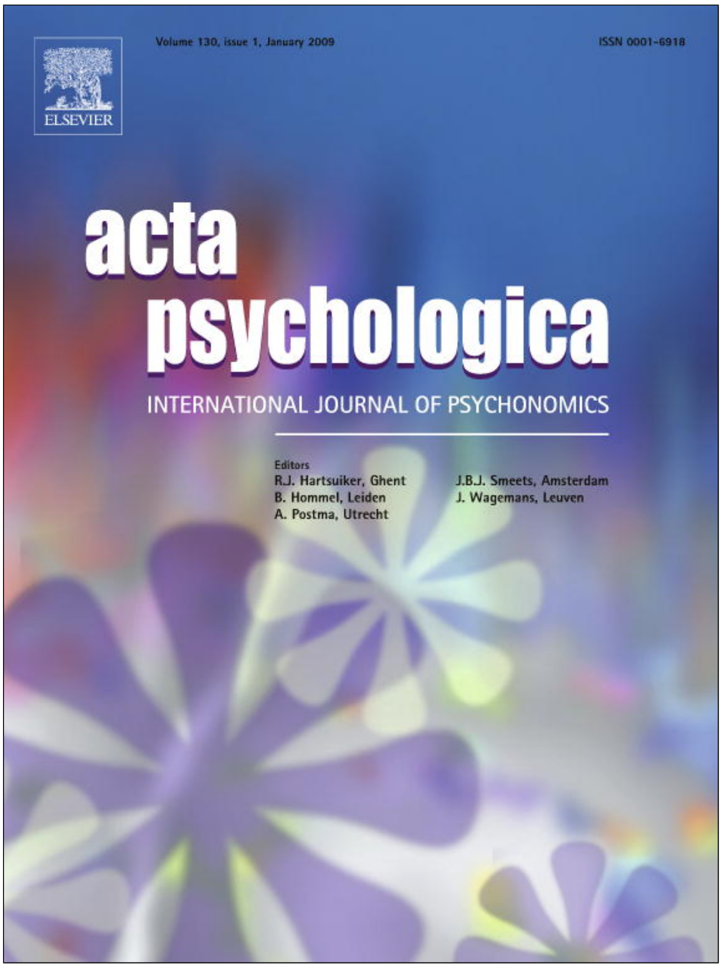
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Memory for an imagined pathway and strategy effects in sighted and in totally congenitally blind individuals

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ABSTRACT

The literature reports mixed results on the imagery abilities of the blind, at times showing a difference between sighted and blind individuals and at other times similarities. However, the possibility that the results are due to different strategies spontaneously used in performing the imagery tasks has never been systematically studied. A large group of 30 totally congenitally blind (TCB) individuals and a group of 30 sighted individuals matched for gender age and schooling were presented with a mental pathway task on a complex two-dimensional (5 × 5) matrix. After administering the task, participants were interviewed in order to establish the strategy they used. Results showed that both sighted and TCB may use a spatial mental imagery, a verbal or a mixed strategy in carrying out the task. Differences between the groups emerged only when last location and then entire pathway had to be remembered rather than just the last position, and were clearly affected by the type of strategy. Specifically, TCB performed more poorly than the sighted individuals when they used a spatial mental imagery strategy, whereas the two groups had a similar performance with a verbal strategy.

1. Introduction

Visuospatial mental imagery processes are very largely analogous to perceptual visual processes. Thus, a typical assumption in the literature is that the mental imagery performance relies on visual experience, and totally congenitally blind people (TCB) who never had a visual experience should have a severe difficulty in mental imagery tasks. In fact, while several authors have reported individuals with congenital or early-blindness to be seriously impaired vs. sighted persons or persons with late-blindness in spatial cognition tasks (Hollins & Kelley, 1988; Noordzij, Zuidhoek, & Postma, 2007; Rieser, Hill, Talor, Bradfield, & Rosen, 1992; Veraart & Wanet-Defalque, 1987), others have failed to replicate these findings and have observed no differences between the two groups (Haber, Haber, Penningroth, Novak, & Radgowski, 1993; Klatzky, Golledge, Loomis, Cicinelli, & Pellegrino, 1995; Passini, Proulx, & Rainville, 1990; Vanlierde & Wanet-Defalque, 2004; see also Cornoldi & De Beni, 2007). Possible explanations of the latter result could be either that the involved imagery processes do not rely on visual experiences, or that the so-called mental imagery processes are not specific or analogous but involve amodal processes common to the non-imagery tasks (Pylyshyn, 2003; see also Kaski, 2002; Zimler & Keenan, 1983). However, these conclusions do not consider the possibility that some mental imagery tasks might be carried out by different subjects using different strategies, and that the blind individuals might perform less well than the sighted counterparts when using a visualization strategy, but not if they use a different strategy.

