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THE SIZE-WEIGHT ILLUSION IN BLIND PERSONS

Thesis for the Degree of M. A.

MICHIGAN STATE UNIVERSITY

Fernando Colon

1960

THESIS

THE SIZE-WEIGHT ILLUSION IN BLIND PERSONS

BY

Fernando Colon

A THESIS

Submitted to the College of Science and Arts
Michigan State University of Agriculture and
Applied Science in partial fulfillment of
the requirements for the degree of

MASTER OF ARTS

Department of Psychology

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AN ABSTRACT

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The present study was designed to investigate the occurrence or non-occurrence of the Size-Weight Illusion in congenitally blind persons and also to determine whether the sighted person develops his reaction to the Size-Weight Illusion by the use of sight as well as the kinesthetic and tactual senses.

The psychophysical method of constant stimuli was used to get a measure of the frequency of occurrence of the Size-Weight Illusion. The apparatus consisted of two series of five blocks each. The first series of blocks were designed to keep the size constant as the weight varied, while the second series of blocks was designed to keep the weight constant as the size varied.

There were three groups of ten observers each: a sighted group, a blind-folded sighted group and a congenitally blind group. One hundred comparisons with each series of blocks were made by the observers in each of the three groups utilizing a pincer lift (using just thumb and forefinger to lift the block.) The congenitally blind group in addition, using the second series of blocks, made 100 judgments with a palmar lift and 100 judgments with a grasp lift.

The experimental results definitely demonstrated that the Size-Weight Illusion does occur in the congenitally blind person and that the sighted person does develop his reaction to the Size-Weight Illusion by the use of sight as well as the kinesthetic and tactual senses.

It is concluded that neither the tactual sense, the visual sense nor the kinesthetic sense alone is enough to elicit the

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Size-Weight Illusion. It seems that at least two of the senses must be involved in order for the illusion to occur.

Approved by: S. Howard Bartley

Date: Mar 8-60

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F.C.

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INTRODUCTION

The size-weight-illusion (SWI) refers to the fact that when subjects are asked to make a judgment about the weight of two equally weighted objects of different size they tend to call the larger sized object lighter and the smaller sized object heavier.

Actually the size-weight-illusion is not really an illusion but it is rather a case in which a person reacts to the density of an object. If a large object weighing 50 grams is compared to a small object weighing 50 grams the latter will have a greater density and appear heavier. Thus in the comparison of two objects density becomes the primary factor when the weights are the same and the sizes are varied and weight becomes the primary factor when sizes are the same and weights are varied.

Charpentier* was the first to describe the SWI. He obtained it by using two balls with the same physical weight but of a different size. Flourney* elicited the illusion even though no tactual contact was made with the objects when the O was told to put his finger through a ring to which a stiff thread was suspended and attached to the objects to be lifted. He had his O's repeat the experiment with their eyes closed and there was no SWI. Van Bierivliet* had his O's lift a bottle by the neck and by the bottom. Here the size was the same in the two situations. He conducted several experiments in this manner with the eyes open and the eyes closed. He got the SWI in all cases.

Koseleff (5) went further and made O compare the heaviness of a small object looked at directly with the heaviness of the same

* Findings translated and reviewed by Koseleff (5)

object perceived through a convex lense. There was a SWI; the thing different was the retinal images. He achieved another reduction of the visual size by making O look through a small hole in a piece of cardboard and again the SWI occurred. Koseleff (5) was also able to elicit the SWI when he used two blocks which were different in height but exactly alike in length and width. When one was superimposed upon the other they seemingly formed one body. The smaller one was about nine times as heavy as the larger one. When both blocks were grasped and lifted with the heavier on top they felt lighter than the heavier one alone. When the heavier one was underneath the illusory effect was smaller and more uncertain than when it was on top. (4) Koseleff (6) obtained data which seemed to signify that the SWI was greater when the larger object was measured by the smaller one than when the smaller one was measured by the larger one.

Usnadze (13) had his O's compare two balls of the same size (diam = 99 mm) weighing 286 grams and 880 grams respectively. When this was done with the eyes closed the lighter one appeared to most persons to be larger. In this case the weight affected the experienced size which was the reverse of the SWI wherein the size affected the experienced weight. Usnadze also placed eight prisms of different heights but with the same weight on the resting arm of the O's. No active lifting was performed and again the SWI was found. It also was found when the weights are placed on the resting hand of the O. However, in the latter case, when O's attention was not on the size of the objects the SWI diminished and tended to disappear altogether when the eyes were closed.

