Representation of survey and route spatial descriptions in children with nonverbal (visuospatial) learning disabilities

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A B S T R A C T

This study aims to investigate the types of difficulty encountered by children with nonverbal (visuospatial) learning disabilities (NLD) during the processing of spatial information derived from descriptions. Two spatial descriptions – one in survey, one in route perspective – and one nonspatial description were orally presented to children aged 9–12 divided in three groups: (i) with NLD (N = 11), (ii) with reading disability (RD) (N = 11), and (iii) without learning disabilities who served as controls (N = 16). Children performed two tasks: sentence verification and location. In the verification task, NLD performed worse in survey text than control and RD groups. Moreover, in the location task NLD were worse than controls in both survey and route descriptions, but significantly poorer than the RD group only in the survey description. The results are discussed considering their implications in understanding the neuropsychological profile of NLD and the processes involved by different types of spatial descriptions.

1. Introduction

Children exhibiting nonverbal (or visuospatial) learning disabilities (NLD) typically show problems in visuospatial-organizational, psychomotor, tactile-perceptual and nonverbal problem-solving skills – which are associated with a right hemisphere dysfunction (Nichelli & Venneri, 1995; Tranel, Hall, Olson, & Tranel, 1987) – but perform normally in linguistic tasks such as rote verbal learning, verbal classification and regular phoneme-grapheme matching.

According to Rourke (1995; see also Rourke et al., 2002), NLD syndrome is characterized by significant primary deficits in some dimensions of tactile perception, visual perception, complex psychomotor skills and in dealing with new circumstances. These primary deficits lead to secondary deficits in tactile and visual attention, and to tertiary deficits in visual memory, concept-formation, problem-solving, and hypothesis-testing skills. Finally, there are very evident and significant impairments in language prosody, content, and pragmatics, while performance in other linguistic tasks (e.g., language form, amount of verbal association and language output) is normal at primary school level, although it may be impaired in children aged 7–8 years (Drummond, Ahmad, & Rourke, 2005). Children with NLD might also encounter difficulties in various other aspects of academic learning, especially in drawing, science (Pelleiter, Ahmad, & Rourke, 2001), arithmetic (Mammarella, Lucangeli, & Cornoldi, submitted for publication; Rourke, 1993; Venneri, Cornoldi, & Garuti, 2003) and in informal learning during spontaneous playing activities and other social situations.

Problems in the social sphere seem to be due to very limited competence in comprehending nonverbal communicative signs in social and emotional contexts (Petti, Voelker, Shore, & Hayman-Abello, 2003). A recent study also demonstrated that nonverbal learning disability children show problems in the processing and transfer of knowledge acquired in one situation or context to another (Schiff, Bauminger, & Toledo, 2009).

Although studies have focused on examination and demonstration of visuospatial deficits of NLD children, concluding that visuospatial working memory (VSWM) tasks may be useful for identifying children with this disability (e.g., Cornoldi, Dalla Vecchia, & Tressoldi, 1995; Mammarella et al., 2006), NLD children seem also to exhibit significant linguistic deficits. Indeed, the language of such individuals may be moderately to severely deficient in content and pragmatics. Pragmatics refers to the functional and contextual aspects of language, including an appreciation of the rules of social discourse, the speaker’s purpose for communication, and how language is modified to fit different situations (Bloom, 1988; Boone & Plante, 1993). Children with NLD are especially deficient in this dimension of language. They tend to be verbose, but their speech is inclined to be straightforward, repetitive, and rote.
Discourse lacking in content and organization, with minimal speech prosody, low appreciation of the social aspects of the discourse is common in children with NLD (Rourke & Tsatsanis, 1996).