Surprisingly, the possibility and implications of using different strategies (e.g. verbal strategies) for performing visual imagery tasks have never been systematically studied. This issue seems particularly critical for congenitally blind people who, because of their visual impairment, could develop alternative strategies. The psychology literature on mental imagery offers examples of studies, where strategy used is manipulated by giving explicit instructions, but the method has been used only with verbal memory tasks and not systematically with blind participants. Furthermore, consideration has not been given to the fact that the strategies were used as a consequence of explicit instructions and training. They may thus not reflect the spontaneous strategies developed by an individual (Deckersbach et al., 2005; Winter, Broman, Rose, & Reber, 2001), and may give rise to artefacts resulting from subjects attempting to meet the experimenter's expectations (Pylyshyn, 2003). In the context of verbal memory, De Beni and Cornoldi (1988) found that TCB individuals were able to exploit instructions to create interactive images as effectively as sighted individuals when memory load was small (e.g. one or two items), but failed when the load was in-

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creased. Cornoldi, De Beni, Roncari, and Romano (1989) then found that the deficit experienced by TCB participants was specific to visuospatial processing but absent when a verbal rehearsal strategy was required. However, these studies did not examine the role of the spontaneous strategy used by the participants. Furthermore, the authors focused on a verbal memory task where the contribution of the mental imagery may be useful but not crucial. In this respect, a study by Vanlierde and Wanet-Defalque (2004) was more critical, since it presented a visuospatial task to sighted, early-blind and late-blind participants. The task consisted in imagining 6×6 grids whose cells were verbally described as blank or filled; participants then had to decide how many cells were symmetrical with reference to vertical or horizontal median axis. The performance of the early blind participants was similar to that of the other two groups; however, in contrast with the latter, they declared during interview of having used a strategy that was not visual, but instead "*XY*-coordinate"-type where each filled cell was encoded with its specific coordinates. The study by Vanlierde and Wanet-Defalque (2004) thus offered evidence that the different participants can use different approaches to mental imagery tasks, and that the early blind may benefit from the use of a verbal strategy. However, this conclusion needs further support and extension, since it is based on a limited number of early-blind subjects. Moreover, the instructions given by the experimenter facilitated a verbal coding of the cells based on *XY*-coordinates, especially in people with low confidence in their mental imagery skills. In the latter respect, the observation that early blind subjects used an *XY*-coordinate strategy seems to conflict with the observation that blind individuals often report having used mental imagery to perform imagery tasks, and seem able to succeed (Cornoldi, Cortesi, & Preti, 1991).

These issues were systematically considered in the present study by administering a mental pathway task to a relatively large number of participants (30 TCB and 30 sighted), and then proposing a systematic interview aimed at individuating the strategy used by each participant. The presence of relatively large groups allowed the participants to be split into subgroups according to the strategy used, without losing the statistical power. Our goal was to examine whether some mental imagery tasks can induce different strategies in different subjects, as well as to study whether blind individuals are poorer than sighted only when they use a mental imagery strategy (i.e. the difference vanishes when the two groups use a different strategy).

The task administered was a modified version of the mental pathway task (Attneave & Curlee, 1983; see also Cornoldi, Bertuccelli, Rocchi, & Sbrana, 1993; Kerr, 1993), adapted by Cornoldi et al. (1991) for use with blind individuals. Specifically, the experimenter verbally presented a pathway; after tactual exploration of a 5×5 matrix, participants were required to imagine moving on the matrix, starting from a given corner. The cells of the pathway were not described on the basis of their coordinates (e.g. B3), but by their spatial relationships (i.e. right, left, towards me, towards you). In half the cases, participants had to remember only the last position reached, while in the other half they had to remember the whole pathway, thus making the use of mental imagery particularly crucial (see Cornoldi & Mammarella, 2007). Furthermore, for half the cases – following a suggestion by Kerr (1987, Exp. 4; Exp. 5) that visual mental imagery may be facilitated when structural boundaries are used – we created a tactual arrangement, dividing the overall matrix perceptually into sections by covering the central cells with a sandpaper.