Huang (3) focused on the factors of density and weight. S's were required to compare under conditions otherwise identical the weights of objects of unequal size in one set of experiments and their densities in another set. To get C's to make judgments based on density they were asked whether one of the objects (apart from their weights) appeared more "empty" or "floating" than the other. The results for the weight lifting experiments show the usual SWI and the greater the difference in the size of the objects compared the greater the illusion. The results for the density experiments showed the same trend with the SWI effect being greater. However, in the latter case the differential limens and the standard deviations of the PSE's were slightly greater than the corresponding values for the weight experiments.

Whipple (14) in his "Manual of Mental and Physical Tests," states that the SWI hardly exists up to the age of three, is well developed by the age of six, continues to increase up to the age of nine, and then slowly declines. Flyssen and Bourdon (9) conducted an extensive experiment with 600 normal S's between the ages of 20 and 60 years. To study the SWI they used as weights parallelipipeds in beechwood. One block was 21 cm. long, five cm. wide and only two cm. high. The other block was the same except that it was seven cm. high. Both blocks weighed 500 grams. They found that the SWI occurred in 99.17% of the 600 cases when the comparison between these two blocks was made. They found that the illusion existed not only when different sizes with the same weight are compared but that it also remained when the weight of the larger size

was sensibly higher than the little sized one. Because of this fact, Nyssen and Bourdon (10) think that the magnitude of the illusion may be rated by the physically heaviest weight for which the illusion is still present. In comparing data from 50 males and 50 females they found that the magnitude of the illusion was the same for both sexes. They also compared 20 university educated O's with 20 unskilled laborers and there was no significant difference in the magnitude of the SWI due to educational level.

Applying the same procedure to 68 general paretics, 42 senile patients and 97 adult oligophrenics, all very generally deficient, the SWI proved to be clinically worthless for the detection of mental deficiency or deterioration in adults. (9) They pursued this idea further using Koseleff's (4) form of the illusion believing it would be more apt to produce a less tenacious illusion, particularly in pathological cases with pronounced deficiency or deterioration but without success. Nyssen and Bourdon (9) cite Claparede's observation of the existence of the illusion in 93% of the pedagogical backward S's of the special classes in Geneva. Doll (1) detected the illusion in 100% of the abnormal S's whose mental age reached eight years. On the other hand, Demoor, as reported by Nyssen and Bourdon (9), found the SWI absent or inverted in feebleminded children. However, most authors are generally agreed that the magnitude of the illusion is of the same rate in normal persons as in deficient or deteriorated ones.

A survey of the work done on the strength or frequency of the illusion in relation to the various sense modalities revealed that there was general agreement in the findings. Seashore (11) found

that the SHI was weaker when the blocks were viewed in indirect vision and still weaker when judged by visual memory. When the size was estimated by the combined effect of all the spatial senses the illusion was weaker than when depending on the tactual and the kinesthetic senses.

Nyssen and Bourdon's (10) results agree with Seashore's. They had a group of 30 S's that were blindfolded while they lifted the blocks and a second group of 30 S's that were not blindfolded but who lifted the blocks with straps from which the weight was hung. Without visual perception the apparent weight was 263 grams, without the tactual perception it was 151 grams and with both tactual and visual cues the apparent weight was 250 grams. Meyers (8) stated that the illusion is strongest when the subject is permitted both to see the objects and to grasp them. Huang (2) did several experiments under five conditions, each of which involved a further reduction of size cues than did the preceding one. His results agree with those stated above.

Thus the degree of the SHI obtained was generally found to be dependent upon the amount and kind of sensory information made available. It was generally agreed that the tactual and kinesthetic senses were more potent than the visual sense and that all the senses together resulted in a weaker illusion than the tactual and kinesthetic alone. Huang (2) states that it is of great interest that with all the sensory cues eliminated, knowledge and memory alone of the difference in size of the objects seemed to lead to only a small degree of the illusion. He feels that this shows that the

SWI is dependent upon actual sensory data rather than on ideational, intellectual attitudes.