Support for Rourke's hypothesis that language comprehension is a further ability impaired in NLD children was offered by Humphries, Cardy, Worling, and Peets (2004), who investigated the narrative discourse comprehension and story retelling abilities of NLD children by comparing them with typical controls and with children identified as having verbal impairment. Results showed the presence of both narrative comprehension and retelling difficulties in NLD children. The narrative performance of the NLD group was not significantly different from that of children with verbal impairment on all the comprehension or story retell measures, and they were poorer than typically functioning children in comprehending inferences, but not literal content.

Other studies seem to suggest that language comprehension difficulties are related in particular to the processing of spatial information. Worling, Humphries, and Tannock (1999) found that children with NLD have difficulty with language inferencing, specifically when this depends on appreciation of spatial relationships. In this study the comparison of an NLD group, a verbally impaired group and typical controls indicated that the language inferencing difficulties of NLD children are as severe as those associated with the general verbal impairment group. The NLD group performed as poorly as the verbally impaired group on all language inferencing tasks. Moreover, for NLD children alone, spatial inferencing problems were significantly correlated with difficulties in emotional inferencing. These results revealed that NLD children have difficulty in developing spatial mental models (Johnson-Laird, 1983), offering support for the multidimensionality of mental models, including those representing spatial information, characters’ emotions, characters’ goals, and plans and temporal information (Zwaan, Langston, & Graesser, 1995).

Finally, some preliminary studies (Pedroni, Molin, & Cornoldi, 2007; Rigoni, Cornoldi, & Alcetti, 1997) examining drawings and object locations based on descriptions of spatial relationships found that NLD can have difficulty in understanding spatial descriptions. In conclusion, these results revealed that NLD children may have problems in processing texts containing spatial information. However, the construction of spatial mental models was not systematically studied. Furthermore, the difficulties met by NLD could be due to a severe and general cognitive impairment rather than a specific weakness related to the NLD profile.

The main aim of the present research was to examine the difficulties shown by NLD children in processing spatial and nonspatial descriptions. Many studies (Bryant, 1997; Perrig & Kintsch, 1985; Taylor & Tversky, 1992; Tversky, 1991) have demonstrated that spatial mental models are spontaneously constructed as a result of reading descriptions of spatial patterns and environments, and maintain spatial properties isomorphic to those of the environments represented (Bower & Morrow, 1990; Mani & Johnson-Laird, 1982; Morrow, Bower, & Greenspan, 1989). Furthermore, literature on spatial cognition shows that an environment’s description can assume two different main perspectives, i.e., route and survey (Tversky, 1991). Route descriptions take the point of view of a person moving within the environment. They are characterized by the use of an intrinsic frame of reference and egocentric terms such as right, left, front and back, and have a linear organization given by the order in which landmarks appear along the route itself. Survey descriptions instead provide an overview of the spatial layout, sometimes with strong hierarchical organization; they are characterized by an extrinsic frame of reference and canonical terms such as north, south, east and west.

Developmental studies showed that children’s representations of large-scale environments tend to be sequential in nature (Allen & Kirasic, 1985; Piaget, Inhelder, & Szeminska, 1960; Siegel & White, 1975). Siegel and White (1975) proposed a model that posits a progression from representing landmarks, then routes, and at the highest-level integration into a spatial mental model. The first type of representation (landmark) represents environmental patterns that are perceptually salient or important for the person involved (e.g., the home). As a second step, children develop a route representation based on routes generally used to connect landmarks. This representation is based on an egocentric frame of reference, and directions follow a precise sequence of motor actions (e.g., turn left, then go straight). Finally, children around 8 years-old can create a survey representation, in which the environment is represented in an overall configuration. This implies the encoding of directions and distances between places regardless of the person’s position, and is based on allocentric frame of references. In a recent study, Uttal, Fisher, and Taylor (2006) demonstrated that children who learned from a map performed significantly better than those learning from a verbal description. Moreover, young children retained the sequential information but did not integrate the relations into a survey-like cognitive map. These studies suggest that children with difficulties in processing spatial information, such as children with NLD, might have less difficulty with route descriptions than with survey descriptions, if these descriptions really involve different processes and representations. The difficulties shown by NLD children in processing spatial descriptions may depend critically on type of task, not just on type of description. In the present study we therefore also examined the different implications of two different tasks, i.e., a sentence verification task, devised to examine memory recall of specific information presented in the description, and a subsequent task (i.e., location task) in which the overall organization of the environment has to be reproduced, devised to assess the spatial mental model generated by the child. NLD and reading disabled (RD) children, with decoding but not comprehension impairments, were compared with a control group of children without learning disabilities: the inclusion of the RD group served to distinguish between specific difficulties related to the NLD condition and more general failures.