In a previous study, using the same task and the same 5×5 matrix, in view of some participants' claims to have used a verbal strategy, Cornoldi and colleagues (1991, Exp. 4) indirectly tested the preferential strategy used by sighted participants, by examining the role of concurrent tasks. The authors found that a concurrent verbal task was disrupting the performance to the same extent as a concurrent visuospatial task, suggesting that in this case sighted subjects tend to spontaneously use not only the visuospatial strategy typically used with other, smaller, matrices, but also a verbal strategy. The authors concluded that the same hypothesis could also be applied – even to a larger extent – to the case of blind individuals. However, a note of caution should be sounded here: use of a concurrent task can imply methodological problems, since it does not guarantee that a specific interference of one particular task (e.g. visuospatial) on another is due to the two tasks being based on the same visuospatial processes – they might both have been performed using the same non-spatial strategy. Furthermore, the complex method for producing a concurrent condition would necessarily create a rather unnatural condition, unable to prime the strategies that the people tend to spontaneously use when faced with a mental imagery request. Only a systematic interviewing of subjects could help disambiguate this point and could offer information on the strategies that the people indeed use spontaneously when having to imagine spatial arrays (Ericsson & Simon, 1993).

In summary, the present study devised a task where both a verbal and a spatial strategy might be used: participants were asked to imagine moving in a 5×5 matrix, and had to recall either the final position of a pathway or the overall pathway; then, on completion of all tasks, participants were interviewed in order to analyze the preferred strategy they employed in performing the task. We predicted that TCB and blindfolded-sighted participants would both use either strategy – spatial or verbal. We also hypothesized that participants might fall into subgroups of specific strategy use: if TCB participants are truly limited in the use of mental imagery with the most complex demands, but compensate for their difficulties using verbalization, then their weakness on the task should be apparent when choosing a spatial mental imagery strategy, but not when using a verbal strategy. Moreover, the difference should be more marked in the task with deeper involvement of spatial mental imagery, i.e. the need to recall the last position plus the entire pathway.

2. Method

2.1. Participants

The experimental group was composed of 30 participants with total congenital blindness[1] (17 men and 13 women, *mean age* = 39.9 years, SD = 14.8). Only two persons were not blind at birth, but they had become blind at 4 and 12 months, respectively. Participant blindness was due to various etiologies: optic nerve damage ($n = 8$), retrolental fibroplasia ($n = 5$), congenital glaucoma ($n = 5$), childbirth trauma ($n = 2$), and oxygen therapy ($n = 10$). As regards occupation, two participants were unemployed, the rest were call operators ($n = 10$), physiotherapists ($n = 2$), clerks (3), teachers ($n = 3$), students ($n = 5$), and five were retired. In no instance was blindness associated with central nervous system dysfunction, and all participants were self-sufficient in navigating their surroundings. A more complete description of the participants is given in Table 1.

Controls were matched for gender and age to participants with TCB and comprised 30 sighted persons (17 men and 13 women, *mean age* = 38.7 years, SD = 13.9). The two groups did not differ in years of education (TCB: Mean = 14.3 years, SD = 3.83; Sighted: Mean = 14.6 years, SD = 3.14). All participants gave informed consent, and received no compensation for taking part in the study.

[1] By "total blindness", we refer to a severe visual deficit, which impairs the perception of object shapes and positions as well as the distinction between light and shade.

