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Introduction

In the educational system called the *Montessori* method sensory training plays a very central part. This part may be called central, in the first place, because the theory of this method is mainly built on the assumed properties of sensory training and, in the second place, for the simple reason that in the application of the method much time is devoted to sensory training of different kinds.

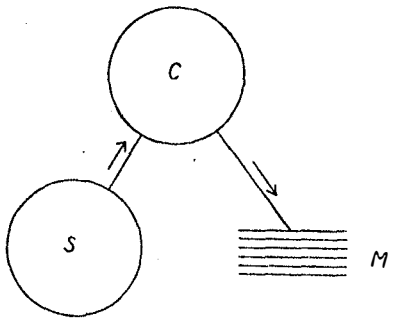
The aims of the sensory training have been very precisely defined in the manuals of the method, as well as the practical requirements to be met with by the sensory training. Thus, the sensory training can be taken as an object of experimental investigation. This is the problem of the present study: to investigate whether the properties of sensory training as experimentally observed agree with the properties assumed in the theory of the *Montessori* method.

The Montessori Method and the Sensory Training

The *Montessori* method was produced about the end of the last century to be a curriculum for schools founded in the quarters of poor people in Rome. The pupils of these schools were about 4—7 years old. As *Montessori* created her method, she was probably influenced by the methods for the training of mentally defectives that had been put forward by *Edouard Séguin* in the middle of the nineteenth century.

An essential part of the method is so called sensory training. The

purpose of the sensory training according to Montessori is in the first place to improve the keenness of the senses. At this point it has to be noted that this improvement is assumed to be general in nature, and not only concerning the tasks trained. In the second place, *Montessori* thought that the sensory training would improve higher mental functions, too. The following Figure 1 presented by *Montessori* illustrates this point, (2, p. 209).



S = sensory mechanism, C = nervous system M = effector system

Figure 1

Obviously *Montessori* thought that if any part of the whole system shown in the Figure 1 could be improved, the functioning of all parts of the system would be improved. Except the effects mentioned above *Montessori* thought, especially in her later writings (3), that the sensory training would have desirable therapeutic effects.

A great number of devices for sensory training have been constructed for the method. The amount of trainings for the sense of sight is perhaps the greatest. Details of the Montessori method or of sensory training of different kinds will not be presented here. Best reports are probably *Montessori*'s own, e.g. (2).

The Purpose of Sensory Training as Psychologically Formulated

As was mentioned above, the purpose of the sensory training is to produce improvement in the general keenness of senses as well as to have improving effects on higher mental functioning. Thus, as improvements are hoped to appear in the specific tasks, that have been under training, as well as in some others, the purposes of sensory

training in the *Montessori* method may be expressed in psychological terms as follows.

1. The purpose of sensory training is to lower the values of thresholds (in general difference thresholds) in the sensory tasks trained.

2. The purpose is to obtain transfer effects to other sensory tasks, in which the thresholds would go down, too.

3. The purpose is to obtain transfer effects to higher, intellectual performances. In these, if one wants to make use of the concept of threshold (e.g. 2, p. 346), the absolute threshold would move to a higher level of difficulty.

4. Some additional therapeutic effects are hoped to appear.

The Purpose and Design of the Present Experiment

The problem to be studied experimentally was restricted to the first two purposes of sensory training as mentioned above.

1. It will be studied, whether sensory training will have the effect of lowering the difference threshold in a task of size discrimination.

2. It will be studied, whether an improvement (if it takes place) in a task will bring about a transfer effect to another task of size discrimination.

3. In addition to the two points given above, it will be studied, whether the sizes of the stimulus differences have any effect to the result. Training with liminal stimulus differences will be compared with training with supraliminal stimulus differences.

Thus, the design for the experiment will be as is shown in the following scheme.

Experimental group	First trial	Training phase	Last trial
1	tasks I and II	task Ia	tasks I and II
2	»	task Ib	»
3	»	no training	»

All three groups thus take part in similar first and last trials. Two of the groups have training in the same task which has been varied (with respect to the stimulus difference). The third, control group, has no training.