Specifically, our purposes were: (a) determine if children with NLD have problems in the comprehension of spatial descriptions in survey and route perspective, and (b) evaluate if children with NLD are able to process and construct mental models of spatial descriptions, i.e., locate landmarks of the environments described in the descriptions. These issues are critical to understanding of the pattern of deficits and resources in children with NLD, and in fact may show the extent to which also language may be impaired in children with NLD. In particular, within the framework of the present study, the predicted differentiation between survey and route representations should offer specific insights into the nature of spatial representations and their implications for children with NLD.

2. Method

2.1. Participants

The sample comprised 39 children aged 9–12 years. Twelve (11 boys and 1 girl, mean age 9.5 years, SD = 1.31) had received a clinical diagnosis of NLD at the Neuropsychiatric Developmental Center of Brescia Hospital (Italy), and 11 (9 boys and 2 girls, mean age 10.27 years, SD = 1.27) had been given a diagnosis of reading disability (RD, i.e., dyslexia) (seven were tested at the University Center for Learning Disability, Padova, and four at the Neuropsychiatric Developmental Center of Brescia Hospital). The 16 control children (mean age 9.69 years, SD = 0.49) were typically developing 4th and 5th graders, and were tested in local schools. In particular, the con-
trol group was formed by children matched for age, schooling and socio-economic status, with no reported school difficulties.

Although both NLD and RD children were referred to Neuropsychiatric Developmental Centres for learning disorders and had received a clinical diagnosis, we also controlled that the groups met specific criteria. The inclusion criteria for NLD group were as follows: (1) diagnosis of NLD; (2) age between 9 and 12 years; (3) following the methodology outlined by Pelleiter et al. (2001), two out of three critical verbal subtests of the Wechsler Intelligence Scale for Children (Wechsler, 1974; 1991) (Vocabulary, Similarities and Information) as highest on the Verbal Scale; two out of three critical performance subtests of the Wechsler Intelligence Scale for Children (Block Design, Object Assembly, and Coding) as lowest on the Performance Scale; (4) Wechsler Intelligence Scale for Children Verbal Intelligence Quotient (VIQ) greater than Performance Intelligence Quotient (PIQ) by at least 10 points (following Harnadek & Rourke, 1994; see also Cornoldi, Venneri, Marconato, Molin, & Montinari, 2003); (5) impairment in learning tasks that require processing of non-verbal material. Exclusion criteria were (1) being treated with psychoactive drugs; (2) fulfilling criteria for diagnosis of clinically significant autistic syndrome or Asperger’s syndrome, developmental coordination disorder, traumatic brain injury; (3) history of seizures during the previous 2 years; (4) total IQ < 80; (5) poor socioeconomic situation; and (6) medical illness requiring immediate treatment.

The inclusion criteria for RD group were as follows: (1) diagnosis of RD through the use of standardized procedures; (2) age between 9 and 12 years; (3) impairment in reading decoding (speed in reading aloud) and learning tasks that require processing of verbal material. Exclusion criteria were the same as for the NLD group.