Table 1
Characteristics of blind participants

Gender	Age (years)	Job activity	Blindness etiology	Blindness onset	Strategy used
M	44	call operator	congenital glaucoma	birth	spatial
M	30	clerk	optic nerve damage	birth	mixed
M	47	call operator	retrolental fibroplasia	birth	verbal
M	46	physiotherapist	optic nerve damage	birth	verbal
M	34	call operator	oxygen therapy	birth	verbal
M	44	call operator	optic nerve damage	birth	spatial
M	24	call operator student	oxygen therapy	birth	mixed
M	58	retired	congenital glaucoma	birth	verbal
M	27	call operator	oxygen therapy	birth	spatial
M	61	clerk	optic nerve damage	birth	verbal
M	20	physiotherapy student	optic nerve damage	birth	verbal
M	29	call operator	oxygen therapy	birth	verbal
M	23	physiotherapy student	optic nerve damage	birth	mixed
M	19	physiotherapy student	retrolental fibroplasia	birth	spatial
M	30	unemployed	oxygen therapy	birth	spatial
M	23	physiotherapy student	retrolental fibroplasia	birth	spatial
M	52	call operator	congenital glaucoma	birth	spatial
F	27	English teacher	oxygen therapy	birth	mixed
F	60	retired	trauma	four months	spatial
F	70	English teacher	optic nerve damage	birth	verbal
F	35	call operator	oxygen therapy	birth	mixed
F	32	call operator	oxygen therapy	birth	spatial
F	37	physiotherapist	oxygen therapy	birth	spatial
F	37	call operator	congenital glaucoma	birth	mixed
F	28	English teacher	trauma	12 months	spatial
F	34	unemployed	optic nerve damage	birth	verbal
F	43	music teacher	retrolental fibroplasia	birth	spatial
F	60	retired	retrolental fibroplasia	birth	mixed
F	68	retired	congenital glaucoma	birth	spatial
F	24	clerk	oxygen therapy	birth	spatial

2.2. Procedure and material

The whole session was recorded: the video tape was necessary for the transcription of the final interview and to check the responses given by the participants during the experiment. Participants were tested individually. Depending on the length of the interview, the duration of the session varied from 45 to 70 min. The whole session was divided into three phases:

1. The experimenter collected personal data about the participants (i.e. age, profession, and schooling).
2. The mental imagery task was administered.
3. An interview was conducted using a *mirror technique* (Crasnich & Lumbelli, 2005), where the basic question (Which strategy did you use for the task?) was developed by repeating the words given by the participant (e.g. you said you were thinking of your experience in everyday life. Can you explain better?). Other questions concerned any shifts in strategy use, fatigue or distraction arising during the experiment, and personal opinions about their own performance. In addition, TCB participants were asked what strategy they employ to learn a new pathway in everyday life, and sighted participants were asked what they think about the strategies that TCB people use to learn a new pathway. The interview typically required approximately between 15 and 20 min, in some cases longer.

In order to make the comparison with TCB participants possible, sighted participants were blindfolded before entering the room where the experiment was to take place. The material comprised two different 2D matrices (5×5) of 25 wooden blocks of 2×2 cm each (see Fig. 1). Between the cells, there was a gap of 1 mm, to allow an accurate identification of each block. Matrix A consisted of smooth blocks while Matrix B presented some rough (covered with sandpaper) blocks arranged in a cross. Participants were allowed to feel the two matrices with both hands, for as long as necessary to form a mental representation of the two configurations. Participants had to mentally follow a pathway on the matrix given verbally by the experimenter. Two task conditions were proposed. In the *final position* (FP) condition, at the end of the presentation of each pathway, the participants had to recall only the last position of the *imagined* pathway; in the *entire pathway* (EP) condition, they had to remember the final position and then the whole pathway.

To make the task more realistic, the metaphor of a visit to a complex building was used: the participants were told to imagine moving inside a building, each block corresponding to a room. Each participant was verbally presented with 6 pathways for each condition (FP vs. EP conditions), for a total of 12 pathways (each including 7 statements of direction) for each matrix (smooth vs. rough). The statements of direction were left, right, towards me, towards you, and were made only once; participants were not allowed to touch the actual matrix. Furthermore, no block was ever repeated in the same pathway. Pathways started from the left-hand corner block on the side remote from the participant (see black dot in Fig. 1) and for each task condition were presented as a set, without break. Before each trial, participants were told whether the matrix they would be using was smooth or rough. At the end of the pathway presentation, the subject had to feel the matrix, find the position(s), and then give the response by touching with one finger of the dominant hand the final position and, in the EP condition, also by using the finger to retrace the entire pathway on the matrix. Type of matrix (smooth vs. rough) and condition (FP vs. EP) was counterbalanced across the participants. Before starting the experimental session, participants were given three practice pathways. Performance was evaluated in terms of number of correct last positions of the pathways in both FP and EP conditions.

3. Results

Two subjects were excluded owing to omission of critical information from the interviews. The final sample included 29 TCB and 29 sighted participants.

