S to remotely adjust horizontal sweep speed of the blip. The control was movable, and was placed before S's preferred hand. S adjusted the control by means of a fluted knob, to which was attached a circular scale. The oscilloscope was positioned on S's left and the phi phenomena device on the right such that the inside edges of both units were tangent to the direct line of sight of S. The S's were asked to sit in a straight back chair and not to deviate their head from the natural sitting posture. Both the screen of the oscilloscope and the front illuminated faces of the three light canisters were placed perpendicular to S's line of sight. The oscilloscope was placed at a distance of 72" from S, and the canisters 98" from S, in order to equate the 12" width of stimulus object travel to the 6" width of blip travel on the oscilloscope screen (Figure 2).

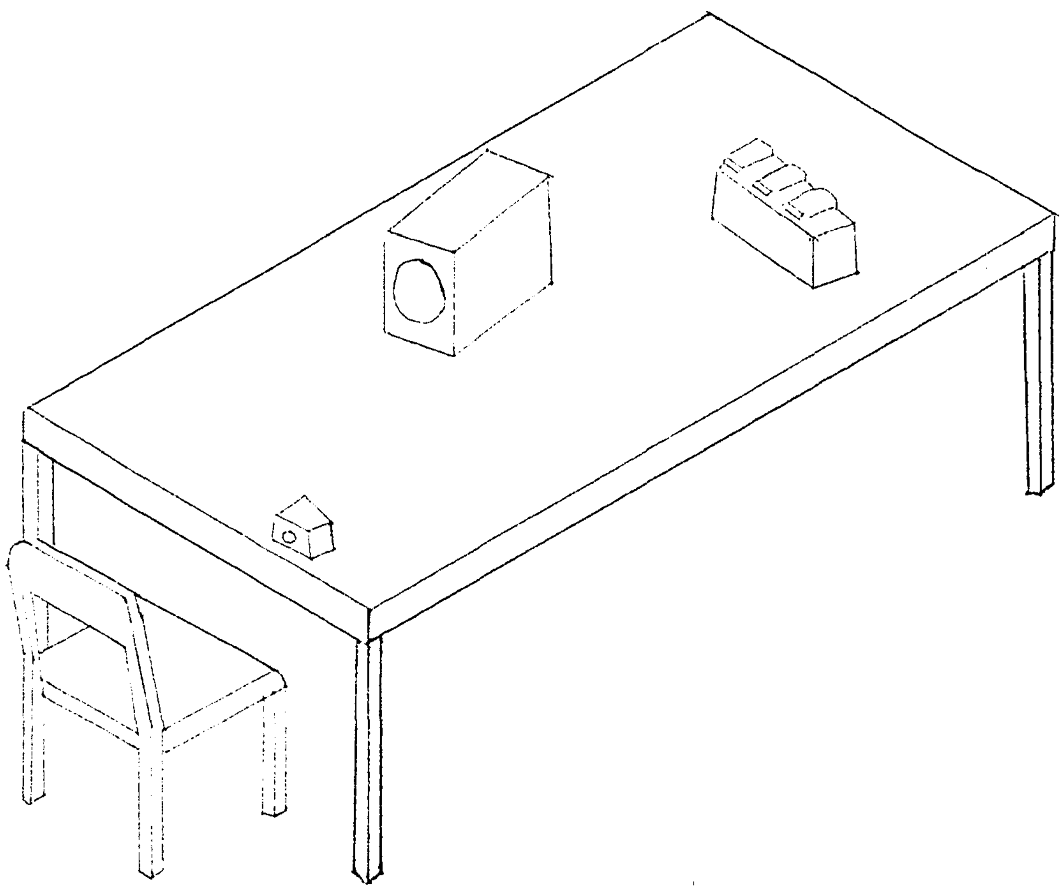

Figure 2

Apparatus

Procedure

To avoid possible interactions between stimulus objects and/or orientations within S's, as well as to preclude satiation of the phi effect, eight random groups were used. Each group was presented only one orientation of one stimulus object. Orientations used were phi sequence direction (Figure 1), and reversed for each stimulus object.

Each S was assigned randomly to one of eight groups. Before each S was tested, he sat in a darkened room for ten minutes to facilitate dark adaptation.

