Available online at www.sciencedirect.com
ScienceDirect
Procedia Social and Behavioral Sciences 1 (2009) 549–553
Procedia
Social and Behavioral Sciences

World Conference on Educational Sciences 2009

Special needs education in the blind population: effects of prior expertise in raised line drawings on blind people's cognition

David Dulin[a*], Coline Serrière[b]

[a]Department of Psychology, (EA 1588 Processus cognitifs et conduites interactives,), University Paris X, 200 avenue de la République, F-92001 Nanterre, France.
[b]C. Serrière, certified teacher, Lycée Jean Racine, 12 rue du Rocher 75008 Paris, France.

Received October 11, 2008; revised December 10, 2008; accepted January 02, 2009

Abstract

In their specialized schooling, blind children are now frequently presented with raised line figures and maps. However there is still a lot to do to evaluate the cognitive effects of training using these displays. The purpose of this research is to determine if the level of prior expertise in the haptic exploration and perception of raised line materials, may enhance blind people's spatial imagery. We observed that in the three spatial tasks used in this study, the congenitally blind experts performed better than the early and late blind non experts and the early blind experts performed even better than the late blind non experts. These observations suggested that a high level of expertise in congenitally and early blind people may compensate for the impairment in spatial representation often resulting from lack of visual experience.

Keywords: Blindness; mental imagery; expertise in raised line drawings; visual experience.

1. Introduction

The role of mental imagery capacities is of primary importance to blind people. Indeed, in the abscence of sufficient imagery capacities and without any visual control, how could they be able to represent any object inaccessible to touch (i.e. cities, wild animals, ...) for themselves, organize tactile information in order to build a faithful representation of a model, move around in an unknown environment, aquire notions in geometry? In fact, these capacities play an essential part in the visually impaired's autonomy, since they facilitate access to knowledge. Amidst the long list of examples illustrating this idea, Braille reading is the most relevant. Indeed, Braille is a complexe code in which the multiple spatial combinations produced from 6 dots can replace the 26 letters of the alphabet, represent accentuated letters, capital and lower case letters, punctuation, numbers... As this mode of writing takes up quite a lot of space, an « abridged Braille » along with a « maths Braille » and « computer Braille code» have been created. Apart from the difficulty of tactile learning, all these codes are extremely difficult to memorize without spatial strategies (Dulin, 2007). A number of studies have then shown that early blind adults have

David Dulin.
E-mail address ; Dulindavid@yahoo.fr

doi:10.1016/j.sbspro.2009.01.099

a more limited spatial mental capacities as compared to the sighted on mental rotation tasks (Marmor and Zaback, 1976), on simultaneous maintenance of different spatial information (Vecchi and al., 2004), in detecting an object's shift in centimeters (Gaunet and Thinus-Blanc, 1996).

Raised line drawings or maps have only been introduced in specialized education within the last twenty years. The appearance, in the 1960s, of a cheap means for blind people to be able to draw, and the even more recent appearance of machines which blow raised line shapes (thermoformed processes) partly explain this phenomenon. But, it is also because graphic representations seem to be an essentially visual activity and for a long time, too few attempts have been made to render it accessible to blind people (Hatwell, 2003). In their specialized schooling, blind children are now frequently presented with raised line figures and maps, but there is still a lot to do to evaluate the cognitive effects of training using these displays.

The purpose of this research is to determine if the level of prior expertise in the haptic exploration and perception of the raised line materials may enhance blind people's spatial imagery. We predicted that visual experience and expertise will interact, showing that a high level of prior expertise in raised line materials may reduce the positive effect of visual experience usually found in the spatial performances of late blind as compared to early and congenitally blind people (Dulin, 2007).

2. General Method

Participants

Twenty four participants who were totally blind (without any light perception), were chosen to form three groups which varied by duration of visual experience (8 were congenitally blind [CB], 8 were in the "early blind" group [EB], with onset of blindness before the age of three, and 8 were in the "late blind" group [LB], with onset of blindness after the age of three). The three groups were matched on gender, age (over and under 30 years), social status (workers and students), school level (English pre-A level and post-A level), and expertise in raised line drawings (experts and non-experts).

Questionnaire and preliminary tests

We evaluated prior expertise in raised line drawings, acquired during previous learning, by a pre-test and a questionnaire asking each participant to specify his/her training and his/her interests in this area (Dulin, 2007). The questionnaire estimated the subjects' degree of autonomy, their sociocultural level, the access they had to raised line drawings during their schooling and their interest in it.

The aim of the three tasks of this pre-test is to determine the level of expertise in raised line materials of the congenitally, early and late blind people, in order to evaluate the effects of this variable on their mental imagery capacities. For that, we evaluated their competences in raised line drawing identification and production (thermoformed shape identification task and graphic representations of a house), as well as their capacities to orientate raised line shapes to make a construction conform to a model (puzzle construction task).