Several explanations of the SWI have been proposed. Muller and Schuman, as cited by Woodworth (15), theorized in 1889 that as O prepares to lift the comparison weight he will do so with a muscular force just previously found adequate for lifting the standard. He carries over a motor adjustment or "Einstellung" from the first lift to the second. If the comparison weight comes up quickly and easily, it seems light and is judged lighter than the standard; if it resists and comes up slowly it seems heavy and is judged heavier than the standard. Therefore, a weight which looks heavier than it is will be lifted with greater force than necessary and accordingly feel light.

Loomis' (7) experiment tends to support this view. He used a method of recording the movements which are executed in lifting two boxes of equal weight but of unequal size. He also had a way of figuring out how much energy was expended and found that an O uses more energy to lift the large box than he does in lifting the small box. Thus, if the two unequally sized boxes that weigh the same are lifted, the larger one will appear lighter because more energy was utilized in lifting it.

Charpentier, as described by Nyssen and Bourdon (10), ascribed the phenomenon to a difference in tactile sensations. He explained the illusion by positing the notion that since the largest object would come in contact with a larger skin surface it would have its weight spread over a greater number of sensorial receptors and therefore seem lighter.

Koseleff (3), after an extensive review of the research done on the SWI, proposes as a working hypothesis for an explanation of the illusion, that the experienced heaviness depends on a number of factors; amongst others, the physical weight and the volume of the object.

Huang (2) thinks that there is a striking parallelism between the problems, facts and theoretical issues of the SWI and the perceptual constancies. He feels that an explanation of the SWI may well lie in conjunction with the constancies. Thus, we have two attempts at a complete explanation of the SWI and two rather incomplete, tentative explanations.

A short perusal of the above reviewed experiments shows that Charpentier's explanation is inadequate when Flourney, as cited by Koseleff (5), and Nyssen and Bourdon (10) elicited the SWI without tactual contact with the objects. The Muller and Schuman theory also falls short because as Seashore (11) pointed out, even if the O's are aware of the experimental situation, the SWI persists. Huang (2) also demonstrated the insufficiency of this theory as he showed that the SWI is dependent upon actual sensory data and not ideational, intellectual attitudes. Thus we are left without a complete explanation of the SWI.

The purpose of this study is to focus on the role of vision in the SWI by studying its occurrence or non-occurrence in congenitally blind persons. Previous studies have only dealt with the role of vision by blindfolding sighted persons. It would seem that by using congenitally blind persons one would have more success in arriving at a clean-cut consideration of the visual factor in the

SWI.

It is known that sighted people make the SWI judgment on the basis of their visual, kinesthetic and tactual senses. We would expect the congenitally blind person (CB) to behave differently than the sighted person (S) in a SWI situation since the former has never directly used his visual mechanism. The only way CB persons have contact with an object is through their kinesthetic and tactual senses.

The purpose of this study is an attempt to answer the following questions:

a. Can the object provide the CB with some basis for the general behavior we call the SWI?

b. Can the CB by his kinesthetic and tactual senses develop an orderly reaction to the density of an object?

c. Does the sighted person develop his reaction in accordance with the density of the object by use of sight as well as the kinesthetic and tactual senses? Or will blindfolding a sighted person make a difference?

METHOD

SUBJECTS: The S's for this experiment were composed of three groups: Group I, ten sighted persons (S); Group II, ten blindfolded sighted persons (SB); and Group III, ten congenitally blind persons (CB). Subjects in Groups I and II were students from Psychology 201 and 300 at Michigan State University. They ranged in age from 18 to 27 years. In all, there were 14 males and six females.

Subjects in Group III were obtained from the Michigan School for the Blind. They ranged in age from 13 to 17 years. There were six males and four females in this group. In selecting subjects for this group it was necessary that they had been totally blind since birth, were 12 years old or older and had an average I.Q. of 100 or better. This was felt to be necessary since their results were to be compared to college students and it was desirable to eliminate any complicating growth factors by having them above the age of puberty.

It turned out that their I.Q.'s ranged from 103 to 129 except for one subject whose I.Q. was 91. It might be argued that the blind group was not comparable to the other two groups. However, the crucial factor was whether or not the groups used would be aware of the SMI. The investigator reasoned that since Whipple (14) found that the SMI was well developed by the age of six and that Nyssen and Bourdon (9) found the SMI to occur in 99.17% of 600 cases between the ages of 20 and 60 years, it was felt that the SMI would probably occur, if it were possible, with the subjects in the CB group who ranged in age from 13 to 17 years. The results indicated that this was definitely so.