Methods Applied

The experimental equipment. An attempt was made to prepare equipment similar to the materials used by *Montessori*. For the experiment four series of stimuli were prepared. Two of these were for the proper experimental trials and the other two were for the training phase. Two types of stimuli were used. The first stimulus type was a straight cylinder, which is a form used by *Montessori*. For the experimental trials a series of ten cylinders was prepared of wood; the height of every cylinder was 100 mm, but the diameter of the base varied from about 50 to 59 mm, with differences of about 1 mm (the exact lenghts of the diameters are given in Table 1.). This was task I of the experimental scheme above. Another, precisely similar series of stimuli was prepared for the training phase; this was task Ia of the scheme. This series had to be distinct from the first, in order that the previous knowledge of wood filaments etc. could not affect the last trial. For the training phase a dissimilar series of cylinders was prepared, too. In this series the height of the stimuli was also 100 mm, but the diameter of the base varied from about 10 to 55 mm, with about 5 mm differences. The number of stimuli in this series was also ten, and this was task Ib of the scheme. In addition to the series of stimuli of the training phase boxes with holes, in which the stimulus cylinders precisely fitted were constructed according to the model of *Montessori*'s materials. The second stimulus type was a parallelepiped, which also is a form used by *Montessori*. A series of ten parallelepipeds was prepared. All of the stimuli had a height of 100 mm and their base was a square. The lenght of the base edge varied from 49 mm to 58 mm, with differences of 1 mm (the lenghts of the edges are given in Table 1.). This was task II of the experimental scheme.

The experimental situation proper was planned to obtain data for the determination of difference thresholds using stimuli »cylinder with diameter = 54,1 mm» and »parallelepiped with base edge = 53,0 mm» as standard stimuli. As the determination of the threshold was intended to be made by the constant method (1, Ch. 6) every other stimulus of the series was shown with the standard stimulus, and the subject was asked to indicate which one of them he thought was the thicker one. As every of the nine variable stimuli was presented five times with the standard stimulus, every subject performed 45 comparisons altogether. The order of stimulus pairs was similar by all subjects; this order was obtained by randomization, but neverthe-

less in such a way, that no variable stimulus appeared twice in succession. The place of the standard stimulus on the right and on the left varied at random, however, in the same way for all subjects. The stimuli were presented so that they were at a distance of about one metre from the subject and about 20 cm from each other. Every other subject was first shown the cylinders, the remainder being shown the parallelepipeds first.

Experimental groups 1 and 2 consisted of pupils of the Päivärinne Kindergarten in Jyväskylä, group 3 consisted of pupils of the Kindergarten of Ebeneser-seminary in Jyväskylä. The subjects were about 5—6 years old and there were both boys and girls in all of the groups. Only those subjects were taken into consideration, who had taken part in both the first and the last trial. Thus, the number of subjects was in the different groups in numerical order, 15, 14, and 16 subjects.

The training of practice was arranged in groups 1 and 2 in such a way, that the teachers at convenient times gave the training materials to children and supervised the practice. The boxes as well as the blocks were given to a child, who tried to match the blocks and holes. The amount of practice was possibly not the same with respect to either the individual subjects or the experimental groups. The time between the first and last trial was the same in all of the groups, about 2,5 months.

Analysis of the results was carried out so that the difference threshold at the standard stimulus was obtained using the graphic normal method (1, p. 125). The sigma was determined as a difference of stimulus values corresponding to the percentages 84 and 50 of correct solutions.

The results of the experiments are given in Table 1. One sample determination of a threshold is given in Figure 2. The values obtained for the thresholds are shown in Table 2. Table 3 gives yet the improvements in size discrimination. From Table 3 it is seen, that a small improvement occurs in all cases. If the F test can be used to measure the significance of the differences (as the difference limens obtained can be regarded as standard deviations determined from cumulative distributions), it is seen, that the performance of group 2 in the cylinder task is the only one, in which there possibly is a significant difference between the values of the first and the last trial.

Table 1

The Results of the Experiment. The Figures Show (in Percentages) How Often the Standard Stimuli Have Been Said to be Thicker Than the Variable Stimuli

Size of Stimulus		Group I First Trial		Group I Last Trial		Group 2 First Trial		Group 2 Last Trial		Group 3 First Trial		Group 3 Last Trial	
Cyl.	Par.	Cyl.	Par.	Cyl.	Par.	Cyl.	Par.	Cyl.	Par.	Cyl.	Par.	Cyl.	Par.
49,7	49	96	92	96	92	86	94	97	90	89	76	86	81
51,2	50	89	92	88	85	72	86	86	87	85	81	85	91
52,5	51	65	73	81	75	79	80	86	83	64	64	61	68
53,3	52	65	69	57	60	54	64	66	70	55	65	51	53
54,1	53												
55,1	54	37	37	33	40	30	46	30	34	31	39	31	58
55,5	55	20	25	13	17	34	17	29	16	33	35	21	28
57,0	56	15	16	11	11	26	19	6	11	23	23	16	16
57,9	57	9	16	9	11	21	6	3	4	15	14	10	11
59,0	58	12	7	0	4	11	2	3	6	14	10	9	10