The S was admitted to the dark experimental room and seated before the apparatus, which was on at all times. S was asked to sit in a normal upright position and not deviate until the experiment was completed. The following instructions were read:

> "This experiment is designed to investigate some of the factors involved in the perception of apparent motion, such as motion pictures and flashing neon signs. The knob on your right/left controls the horizontal speed of the blip on this oscilloscope. Turning the knob to the right causes the blip to slow down; turning it to the left causes the blip to speed up. You may adjust the knob while I continue. Your task is to adjust the knob so that the horizontal speed of the blip matches the horizontal speed of the object on the right. I am going to ask you to make five adjustments. When you have made an adjustment, tell me so and remove your hand from the control knob momentarily while I read and record the dial setting using this penlight. I will then reposition the knob one way or another and ask you to adjust it again. Please note that it is electronically impossible to adjust the knob in such a fashion that the blip and the object on the right start and stop at the same time. Therefore please do not waste time trying to match or align them in that manner. Concentrate only on horizontal speed matching of the apparatus."

The S was then asked if there were any questions. If so, the directions were repeated until S understood.

After five adjustments had been made and recorded, S was thanked for his time and cooperation and dismissed. The E requested that S not discuss the experiment with any potential S's until the end of the experiment.

RESULTS

The data were subjected to a two-way analysis of variance as described by Kirk (1968) and summarized in Table 1. While the figure effect and orientations produced significant F values (p. 101), the interaction effect did not. Tukey's Honest Significant Difference (HSD) test was then applied on the data to pinpoint the significant differences between objects. The results of the Tukey's test are summarized on Table 2. While the phi sequence orientation produced significance between the baboon and hand, the baboon and cycle, and the girl and cycle, the reversed orientation revealed the additional significant comparison between the girl and the hand.

In Table 2 the row and column headings are presented in ascending rank order by perceived speed.

Table 3 presents the perceived speed of each figure in each orientation. The figures are presented in rank order by speed. Note the reversal of the perceived speed of the girl from phi sequence orientation to reversed orientation.

Table 4 gives the totals of grouped perceived speeds for aversive, non-aversive, and speed, for phi sequence orientation.

Table 5 shows the actual differences in perceived speeds between phi sequence orientation and reversed orientation. The column is presented in ascending rank order.

Table 6 summarizes another series of Tukey's tests conducted to pinpoint the significant differences between orientations of each stimulus figure.

Table 1

Analysis of Variance Summary

Source	SS	df	MS	F
Figures	3192.63	3	1064.21	8.40*
Orientations	715.57	1	715.57	5.64*
Interaction	340.33	3	113.44	.89
Error (within cells)	49653.26	392	126.66	
Totals	53901.78	399		

*p.<01

Table 2

Tukey's HSD test between Ordered Pairs of Mean Perceived Speeds

Phi Sequence Orientation

	baboon	girl	hand	cycle
baboon		2.02	5.28**	7.46**
girl			3.26	5.44**
hand				2.18

Reversed Orientation

	girl	baboon	hand	cycle
girl		3.10	6.80**	7.76**
baboon			3.70*	4.66**

Figures are presented in ascending speed rank order.

**p.<01, HSD = 4.12
*p.<05, HSD = 3.31

Table 3

Perceived Speeds (in inches per sec) of the Stimulus Figure

Phi Sequence Orientation

1	baboon (aversive, no speed)	16.80
2	girl (non-aversive, no speed)	17.27
3	hand (aversive, with speed)	18.03
4	cycle (non-aversive, with speed)	18.53

Reversed Orientation

1	girl (non-aversive, no speed)	16.02
2	baboon (aversive, no speed)	16.74
3	hand (aversive, with speed)	17.60
4	cycle (non-aversive, with speed)	17.82

Figures are presented in ascending speed rank order for each orientation.

Table 4

Averages of perceived speeds by aversive, non-aversive, and speed, no speed, for phi sequence orientation.

	Phi Sequence Orientation
Aversive	17.41
Non-aversive	17.90
No speed	17.03
Speed	18.28

Figures are presented in perceived speeds in inches per sec of the stimulus figures.