APPARATUS: The apparatus consisted of two series of wooden cubes, five in each series. The cubes in Series I were used to get the O accustomed to making weight discriminations. Therefore, these cubes were constant in size and varied in weight. The cubes in Series II were used to get a measure of the frequency of occurrence of the SWI and they were thus constant in weight but different in size.

Standardization of the Stimuli:

Since the ultimate aim of the experiment was to elicit the SWI if possible, the goal in constructing the blocks to be used was to space the blocks so that they were readily discriminable with reference to size or weight. A wooden cube happened to be available that weighed 55 grams and was two inches square. This cube was relatively easy to manipulate and therefore it was decided to use it and another one like it as the standard in each series of blocks.

As all the blocks in Series I were to be the same size they were all made two inches square. A multiple of Weber's fraction (300 x 1/40) for lifting weights was used to give approximate values in weight that would be readily discernible. In addition, this multiple of Weber's fraction would maintain a constant fraction in weight between the five blocks. The following were the calculated sizes and weights for Series I:

Stimulus A - 40 gms.
Stimulus B - 48 gms.
Stimulus C - 57.6 gms. (Standard)
Stimulus D - 69.12 gms.
Stimulus E - 82.94 gms.

All two inches square

Using these weights as a guide an empirical investigation was conducted to discover a scale of values that could actually be used

for the purpose of this experiment. Rather than constructing many differently weighted blocks to determine the weights to be used, silica sand was placed in 30 ml. beakers so that there was a series of beakers with total weights as follows:

Beaker Number	Total Weight
1	37.5 gms.
2	40.0 "
3	42.5 "
4	45.0 "
5	47.5 "
6	50.0 "
7	52.5 "
8	55.0 "
9	57.5 "
10	60.0 "
11	62.5 "
12	65.0 "
13	67.5 "
14	70.0 "
15	72.5 "
16	75.0 "
17	77.5 "
18	80.0 "

A criterion of 100% was employed which required the subjects to be correct in their judgments of the weight five out of five trials with either hand before a value would be accepted for use in one of the cube shaped blocks. Three male subjects aged 23, 40 and 60 respectively were used in this study. The subjects were blindfolded throughout this procedure since permitting them to see the differently weighted beakers would cue them as to weight.

Using 55 gms. as the standard it was found that 47.5 gms. was the first discernible weight difference that met the criterion. To determine the next discernible weight the 47.5 gm. beaker was used as the basis for comparison since a scale of values was desired. It was found that 37.5 gm. met the criterion when compared with 47.5.

Working in the other direction from 55 gms., 67.5 gms. and 77.5 gms. were found to meet the criterion.

The record of the three subjects was as follows:

23	40	62
37.5 gms.	37.5 gms.	40 gms.
47.5 "	47.5 "	---
55.0 "	55.0 "	55.0 gms.
67.5 "	67.5 "	67.5 "
77.5 "	77.5 "	77.5 "

Since the data showed good regularity it was decided to aim for these weights in making the blocks for Series I. After construction the actual weights as measured on an analytical scale were:

Stimulus	Weight
A	77.19 gms.
B	67.27 "
C	55.05 "
D	47.48 "
E	37.26 "

Thus all blocks were within .5 gm. of the desired weights. This discrepancy was considered negligible since it was found that a 2.5 gm. difference in weight was not discernible by the subjects on whom the empirical study was conducted.

A similar investigation was conducted to determine the sizes of the blocks to be used in Series II. Since the standard of each series of blocks had necessarily to be of equal size and weight a piece of wood two inches wide served as the starting point in determining the values to be used in Series II. Thus two inches served as the value above which and below which the other values would range.

Fifteen pieces of wood were cut at 1/16 inch intervals so that they ranged in width from two inches to two and 14/16 inches. By

a method similar to that described above in determining the weights, the S's again being blindfolded, it was found that 5/16ths of an inch was the difference needed in size in order for a person to detect a discrepancy in the sizes of two blocks. This was true both above and below the standard value of two inches. Again the 100% criterion was used. If the conventional criterion of 50% or 75% was used it would have narrowed the range of sizes in the blocks and probably have reduced the chances of eliciting the SWI. This study was conducted on two males aged 23 and 62, and three females aged 16, 22 and 57.