Table 2

Difference Thresholds at Standard Stimuli »Cylinder with Diameter = 54,1 mm» and »Parallelepiped with Base Edge=53,0 mm», in Millimetres

Group	First Trial Cylinders	First Trial Parallelepipeds	Last Trial Cylinders	Last Trial Parallelepipeds
1	2,5	2,9	2,3	2,8
2	4,1	2,6	2,3	2,4
3	3,5	3,7	3,3	3,3

Table 3

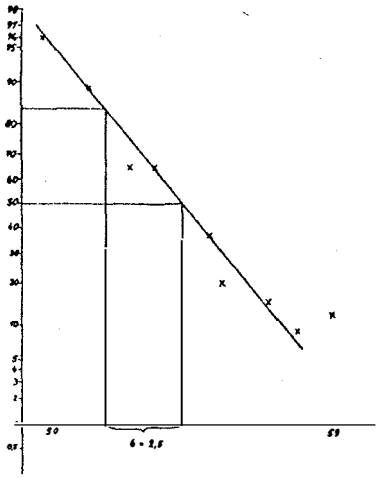
Improvements in Millimetres as the Differences Between the Values of Difference Threshold in the Different Situations

Group	Cylinders	Parallelepipeds
1	0,2	0,1
2	1,8[1]	0,2
3	0,2	0,4

[1]) Significant at .05 level as tested by F test

Results

An inspection of the Tables 2 and 3 shows that the performance of group 2, which was given practice in the cylinder task with supraliminal differences possibly has been improved significantly; the improvements of the other groups in the cylinder task are very small. Further, in the parallelepiped task (in which no group was given any practice) all groups improved only very slightly; the difference thresholds are



A Sample Determination of a Difference Threshold, Group I, First Trial, Cylinders
Figure 2

almost the same in the first and last trials. One could say, thus, that an improvement in a task of size discrimination may occur as a result of practice, but that it is not necessary that this improvement would have a transfer effect with respect to another task of size discrimination. It is the practice with supraliminal differences, that here gives the improvement of performance, but the difference between the different kinds of practice, subliminal and supraliminal, remains here unsettled, as the amount of practice was not controlled.

Finally, it may be noted that the difference limens in tasks of size discrimination, as children are used as subjects are in conditions that prevailed in the experiment in cylinder task 5—6 % from the diameter and in parallelepiped task 5—6 % from the lenght if the base edge.

Critical Comments

We have to set forth some critical remarks concerning the interpretation of the results of the experiment.

From the point of view of the *Montessori* method it may be noticed that the external conditions, in which the experiment was carried out, do not resemble the conditions of real *Montessori* schools. The experiment was carried out in two Kindergartens as an addition to their ordinary programmes. The situation is different, however, if a very great part of time is used for sensory training as in *Montessori* schools. Secondly, it has to be noted that whatever the outcome of the experiment would have been, generalizations of an experiment of very narrow scope are always most uncertain.

From the technical point of view it must be pointed out that a greater amount of subjects would have been necessary. The results are not too reliable in the present case. Especially, the difference threshold in the cylinder task of group 2 differs markedly from the value of difference threshold in the parallelepiped task in the first trial; both of these difference thresholds of the other two groups are about the same. Thus, it seems very probable that the performance of group 2 was not improved in the cylinder task, but was in the first trial for some reason worse than the »real» level of performance of that group. If this is case, the result would only be that the amount of practice given was not sufficient to produce any significant changes in performance.

SUMMARY AND CONCLUSION

An experimental study of the *Montessori* method has been carried out. Sensory training was given in a task of size discrimination to study whether any transfer effect to another task of size discrimination could be found. The results show that there occurs an improvement as a result of practice with supraliminal stimulus differences. No transfer effect to another task of size discrimination could be ascertained. Essential reserves were presented, however, to show that the result may be a consequence of an unusually poor performance of one experimental group in the first trial.

The experiment perhaps has some demonstrative value, however, and this is mainly the reason, why this report was written. Educational systems seek to give aims, goals, to which education ought to strive with means and methods as descibed in these educational systems. The question of the successfulness of these methods

may be solved by means of experimental methods, however, only if both the aims and practical means or methods are defined using concepts, that have a precise meaning and the same meaning to different persons, and if the phenomena in question can be taken as an object of observation and measurement. The present experiment shows that the *Montessori* method is of this type. Both the aims and means of the method are described very precisely, and consequently this educational system could even in the whole be taken as an object of empirical study.

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