The general information from the interviews showed that the participants did not report any particular difficulties during the task, or any attention losses. Furthermore, subjects did not report clear differences in strategy used for the different conditions. For this reason, we decided to include the overall performance of each subject in only one strategy group. Two independent judges classified the interviews according to the strategies employed during each task. Specifically, strategies were divided into three categories:

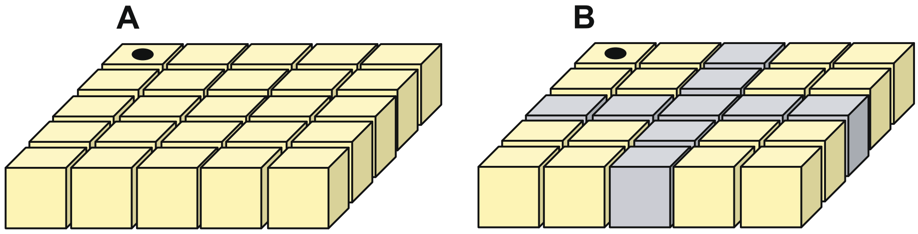

Fig. 1. Example of material used. The dot represents the starting point of the pathways. (A) represents matrix A with smooth blocks while (B) represents matrix B, which contained some rough blocks arranged in a cross.

(i) *verbal* when participants verbally rehearsed information or else recoded spatial information;
(ii) *spatial* (based on mental imagery) when participants tried to visualize and/or imagine information in order to perform the task;
(iii) *mix of verbal and spatial* when participants shifted between strategies during the experiment, demonstrating the use of both verbal and spatial strategies.

Examples of classifying participants in the three categories are given in the Appendix. The independent judges agreed on 48/58 cases, i.e. high agreement, with *Kendall's tau* = .73. The judges took a joint decision on the remaining 10 interviews, which were then independently assessed by a third judge who agreed on 9 of 10 decisions taken by the first two judges. The tenth case was included, after discussion, in the verbal category. The number of cases classified into the three categories was very similar for the two groups of participants:

– 13 TCB and 12 sighted used a spatial strategy,
– 9 TCB and 9 sighted used a verbal strategy;
– 7 TCB and 8 sighted used both verbal and spatial strategies.

The frequency of the three types of strategies used was not significantly different in the two groups, $\chi^2(N = 58, 2) = .11$ $p = .95$.

For the imagery task, initial analysis revealed that the presence of a central rough cross did not affect the performance at all. The result showed that tactual exploration did not enable participants to benefit from learning the perceptual organization of the matrix, in contrast with Kerr's observation of visual modality (Kerr, 1987, Exp. 4; Exp. 5). In other words, participants did not benefit from splitting the matrix into manageable segments.

In view of the absence of effects related to the type of matrix, data were collapsed with respect to this variable, summing the correct responses given in the two types of matrices. Table 2 presents the mean number of correct responses for the two task conditions, which are split according to group and strategy used.

A2 (group: TCB vs. sighted) × 2 (condition: FP vs. EP) × 3 (strategy: verbal vs. spatial vs. mixed) mixed ANOVA showed a main effect of group, $F(1,52) = 8.51$ MSE = 4.61 $p = .005$ $\eta_p^2 = .14$, revealing that the sighted group ($M = 9.53$) performed better than the TCB group ($M = 8.34$). The main effect of condition was significant $F(1,52) = 221.06$ MSE = 2.94 $p = .001$ $\eta_p^2 = .81$, demonstrating that the recall in FP condition ($M = 11.36$) was higher than the recall in the EP condition ($M = 6.52$), whereas the effect of strategy type was not significant. Furthermore, we found a significant interaction of group × condition $F(1,52) = 11.63$ MSE = 2.94 $p = .001$ $\eta_p^2 = .18$. Post hoc analyses using the Tukey test demonstrated that although there were no differences in the FP condition, sighted participants performed better than TCB participants in EP condition ($p < .01$). Finally, the third-order interaction group × condition × strategy was significant $F(2,52) = 3.25$ MSE = 2.94 $p = .047$ $\eta_p^2 = .11$. As shown in Table 2, the difference between groups was particularly evident when a spatial strategy was used, and recall of the entire pathway was required. In the latter case, the sighted produced the highest performance in the EP condition, thus showing the usefulness of the spatial strategy, whereas the TCB produced the lowest performance. Post hoc comparisons using the Tukey test showed that the TCB participants performed more poorly than the sighted participants in the EP condition when they used both spatial ($p < .01$) and mixed ($p < .01$) strategies, but not when using a verbal strategy.