The goal, with reference to the weights of the blocks in Series II, was to get them to all weigh 55 gms. After construction the blocks in Series II had the following dimensions and weights:

Stimulus	Size	Weight
A	1.375" or 1 3/8" sq.	54.61 gms.
B	1.750" or 1 3/4" sq.	54.55 "
C	2.000" or 2" sq.	54.57 "
D	2.312" or 2 5/16" sq.	54.62 "
E	2.687" or 2 11/16" sq.	55.79 "

All these blocks were within .5 gms. of 55 gms. except the largest. These weight discrepancies from the desired 55 gms. can be considered negligible since, on the basis of the above mentioned investigation, a difference of 2.5 gms. in weight cannot be detected by human subjects when a standard weighing 55 gms. was used.

The cubes were constructed out of white pine wood and were made of two to four pieces of white pine wood glued together depending upon the size required. To add the gross weights lead was placed in the center of the blocks. When it was necessary to take away weight the blocks were hollowed out correspondingly. The blocks were

finished with one coat of wood filler, one to four coats of plastic finish and one to four coats of hard wax depending upon how much additional weight had to be added to the individual blocks.

A box 5" high, 7 3/4" wide and 24 1/2" long was constructed to serve as a shield so that the sighted group could not see the manipulation of the blocks by the experimenter. The box was made out of 1/4" plywood and had a blotter strip attached to its top and to its inside bottom to deaden sounds and to protect the surfaces of the blocks. This box was also used as a stand for Group I and Group II on which the experimenter placed the pair of blocks to be compared on each trial.

PROCEDURE: Each S in Groups I and II was brought into the experimental room, seated at the apparatus and was read the following directions:

> I will present to you on each trial a pair of blocks. They will be placed on the top of the box that you see or feel before you. You are to take a block in each hand at the same time, using only your thumb and your forefinger to lift the block. Your part in this experiment is to answer the question: which of the two blocks given to you weighs the most? You are not to move the blocks up and down. Five practice trials will be given before the actual experiment begins. There will be two sets of 100 judgments each. A break will be given between the sets. If you are undecided as to which of the two blocks is heavier, just guess. Are there any questions?

The directions for Group III were somewhat altered because the total procedure of that group was different. However, the directions were essentially the same.

The psychophysical method of constant stimuli was used in presenting the stimuli to the subject. In both series block C served as the standard against which the other blocks in its series

were compared on the basis of weight. To determine which hand of the S was to be given the standard a half dollar was thrown 100 times prior to the experiment. If it landed heads, the standard was presented to the subject's right hand and if it landed tails the standard was presented to the subject's left hand. The order of presentation of the stimuli was randomized on the basis of a table of random numbers.

Groups I and II had to make a total of 100 judgments in both Series I and II using a pincer lift. A pincer lift meant that the blocks were to be lifted with the thumb and index finger. For Group III the procedure was slightly altered. They had 50 judgments in Series I followed by 100 judgments in Series II using the pincer lift. This was followed by 10 judgments in Series I using the pincer lift and then they had 100 judgments in Series II using the palmar lift. Finally, they again made 10 judgments with the pincer lift followed by 100 judgments with the grasp lift. Five minute breaks were given at the completion of each way of lifting the blocks.

RESULTS

Figure 1 shows the plotted lines for the occurrence of the SWI for the various groups. The lines were plotted by the use of averaged Z scores, a method described by Woodworth and Schlossberg (16). The ordinate represents the Z scores and the abscissa represents the stimuli used in Series II which were used to elicit the SWI.

Comparing all groups with reference to the pincer lift on the basis of the occurrence of the SWI, it is seen that Group I was highest, followed by Group III and Group II. It is also seen that the congenitally blind, Group III, had successively higher occurrences of the SWI with reference to the three conditions of the pincer, palmar and grasp lifts. In all three of these conditions they had a higher occurrence of the SWI than the blindfolded-sighted, Group II, and also came progressively closer, but not quite up to, the performance of the sighted, Group I.

The graph also demonstrates that the greater the discrepancy in the size of the stimuli, the greater is the occurrence of the SWI.

Statistical tests of significance between the various groups were computed. The median chi-square test for two independent samples as described by Siegel (12) was used as the test of significance. The one per cent level of significance was employed.