All the children spoke Italian as first language, and none was primarily visually or hearing impaired, or identified as having a neurologically degenerative condition. A signed consent form was obtained from parents and an assent form from each child. In the case of the control group the consent was given only for the experimental test, but not for other assessments, and was limited to a group of 8 boys and 8 girls. The other assessments included the most recent available standardized Italian version of the WISC battery1 and the MT battery (Cornoldi & Colpo, 1981) measuring children’s reading skills. In particular, with the MT battery, a measure of children’s reading speed is obtained by computing the mean number of syllables read by the child while reading texts aloud, a measure considered as the best index of a reading disability for transparent languages. The other two measures collected by the mean number of syllables read by the child while reading texts measure of children’s reading speed is obtained by computing the

2.2. Experimental materials

Three different types of description were devised: two spatial and one nonspatial (adapted from the materials used by Taylor & Tversky, 1992, and in Italian by De Beni, Pazzaglia, Gyselinck, & Meneghetti, 2005). The spatial descriptions illustrated two outdoor environments (i.e., a zoo and an amusement park), each given in both route and survey perspective. Each spatial description was eight sentences long (ca 200 words long) and mentioned five landmarks; the two environments had similar layout as regards landmark positions: one landmark was located at the center, the other four at the corners. The zoo was square-shaped (“The zoo has a square shape”); the amusement park rectangular (“The amusement park has a rectangular shape”).

The survey descriptions first gave the general structure of the environment and then defined the relations between landmarks within the environment, using terms such as “north”, “south-east”, etc. In both survey descriptions the child had to imagine flying over the environment in a helicopter (e.g., “Now you are going to be told the layout of the zoo as seen from a helicopter flying over it”); the central landmark was then introduced (e.g., “In the center of the square there is a café...”), and after that the landmarks at the corners, from south to north (e.g., “In the south-west corner there is the gate”).

In the route descriptions, the child had to imagine walking along a route; the positions of the various landmarks were defined with respect to the child using terms such as “left”, “right”, etc. In both route descriptions, the participant had to imagine making a tour round the environment (e.g., “Now let’s start our visit to the zoo, beginning on the first side”); the path description started on the left-hand (zoo) or right-hand (amusement park) corner of the first side; after that, the landmarks at the other three corners were mentioned, specifying the side (e.g., “keep straight on until the end of the second side; in the corner you will see the monkey enclosure”) and in the center (e.g., “…walk straight on until you get halfway along the second side; look to your right and you will see the cafe”).

For each landmark, nonspatial information was provided (e.g., “...the cafe where you can get very good ice-cream”, “…cage with the monkeys, who are having fun playing together”). A preliminary check controlled that the children had a clear representation of the cardinal points and of the right/left sides.

The nonspatial description was an explanation of the wine production process, and provided procedural instructions for each phase (from harvesting through to bottling); it was composed of 10 sentences (ca 200 words).

The verification test included four sentences of approximately the same length for each description. Spatial and nonspatial sentences contained paraphrased information and the spatial sentences maintained the same perspective of the description. The child had to decide whether each sentence was true or false.

In the location task, for each environment, an A4 sheet of paper (29.5 × 21 cm) containing a written list of the five landmarks was prepared, so that the children only had to recall their actual locations. The landscape perimeter was already drawn out for both environments in the center of the page: for the zoo a square of 15 × 15 cm, and for the amusement park a rectangle of 18 × 11 cm. In the survey version, a compass drawn on the page indicated the cardinal points (north, south, west and east), while in the route version the perimeter sides were labeled (“side 1”, “side 2”, “side 3”, “side 4”).

2.2.1. Procedure

The three descriptions were administered in a single session of approximately 30 min.

The children were tested individually, and instructed to listen to and memorize the three descriptions. For the spatial descriptions they were instructed to remember the location of each landmark. The perspectives and the descriptions were counterbalanced among children. Specifically, a child might receive the zoo description in route perspective, the amusement park in survey perspective and the nonspatial description, while another child might receive the amusement park in route perspective, the zoo in survey perspective and the nonspatial description, and so on. The nonspatial description was always given last. Each description was read twice and followed by the verification task and, in the case of the spatial descriptions, with the request to relocate the landmarks.