Table 5

Actual differences in perceived speeds (in inches per sec) between phi sequence orientation and reversed orientation.

baboon	- .06
hand	- .43
cycle	- .71
girl	-1.25

Table 6

Tukey's HSD test between ordered pairs of perceived speeds.

	baboon	hand	cycle	girl
baboon	.17			
hand		1.02		
cycle			1.09	
girl				3.39*

Orientations are presented in ascending speed rank order.

*$p < .05$

DISCUSSION

The rank ordering of the stimulus objects when shown in phi sequence orientation indicates that perceived speeds of stimuli with aversive qualities are slower than those of stimuli without aversive factors. Those data support the first hypothesis. Table 3 indicates that the baboon, which is aversive and lacks speed connotative factors, was perceived as moving the slowest of all the stimuli when presented in phi sequence. Table 4 shows the totals of grouped perceived speeds which clearly indicates that aversive stimuli are perceived to move slower than non-aversive ones.

The second hypothesis was that aversive stimuli without speed connotative factors will be perceived as moving slower than aversive stimuli with speed connotative factors. Referring to Table 2 the data show the baboon, which is aversive without speed connotative factors, was perceived as moving significantly slower than the hand, which is aversive with speed factors. The aversiveness of the baboon and the hand was indicated by some of the _S_'s verbal reactions upon first exposure. The hand was generally perceived as aversive and showed strong directionality determinants since the fingers are arched and pointing in a horizontal direction (Figure 1). These strong directional factors may explain the high ranking in Table 3. The speed structural factors of the hand dominate the perception of the aversiveness effect. The baboon, lacking speed factors, however, is a more powerful aversive stimulus.

The third hypothesis finds support in that the girl, a non-aversive stimulus without speed factors, was perceived as moving significantly slower than the motorcycle, which is a non-aversive stimulus with speed connotative factors.

In all cases reversing the stimulus orientation reduced the motion effect which substantiates the fourth hypothesis, which states that reversing the figures from phi sequence orientation will significantly reduce the overall perceived speed of the stimulus. These results compare favorably with the results of Walraven (1968).

The fifth hypothesis states that with figure reversal, speed connotative figures will be perceived as moving slower than non-speed connotative figures. Rank ordering the data as shown in Table 3 shows that this hypothesis was not supported. The girl, which lacks speed connotative factors, when presented in the reversed orientation was perceived as moving slower than the other stimuli. It was hypothesised that the hand or motorcycle would show a greater difference in perceived speeds on orientation reversal. Table 5 gives the actual speed differences and Table 6 shows that the girl is the only stimulus speed difference that achieves significance between orientations. A complete explanation cannot be given at this time. It may be argued that the meaningfulness of the girl is the dominating theme which contributed to the lower perceived speeds.

The direction of the phi sequence is presented left to right, in the direction in which we read printed material. The effect of reversing stimuli from this normally perceived expected direction may give some further indication as to the large reversal effects of the girl. Future research may incorporate a counterbalanced design of presenting phi sequence from left to right and from right to left and showing the stimuli in both orientations of each direction.

Clearly the data generated by this investigation are insufficient to unquestionably explain all the differences discovered. Further research should be directed at isolating differences between stimulus figures without speed factors that have aversive effects and figures that do not. In addition, research may be directed at examining speed connotative and denotative stimuli, both aversive and non-aversive.

Comparison of the data in this study with the data of Walraven (1968) shows the perceived speeds to be similar for the silhouette figures and photographic figures. The random groups design employed in this study precluded intra-S interactive effects such as contrast.

SUMMARY

This study was conducted with 80 subjects assigned randomly to eight groups to determine the effects of different photographic stimuli on phi phenomenon apparent speed. The stimulus figures were four photographic slides presented in two orientations via a modified phi apparatus. The results supported the hypotheses that stimuli with aversive factors will be perceived as moving slower than stimuli without aversive factors, and that aversive stimuli without speed connotative structure will be perceived as moving slower than aversive stimuli with speed connotative factors. Other hypotheses were presented and discussed. The results were compared to previous research of apparent visual motion. Suggestions for further examination of aversive and non-aversive stimulus figures were made.

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