Table I lists the comparisons made. It can be seen that the results for Group I and Group II, both groups using the pincer lift, are in general significantly different from each other. The same was true for the comparison between Group II and Group III where

Occurrence of the SWI

Group I - Sighted - pincer lift

Group II - Sighted Blindfolded - pincer lift

Group III - Congenitally Blinded - pincer lift
palmar lift
grasp lift

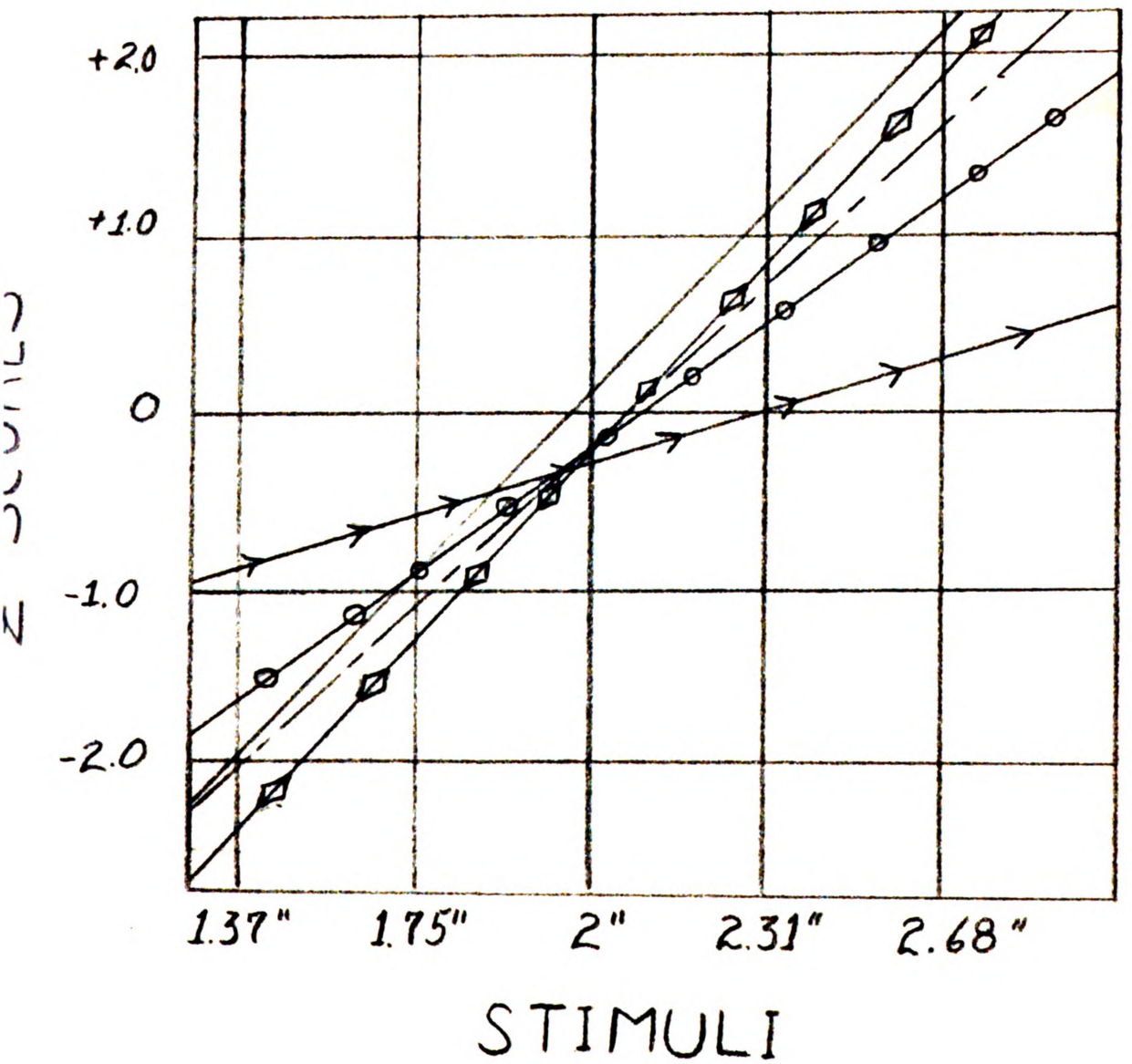

Figure 1

Summary of Statistical Analysis Based on Median Chi-square Test

	Stimulus	x^2	df	l. of signif.
Group I versus Group II Both pincer	CA	1.07	1	15%
	CB	5.21	1	5%
	CD	10.20	1	.1%
	CE	9.80	1	1%
Group II versus Group III Both pincer	CA	7.27	1	1%
	CB	6.79	1	1%
	CD	7.27	1	1%
	CE	9.8	1	1%
Group I versus Group III Both pincer	CA	.68	1	45% approx.
	CB	.00	1	99% "
	CD	1.06	1	30% "
	CE	1.8	1	15% "
Group I versus Group III Pincer vs palmar	CA	.87	1	45% approx.
	CB	.91	1	45% "
	CD	7.27	1	1%
	CE	.00	1	99%
Group I versus Group III Pincer vs grasp	CA	4.27	1	5%
	CB	5.23	1	10%
	CD	.20	1	65% approx.
	CE	.00	1	99%

Table 1

both groups used the pincer lift. However, the comparison between Group I and Group III, where again both groups used the pincer lift, is not significantly different. This was also generally true of the comparisons of Group I against Group III with reference to both the palmar and the grasp lifts.

It will be noticed that there was a flaw in the consistency of of the statistical findings. This occurred in the comparison of CD in Group I and Group III in the pincer versus palmar comparison and as shown, the result was significant at the 1% level. Since 10 comparisons were made one could expect at least one of the comparisons made to be significant, purely on the basis of chance. This possibility is also enhanced by the fact that large N's were not used. It is also seen with these groups that the two extreme stimulus values, DA and DE, were no where near significant and it follows that DB or DD would have even less chance of being significant. For these reasons, this discrepancy in the statistical findings may well be due to chance.

Another possibility is that there might have been a confounding effect at work since Group I used a pincer lift and Group III used a palmar lift. Chance, or a confounding effect, may also have occurred when Group I was compared to Group III in the pincer versus grasp comparison, since it is seen that the statistical findings for this comparison were not perfectly smooth either.

DISCUSSION

The results of this experiment gave answers to the questions set forth in the first part of this paper.

a. It was found that the object can provide the congenitally blind person with some basis for the general behavior we call the SWI.