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1 The WISC III was published in Italy in 2007; all children were tested in late 2006 and early 2007.
in the environment. In the verification task, each sentence was read aloud and the child had to decide whether it was true or false. For the location task, the children were given oral and written instructions to locate each of the five listed landmarks on the landscape within the perimeter box. The child had to locate the landmark in the correct position, by either writing its name or drawing it. The location task always followed the other task in order to avoid the more general process required during the reassembling of the overall environment affecting recall of specific information. There was no time limit for either task.

3. Results

3.1. Statistical analysis

The comparability of groups on demographic measures was determined by one-way ANOVAs and Tukey HSD.

Moreover, one-way ANOVAs were performed to compare the groups on the verification test and location task of the spatial and nonspatial descriptions. Tukey HSD post-hoc was used to test specific group differences considering parametric variables (i.e., the number of correct responses in the verification test and the sum of the scores obtained in the location task). Significant $z$ was set at $p < .05$.

3.2. Demographic measures

Table 1 summarizes IQ and reading performances for the NLD and RD groups.

NLD, RD and controls were not significantly different in mean age $F(2,36) = 1.74$, $MSE = 1.07$, $p = .19$, $\eta^2 = .09$ observed power = .26. The NLD and RD groups were not significantly different in either the full scale IQ or VIQ. However, the two groups did differ in PIQ $F(1,21) = 29.67$, $MSE = 73.99$, $p < .001$, $\eta^2 = .59$. For the Verbal Scale subtests, the RD group performed worse than the NLD group on the Similarity $F(1,21) = 7.54$, $MSE = 10.77$, $p = .01$, $\eta^2 = .28$ and Vocabulary subtests $F(1,21) = 5.64$, $MSE = 8.97$, $p = .03$, $\eta^2 = .23$. For the Performance Scale subtests, the NLD group performed worse than the RD group on the Picture Completion $F(1,21) = 6.67$, $MSE = 5.17$, $p = .02$, $\eta^2 = .26$, Block Design $F(1,21) = 5.87$, $MSE = 7.04$, $p = .03$, $\eta^2 = .24$, Object Assembly $F(1,21) = 8.18$, $MSE = 4.45$, $p = .01$, $\eta^2 = .30$ and Coding $F(1,21) = 10.78$, $MSE = 8.30$, $p = .004$, $\eta^2 = .37$ subtests.

For reading abilities, the RD group performed worse than the NLD group on reading speed measured on mean number of syllables per second, considering both raw scores, $F(1,21) = 12.98$, $MSE = 60$, $p = .002$, $\eta^2 = .38$ and $z$ scores, $F(1,21) = 21.85$, $MSE = 57$, $p < .001$, $\eta^2 = .51$. Moreover, the two groups did not differ in reading accuracy or in comprehension.

3.3. Verification test

In the verification test, one point was assigned for each correct response. The maximum score was 4 for each description.

A preliminary comparison of the boys and the girls in the control group showed that gender did not affect the performance in the tasks. Also ANCOVAs – comparing the groups in all variables with gender as covariate – showed that the covariate variable was never significant and did not change the pattern of results. For this reason, gender was not taken into account in the following analyses.

Groups significantly differed in the number of correct responses for the verification test on the survey perspective descriptions $F(2,36) = 4.74$, $MSE = 1.21$, $p = .015$, $\eta^2 = .21$. The NLD group performed worse than either RD ($p = .025$) or controls ($p = .033$), while the RD group did not differ from the typical control group ($p = .93$). The groups showed no differences in either route or nonspatial descriptions (see Table 2).