A final analysis – for the EP condition – considered the recall of the entire pathway required after the last position had been identified. To this purpose, we measured the mean proportion of correctly recalled positions on the pathways of the EP condition, and found a general pattern of performance similar to that observed for recall of the last position: in particular, TCB participants performed less well than sighted participants $F(1,58) = 11.4$ $p < .01$, (TCB: $M = .45$, SD = .26; Sighted: $M = .64$, SD = .16).

Table 2
Mean values (standard deviations in brackets) for blind and sighted participants using verbal, spatial and mixed strategies in final position (FP) and entire pathway (EP) conditions

		Strategies		
		Spatial	Verbal	Mixed
Blind	FP	11.85 (.37)	10.56 (2.19)	11.57 (.53)
	EP	4.54 (2.96)	5.55 (3.35)	6.00 (2.89)
Sighted	FP	11.50 (.67)	11.33 (.87)	11.38 (.74)
	EP	8.33 (1.92)	6.67 (1.94)	8.00 (1.69)

4. Discussion

In general, the results confirmed that TCB individuals can successfully perform mental imagery tasks: in the condition requiring recall of only the final position (FP condition), TCB performed as well as sighted subjects, making very few errors. The observation that in this condition, using a spatial strategy, TCB may also perform well, comparably with the sighted individuals, is in line with the hypothesis that mental images do not necessarily rely on visual experience and may be the end product of a series of constructive processes using different sources of information (e.g. Cattaneo et al., 2008; Pearson, De Beni, & Cornoldi, 2001; Vecchi, Tinti, & Cornoldi, 2004). By contrast, when the task also involved a high spatial memory load (i.e. EP condition), the performance of TCB group was significantly poorer than that of the sighted group.

However, the present results would have remained ambiguous without an analysis of participants' strategies, and indeed, the main goal of the study was to examine the strategies spontaneously used by the participants, and their implications. Analysis of the interviews revealed the nature of the strategies reported unequivocally for most of the participants. Moreover, even in the unclear cases, the independent judges reached an agreement about the strategy used. It is interesting that many sighted individuals – in addition to the TCB participants – also reported of having used a verbal strategy, confirming the observation by Cornoldi et al. (1991) that when a matrix becomes complex, as in the case of a mental pathway on a 5×5 matrix, pure visualization runs into some difficulty. This may be partially explained by the mean age of participants (Kliegel & Altgassen, 2006); however, a supplementary analysis failed to find any relationship between age and type of strategy.

The main result of the present study derives from the comparison of the effectiveness of the three strategies in the two groups in the EP condition. Results showed that sighted people who used a spatial strategy benefited from it, whereas this was not the case for TCB participants. In fact, performance by TCB participants who attempted to use a spatial mental imagery strategy was particularly low, and significantly poorer than for sighted controls. In other words, subjects used for the same task different strategies leading to different outcomes. This resembles the observations by Postma, Zuidhoek, Noordzij, and Kappers (2007) that blind individuals use different spatial description strategies than sighted after haptic exploration of arrays of objects. It should also be noticed that, when using mixed and – in particular – verbal strategies, differences between groups in the EP condition disappeared. It is worth noting that sighted people who decided to use a verbal strategy performed least well in the EP condition. Why some sighted people decided to use a poorly effective strategy is unclear: reasons might be inappropriate strategy selection, more general difficulty with the task, or individual differences in performing spatial tasks; only future research obtaining independent measures of spatial and verbal abilities will help disambiguate this point. By contrast, highlighting a portion of the matrix which, in visual modality, facilitated effective use of mental imagery (Kerr, 1987) did not affect either group. This result offers further evidence that factors affecting perceptual organization in the visual modality may be irrelevant in the haptic modality (e.g. Postma et al., 2007; Vanlierde & Wanet-Defalque, 2004). However, it is worth noting that the facilitation of the sandpaper was not available during the presentation of the pathways, but only during the initial presentation of the matrices and at retrieval: it is possible that participants could benefit from learning the perceptual organization of the matrix only if they were able to use it while encoding the pathway.