b. The results also indicated that the congenitally blind person, by his kinesthetic tactual senses, can develop an orderly reaction to the density of an object.

c. Finally, the sighted person, it seems, develops his reaction to the SWI by the use of sight as well as the kinesthetic and tactual senses, since blindfolding a sighted person decreases the frequency of occurrence of the SWI.

The general findings show that in reference to the frequency of occurrence of the SWI the sighted, Group I, gave the highest frequency of occurrence of the SWI; the congenitally blinded, Group III, were next; the blindfolded-sighted, Group II, were last.

Fleurney, as cited by Koseleff (5), and Hyssen and Pourdon (10) demonstrated that the SWI could be obtained without the use of the tactual sense. The present study showed that the illusion could be obtained without the use of the visual sense. However, Usnadze (13) was not able to elicit the illusion when only the tactual sense was involved. A consideration and analysis of these studies, along with the others reviewed in the first part of this paper (3,4,5,6), seems to show that the tactual sense, the visual sense or the kinesthetic sense alone is not enough to elicit the SWI. It seems that at least two of the senses must be involved in

order to get the illusion.

In the present study it was found that the congenitally blind group gave a higher frequency of occurrence of the SWI than the blindfolded-sighted persons. This result is understandable in view of the fact that when one blindfolds a sighted person and asks him to do a task in which he would ordinarily use his sight he will naturally be handicapped to a certain extent. The greater frequency of occurrence of the SWI in the congenitally-blinded in this instance is not surprising because they, in effect, have been "blindfolded" all their lives and have learned to utilize their tactual and kinesthetic senses to a greater extent than the sighted person who relies more on his sight.

In line with Huang's (2) experiment in which he got less SWI by the successive reduction of the size cues, it was found in this study that by increasing the amount of tactual and kinesthetic information made available to the subject a higher frequency of occurrence of the SWI was obtained. This was demonstrated in the congenitally blind group as they gave successively higher frequency of occurrence of the SWI under the three conditions of the pincer, palmar and grasp lifts. It may be that they obtained a higher frequency of occurrence of the SWI not because of the increased amount of sensory data but simply because of the effects of learning. Unfortunately, the number of congenitally blind subjects available precluded the possibility of directly testing this hypothesis. It is probably safe to conclude that the increase in their performance was in all probability due to a combination of both factors.