3.4. Location task

For the location task, two points were assigned for each correctly located landmark, i.e., exactly in the corner or at the center of the environment; and one point was assigned for each partially located landmark. In the survey description, a landmark was considered partially located when only a part of the description was taken into account (for example, in the case of north-east, the child showed it on the north or east side, but not exactly at the northeast corner). Similarly, in the route description, a landmark was considered partially located when the description gave it at a corner of the landscape and the child placed it on an adjacent side but not in the correct corner. Zero score was assigned for a landmark

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Table 1

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<td>Max</td>
<td>M (SD)</td>
<td>Min</td>
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<td>df</td>
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<td>117</td>
<td>102.66 (12.67)</td>
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<td>106</td>
<td>106.73 (9.44)</td>
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<td>8.70 (4.00)</td>
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<td>.98</td>
<td>.79 (1.51)</td>
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<td>-.18</td>
<td>-.35</td>
<td>-2.13 (-.71)</td>
<td>-.34</td>
<td>-.57</td>
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<td>-.47 (-.72)</td>
<td>-.88</td>
<td>-.98</td>
<td>-1.73 (-.71)</td>
<td>-.34</td>
<td>-.57</td>
<td>1.21</td>
<td>.23</td>
<td>.75</td>
<td>.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comprehension (z scores)</td>
<td>.42 (.01)</td>
<td>-2.16</td>
<td>1.76</td>
<td>-1.06 (.96)</td>
<td>-1.7</td>
<td>1.09</td>
<td>1.21</td>
<td>1.34</td>
<td>.26</td>
<td>.06</td>
<td></td>
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located in the wrong position. For both spatial descriptions, maximum score was 10.

Groups were significantly different in the location task for both route \( F(2,36) = 5.16, \text{MSE} = 6.91, p = .011, \eta^2 = .22 \) and survey perspective descriptions \( F(2,36) = 6.05, \text{MSE} = 9.31, p = .005, \eta^2 = .25 \). For the route perspective description, the NLD group performed worse than typical controls \( p = .008 \) whereas the difference between the NLD and RD groups did not reach significance \( p = .11 \). Moreover, the RD group was not different from the control group \( p = .65 \). Finally, for the survey perspective description, the NLD group performed worse than either the RD group \( p = .013 \) or typical controls \( p = .011 \), while the RD group did not differ from the control group \( p = .98 \).

4. Discussion

In this study, NLD children were compared with RD and typical controls in the ability to process and graphically represent spatial descriptions using route and survey perspectives.

Our first aim was to examine whether children with NLD encounter difficulties in processing and comprehending spatial descriptions, and whether they show differences in relation to spatial perspective, i.e., survey and route.

The results showed that NLD children had reading comprehension ability of nonspatial description similar to that of RD and control children: the three groups did not differ in the verification test of sentences derived from the nonspatial description. As assumed, the NLD children had more difficulty in comprehending spatial information than the other groups. In particular, the NLD children were found to have significantly poorer performances than either RD or typical control children in responding to the survey perspective description.

The second objective of our research was to test whether children with NLD were able to construct a spatial mental model. To test this, children were required to locate the landmarks of the environments illustrated in the description (i.e., location task). For the route perspective description, NLD obtained scores lower than typical control children, but their performances did not significantly differ from those of the RD group. Instead, for the survey perspective description, NLD performed more poorly than either RD or typical control children. Performances of RD and control children never differed.

Overall, the results showed that NLD children, even if competent with verbal material, are poor in processing spatial descriptions, but particularly poor with survey descriptions. These results are in agreement with the Siegel and White (1975) model assuming that route and survey descriptions can be distinguished and the latter represents a more developmentally mature stage of spatial cognition (see Uttal et al., 2006). Hence, according to our data, NLD children formed mental models of spatial descriptions that reflected the serial nature of language (i.e., route), but did not integrate the descriptions into a survey-like cognition map. Moreover, the fact that children with NLD failed in particular with survey descriptions suggests that these descriptions rely on spatial processes more than route descriptions. In fact, people with good verbal skills but poor spatial skills can find it easy to process route descriptions involving the same sequential structure as the superficial structure of language.