We considered as 'expert' all the participants who were classified as 'competent' in the three tasks of the pre-test and who were interested by the manipulation of raised line geographical maps and the geographical shapes, by drawing, poking and putting together the shapes of a puzzle. The 'non-expert' participants were classified as 'less competent' in the three tasks of the pre-test and did not take any interest in the latter activities, all the others were left out.

3. Experiment 1: Mental rotation task.

Material and procedure:

There were four sheets of paper on which four lines contained each five identical thermoformed rectangular shapes (4 x 3 cm). A small square (1,5 x 1,5 cm) was drawn in one of the corners of each rectangle, and the position of this square varied from one rectangle to another. In each line of drawings, the shape on the left represented the model. The four other shapes were either the same as the model (in the same orientation or rotated 90°, 180° or

270°), or were mirror images. Participants haptically explored the geometrical thermoformed shape model, and then were asked to indicate whether the four rotated comparison shapes were the same or were a mirror image of the model (Figure 1).

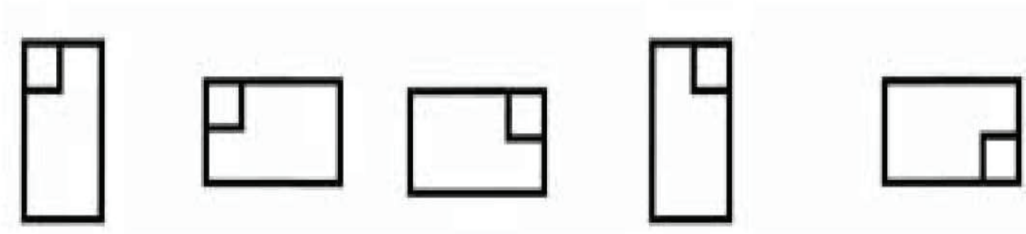


Figure 1. First row of first series of thermoformed shapes (all stimuli were of this type).

Scoring:

The proportion of correct responses per sheet was calculated. Since there were 16 responses per sheet, each correct response was scored 1/16e. The maximum score per sheet was therefore 1 and the maximum score for the task was 4.

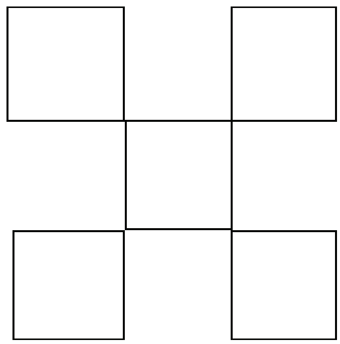
Results:

The Kruskal-Wallis test on visual experience showed an effect of this factor ($p = .002$), showing that the longer the participant had seen, the better the performance. The Mann-Whitney's test revealed a significant effect of the prior expertise in raised line materials ($p = .0002$) showing a superiority of the experts (ranks = 214) over the non experts (ranks = 86). This test also indicated that the experts succeeded better than the non experts in the CB group ($p = .0209$), EB group ($p = .021$) and LB group ($p = .0201$). Finally, the CB experts performed better than the non experts EB ($p = .0433$) and LB ($p = .0109$), and the EB experts performed better than the LB non experts ($p = 0.0209$).

4. Experiment 2: Mental spatial displacement of a spot

4.1 Material and procedure

The participants were to mentally imagine and memorize the course of a spot moving according to the oral instructions of the experimenter (North, South, West, East) until it formed a certain rectilinear geometrical shape. A direction was given every two seconds and was given only once. At the end of each item, the participant was asked to draw the whole course of the spot with a Swedish drawing kit. The test was composed of five items of increasing difficulty: the first had 6 directions and the following four had 7, 8, 12 and 20 directions (Figure 2).

Directions	Rectilinear Geometrical Shape
East – South – West - North – North – North – East – South – West – West – West – North – East – South – South – South – West – North – East – East.	

Figue 2. Fifth direction of mental spatial displacement of a spot.

4.2 Scoring

The scores were controlled by another experimenter. The dependent variable was the number of lines correctly drawn in each item, converted into a proportion. The maximum score per item was therefore 1, and the maximum score for the task was 5.

4.3 Results

The Kruskal-Wallis test on visual experience showed an effect of this factor produced the following result (p =,0018), showing that the longer the participant had seen, the better the performance. The Mann-Whitney's test revealed a significant effect of the prior expertise in raised line materials (p = .0152) showing a superiority of the experts (ranks = 192) over the non experts (ranks = 108). This test also indicated that the experts succeeded better than the non experts of each group (p = .0209). Finally, the CB experts performed better than the EB non experts (p = .0209) and LB non experts (p = .0433) and the EB experts performed better than the LB non experts (p = .048).