It should be observed that the study of the preferred strategies was based on subjective reports, and there is no additional evidence that these reports were reliable. In fact, strategy reported after the task does not necessarily reflect what an individual actually did. Therefore, the method used in the present study should be combined in further research with the other two typical manipulations used in this field, i.e. examination of the effects of different instructions and/or analysis of the effects produced by different concurrent tasks. However, these manipulations also involve a series of difficulties, and in particular cannot capture the actual strategies that people spontaneously use when performing a mental imagery task. For these reasons, further evidence is needed to reinforce the present data. However, in our view, two main considerations lend support to the interview method: first, the fact that TCB individuals were able to differentiate the strategies they used (and this took place in a way similar to that found in sighted individuals); second, the fact that differences in the reported strategies corresponded to differences in performances. In the present study, in order to avoid interviewing at different points in the experiment affecting performance later on, we did not collect separate information (i.e. by interviewing after each task condition) about the possible differences related to task differences; consequently, in their single interview participants were not able to make subtle differentiations: future research could more directly assess the issue of strategy shifts within a subject.

In general, our results are in agreement with those of the previous studies. Cornoldi et al. (1989) found that verbal instructions improved memory in both sighted and TCB individuals, but the latter did not benefit from imagery strategies. Vanlierde and Wanet-Defalque (2004) found a similar pattern of performance in blind and sighted participants on a spatial task requiring memorization of a number of target locations presented on a series of grids, but the former reported using different strategies compared to the latter. In fact, sighted and late-blind subjects reported taking advantage of a visual process, whereas early blind participants reported encoding the relevant locations in an *XY*-coordinate system, which involves verbal processes (Vanlierde & Wanet-Defalque, 2004).

In conclusion, our results suggest that at least some mental imagery tasks may be carried out making use of different strategies, and indeed similarities and differences between sighted and blind individuals in such tasks cannot be well understood without considering the specific strategies used by different individuals. Strategies spontaneously used by the subjects reflect the way they carry out these tasks and can be better identified by a systematic interviewing of participants, as suggested by Vanlierde and Wanet-Defalque (2004). However, in contrast with the latter study, the present study employed larger groups of TCB and sighted participants and revealed a greater variation in verbal, spatial or mixed strategy usage in both the groups. TCB performed as well as sighted participants in a spatial task when they derived support from a verbal strategy, while for the sighted support of a verbal strategy proved to be less effective. This result is consistent with the observation that blind individuals compensate for lack of vision at a perceptual level, by enhancing their auditory and verbal capacities (Röder, Rösler, & Neville, 2000; Röder et al., 1999). Data analysis also showed that a spatial strategy may be effective in performing a complex mental imagery task, but only for sighted individuals; in the blind–despite their apparent ability to use spatial imagery with a simpler task – a spatial strategy may be less effective: indeed, difficulty encountered by the blind was evident when a complex task placed high demands on spatial memory.

Appendix. Examples of responses classified within the three categories of strategy

Spatial-mental imagery strategy

(C.M. sighted group). I tried to imagine pathways and positions and later tried to focus on the positions and retrieve them.

(M.T.G. sighted group). I imagined the visual arrangement of a shape formed by my finger moving from one cell to another.

(A.B. blind group). I built a mental image of the pathway.

(A.P. blind group). I imagined the shapes of the Braille alphabet and tried to associate the pathways to these images.

Verbal strategy

(G.P. sighted group). I made reference to repetitive games, for example 'right, down, right, down, and then two right and two down

(G.P.B. sighted group). I counted one right, one left, etc.

(M.P. blind group). First I counted the cells, of which there are 25, and then I focused on the central cell and started to count from there.

(R.C. blind group). I recalled how many times I had to go left, and how many right. The only possible technique was to count the cells and associate the locations to them.

Mixed strategy

(C.G: sighted group). First I tried to imagine the shape of a snake and then I tried to use counting.

(E.C. sighted group). I tried to recall by mentally rehearsing the sounds of the statements, but I also tried to visualize the cells I had to change direction and thought about a finger drawing out a pathway that was gradually being highlighted. During recall I did not rely on a single method but instead tried to combine the recall of the words and of the highlighted cells.

(C.V. blind group). First I tried to memorize the words of the statements and then tried to mentally represent the pattern of the pathway described by a moving finger.

(E.B. blind group). First I tried to memorize the locations, imagining myself in a room of a building and moving to a nearby room, but then I found it might be useful to link together and sum the movements in the various different directions.

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