Using the mental model approach (Mani & Johnson-Laird, 1982), it can be concluded that NLD children are able to construct a text-based representation, while RD children can construct a mental model representing not only the local relationships between landmarks explicitly expressed in the description, but also implicit relationships. In the present context, processing a spatial description involved a series of different processes, i.e., verbal comprehension, processing of spatial information, generating a spatial mental model, memory encoding, maintaining and retrieving the spatial mental model. It is worth noting that although the verification test and location task involved different processes, the performances of the NLD and RD children presented the same patterns. Specifically, the verification test maintained the same text format, i.e., spatial relationships were given verbally and then tested. Instead, in the location task, spatial information, verbally encoded, had to be converted to a graphical spatial format. The fact that performance of the NLD was generally poorer suggests that the difficulties of these subjects also involved the basic level of spatial information processing and comprehension, but the increase in differences for the location task suggests that creation of a spatial model posed particular problems.

Moreover, it should be noted that, in the location task, route and survey perspective descriptions also demanded different processes. In particular, in the route description, sequential information expressing local relationships between landmarks had to be converted into a simultaneous configuration; instead, in the survey description, if properly understood, the passage from description to map was more immediate because information could be transposed into a landscape. This could explain why the location task mean scores, of both RD and control children, were higher for survey than for route perspectives. It is possible that NLD children, in view of their specific difficulty in integrating spatial information derived from a survey perspective, were unable to take advantage of receiving the global representation of survey information, in contrast with RD and control children.

The pattern of difficulties observed in the NLD group seems to have general implications, since it might be extended to other spatial tasks and related to VSTM (Brunyé & Taylor, 2006).

2008; Deyzac, Logie, & Denis, 2006). In fact, the role played by VSWM in the encoding of spatial descriptions has been demonstrated by a number of studies (De Beni et al., 2005; Noordzij, van der Lubbe, Ngregs, & Postma, 2004; Pazzaglia & Cornoldi, 1999; Pazzaglia, De Beni, & Meneghetti, 2007). The specific failure on survey perspective descriptions in children with NLD can therefore be linked to a VSWM deficit. This conclusion is consistent with evidence from previous studies showing the severe deficit of NLD children in VSWM tasks (Cornoldi et al., 1995; Mammarella & Cornoldi, 2005a, 2005b). The present study illustrates a critical difficulty of NLD in processing spatial information, even when this is expressed linguistically and reveals that this difficulty is particularly evident in descriptions, whereas the spatial relationships must be processed simultaneously, as occurs for survey descriptions. The difficulty found in the NLD group does not depend on a general learning disability, since RD children did not present any similar difficulty. By contrast, the difficulty represents a specific pattern of performance of the NLD group which might clarify the nature of the problems met by NLD children both in neuropsychological tasks measuring VSWM and in adaptive functioning. In this respect, our findings also provide information regarding appropriate choices for treating NLD and the risk of using linguistic material with these subjects without careful consideration of its characteristics. However, further support is needed for these conclusions, since the study has a number of limitations in present form.

First, replication on a larger sample is needed, controlling better for gender effects. In our samples, different numbers of males/females were involved: while control children were divided equally for gender, the NLD and RD groups both involved a larger number of males. Our results demonstrated that there was no gender effect, but this variable should be better controlled in future studies. With a large number of subjects, it is also possible that differences between the groups would be more evident and extended to the location task involving route perspective description, in which we only found a tendency. Finally, the relationship between the failure on survey perspective descriptions of children with NLD and VSWM should be examined more directly.

In conclusion, the novel finding of our study is that the visuospatial difficulties of NLD are both specific and general: specific in that the core deficit of these children is spatial, probably in relation to VSWM functioning (Cornoldi et al., 1995), but at the same time general, since verbal abilities, in particular the processing of survey descriptions, are impaired in children with NLD. The results of the present study consequently offer new insights into the pattern of difficulties shown by NLD children, and have clinical implications: alongside impairment of visuospatial skills, abilities connected with language processing are also impaired under certain conditions, a finding that should be taken into consideration in the treatment of NLD children.

References