A question that might well be worth investigating is if more

tactual and kinesthetic information is made avialable to the blindfolded-sighted person, would he then give a frequency of the occurrence of the illusion more comparable to the congenitally blind person? This could readily be done by getting two more blindfolded-sighted groups and have one group utilize the palmar lift and the other group utilize the grasp lift. Also to check on the possible influencing effect of learning, one might test two additional groups of congenitally blind persons who would use the palmar and the grasp lifts respectively.

In summary, the major finding of this study is that the SWI can be elicited without the use of vision and that the congenitally blind persons can develop an orderly reaction to the density of an object. In addition, it was found that blindfolding a sighted person handicaps his ability to be aware of the SWI.

SUMMARY

An experiment was conducted to determine: 1) whether an object can provide the congenitally blind person with some basis for the general behavior we call the SWI; 2) whether the congenitally blind person, by his kinesthetic and tactual senses, can develop an orderly reaction to the density of an object; and 3) whether the sighted person develops his reaction to the SWI by the use of sight as well as the kinesthetic and tactual senses.

There were three groups of ten observers each; a sighted group, a blindfolded-sighted group and a congenitally blind group. The apparatus consisted of two sets of five blocks each. One set was designed to be all of equal size but with different weights. The other set was to be all of equal weight but different in size. One hundred comparisons with each series of blocks was made by the method of constant stimuli. The sighted and blindfolded-sighted groups performed the experiment using the pincer lift. The congenitally blind group, in addition, had to make 100 judgments with a palmar lift and 100 judgments with a grasp lift.

The results indicate that the following conclusions can be drawn:

a. The object does provide the congenitally blind person with some basis for the general behavior we call the SWI.
b. The congenitally blind person, by his kinesthetic and tactual senses, can develop an orderly reaction to the density of an object.
c. The sighted person develops his reaction to the SWI by the use of sight as well as the kinesthetic and tactual senses.

A discussion of the variables influencing the occurrence or non-occurrence of the SMI was given together with some suggestions for future research.

BIBLIOGRAPHY

1. Doll, E., The Demoor Size-Weight Illusion. Training School Bull., 1913, IX.
2. Huang, I., The Size-Weight Illusion in Relation to Perceptual Constancies. J. of Gen. Psychol., 1945, 33, 43-63.
3. Huang, I., The Size-Weight Illusion and the Weight-Density Illusion. J. of Gen. Psychol., 1945, 33, 65-84.
4. Koseleff, P., A Modification of the Charpentier Effect. Psychol. Forsch., 1936, 21, 142-145.
5. Koseleff, P., Studies in the Perception of Heaviness I, Some relevant facts concerning the size-weight effect. Acta Psychol., 1957, 13, 242-252.
6. Koseleff, P., Studies in the Perception of Heaviness II, Concerning the quantitative determination of the size-weight effect. Acta Psychol., 1958, 14, 109-130.
7. Loomis, H. N., Reactions to Equal Weights of Unequal Size. Psychol. Rev., 1907, 8, 334-348.
8. Meyers, C. S., A Textbook of Experimental Psychology, New York: Longmans, Green, 1928, 207.
9. Nyssen, R. and Bourdon, J., Contribution to the Study of the Size-Weight Illusion by the Method of P. Koseleff. Acta Psychol., 1955, 11, 467-474.
10. Nyssen, R. and Bourdon, J., A New Contribution to the Experimental Study of the Size-Weight Illusion. Acta Psychol., 1956, 12, 157-173.
11. Seashore, C. E., Measurements of illusions and hallucinations in normal life. Stud. Yale Psychol. Lab., 1895, 3, 1-67.

12. Siegel, S., Nonparametric Statistics for the Behavioral Sciences, New York: McGraw-Hill Book Company, Inc., 1956, 111-116.

13. Usnadze, D., Concerning the Size-Weight Illusion and its Analogues. Psychol. Forsch., 1931, 14, 306-379.

14. Whipple, G.M., Manual of Mental and Physical Tests, Part II. Baltimore: Warwick and York, 1921.

15. Woodworth, R. S., Experimental Psychology, New York: Henry Holt and Company, 1938, 440-441.

16. Woodworth, R.S., and Scholossberg, H., Experimental Psychology, New York: Henry Holt and Company, 1954, 205-206.

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