5. Experiment 3: Length estimation task

5.1 Material and procedure

Participants indicated on the edge of the paper, between their two forefingers, the estimation of five lengths in centimetres (3 cm, 8 cm, 14 cm, 20 cm and 31 cm). First, they placed both of their forefingers side by side on the edge of the paper and slid their forefingers to the wanted dimension. They were not timed and lengths in centimetres were orally presented by the experimenter in a counter balanced order.

5.2 Scoring

Results obtained took into account a length difference between the mental images of lengths in centimetres and their real dimensions. Then, this length difference was transformed into a proportion of error, allowing us to mark this task over five points (one point per length in centimetres).

5.3 Results:

The Kruskal-Wallis did not reveal any significant effect for the visual experience, whereas the Mann-Whitney's test revealed a significant effect in the prior expertise in raised line materials (p = .000032) showing a superiority of the experts (ranks = 78) over the non experts (ranks = 222). This test also indicated that the experts succeeded better than the non experts ($p = .00209$) for each population group. Eventually, the CB experts performed better than the EB non experts ($p = .00209$) and LB non experts ($p = .0384$), and the EB experts performed better than the LB non experts ($p = .0209$).

6. General discussion

A great part of the difficulties resulting from congenital and early blindness can be explained by the characteristics of touch. Therefore, the global intellectual development, mesured by verbal general intelligence tests (Davis, 1980), the acquisition and use of speech (Millar, 1983) are not altered by visual impairment in childhood. However, congenital and early blindness significantly delays a child's development of spatial representations. Blind children show difficulty in the cognitive mapping of the environment and in the representation of spatial consequences of object displacements or their own movements. (Dekker et al., 1991). The recent works concerning the blind adults' mental imagery also showed that the blind people's mental images, even if they partly share the same structural and functional properties as those of the sighted, have certain specific features. It therefore seems that during adulthood, congenital and early blindness also affects spatial representations and those of displacement and cognitive mapping (Heller, 2000).

The results obtained in this research generally support our hypothesis. They confirm that previous visual experience increases the ease in the mastery of mental spatial imagery in the blind. More importantly, they show in addition that the mental imagery capacities are not the same according to the level of expertise in raised line materials attained by congenitally, early and late blind people. We observed that in all the tasks (mental rotation, mental spatial displacement and estimation of length tasks) the congenitally blind expert groups performed better than the early and late blind non expert groups and that the early blind expert groups performed even better than the late blind non expert groups. Therefore, a high level of prior expertise in the congenitally and early blind groups may compensate for the impairment in spatial representation which often results from the lack of visual experience.

In addition to a better understanding of the cognitive functioning of blind people, these results may have a practical interest. The use of raised line materials tends today to be generalized in the teaching and education of visually impaired people. The utility and pertinence of this training is supported by our observations. Nevertheless, we should bear in mind that the identification of raised line pictures is not innate, it requires the aquisition of a certain number of prerequisites. Therefore, the learning of projection rules for placing an object in a drawing and the optimization of touch and haptic exploration processes need to be taught together with the use of raised line pictures. Finally, even if over the last twenty years the use of this type of material tends to be generalized, there is still a lot to do to improve accessibility, especially by looking for methods of presentation compatible with the constraints imposed by the slow development of haptic abilities in children and those resulting from the lack of representation of perspective in congenital blindness. Nevertheless, training in raised line drawings may have positive effects on the spatial abilities of blind people and should thus be encouraged during schooling.

References

Davis, C. J. (1980). Perkins – Binet tests of intelligence for the blind. Watertown, M. A. : Perkins school for the blind.

Dekker, R., Drenth, P. J. D., Zaal, J. N. (1991). Results of the intelligence test for visual impaired children (ITVIC). Journal of visual impairement and blindness, 85, 261-267.

Dulin, D. (2007). Effects of the use of raised line drawings on blind people's cognition. European Journal of Special Needs Education, 22 (3), 341–353.

Gaunet, F., Thinus-Blanc, C. (1996). Early blind subject's spetial abilities and the locomotor space: a study of exploratory strategies and reaction to change performance. Perception, 25, 967-981.

Hatwell, Y. (2003). Psychologie cognitive de la cécité précoce. Paris : Dunod Editeur.

Heller, M. A. (Ed.) (2000). Touch, representation and blindness. Oxford: Oxford University Press.

Marmor, G. S., Zaback, L. A. (1976). Mental rotation by the blind : does mental rotation depend on visual imagery. Journal of Experimental Psychology : Human Perception and Performance, 2, 515-521.

Millar, S. (1983). Language and active touch : some aspects of reading and writing by blind children, in A. E. E. Mills (Ed), Language acquisition in the blind child : normal and deficient. London : croom helm, 167-186.

Vecchi, T., Tinti, C., Cornoldi, C. (2004). Spatial memory and integration processes in congenital blindness. NeuroReports, 15, 2787-2790.