



Research article

AGE-GENDER RELATED DIFFERENCES ON LINE-BISECTION IN CHILDHOOD

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Abstract: *The article presents the results of a study aiming to investigate the impact of age and gender on the lateralization of visual spatial attention. Using a line-bisection task, 178 children, divided into two age group: a younger group (81 children aged 3,4 – 4,2 years; 37 boys), and an older group (97 children aged 5,11 years – 6, 7 years; 47 boys), were examined. The results showed that pattern of line-bisection performance underwent slight developmental changes during the preschool age and gender had no modulating effect.*

Keywords: *line-bisection, functional asymmetry, children.*

Introduction

Attention is multicomponent and complex integrative mechanism of mental activity which underlies all processes related to mental flexibility, learning and self-consciousness (Asenova, 2009).

Attention is one of the lateralized brain functions and line-bisection is a task widely employed both to measure hemi-spatial neglect in neurologically impaired patients and to study lateralization of visual spatial attention in neurologically healthy people (Jewell & McCourt, 2000). Line-bisection task consists in the subjective determination of the center of visually presented horizontal lines with different lengths, by marking a sign with a pencil. The typical right-hemispheric dominance for spatial attention, which is seen in the mature brain, is reflected in the tendency of systemic slight deviation of the bisection to the left of the real center when the task is performed by healthy adults, regardless of which hand the lines are bisected with (Asenova, 2014; Bowers, & Heilman, 1980; Failla, Sheppard & Bradshaw, 2003; Jewell & McCourt, 2000).

Studies the line-bisection performance in subjects of different ages and gender have found that four patterns of task performance can be observed when the line-bisection task is done once with the left hand and once with the right hand (Andonova, 2015). The first pattern – the bisection is done to the left of the real center with both hands (it is named "right pseudoneglect"); the second pattern – the bisection is done to the right of the real center with both hands (it is named "left neglect"); the third pattern – the bisection is done to the right of the real center with the right hand and to the left of the real center with the left hand (it is named "symmetrical neglect"); the fourth pattern – the bisection is done to the right of the real center with the left hand and to the left of the real center with the right hand (it is named "reversed symmetrical neglect)" (for a review see Jewell & McCourt, 2000).

The results of previous studies evidenced that healthy right-handed adults typically demonstrate a persistent leftward error, i.e. slight pseudoneglect which is considered to be due to a right hemisphere attention bias to the left field related to right-hemispheric asymmetry in the control of visual spatial attention (Asenova, 2014; Beste, Hamm, & Hausmann, 2006; Bowers, & Heilman, 1980; Failla, Sheppard & Bradshaw, 2003; Jewell & McCourt, 2000; Kaul, Papadatou-Pastou, & Learmonth, 2021; Varnava & Halligan, 2007).

When patients with right hemispheric lesions and hemispatial neglect perform line-bisection task they produce prominent deviation from the real half placing the subjective midpoint toward the ipsilesional

side - a performance caused by a reduced or absent awareness of this part of the space and body, which is contralateral to the damaged hemisphere (Corbetta, 2014; Parton, Malhotra, & Husain, 2004).

Reversed neglect is a rare pattern of line-bisection performance and the literature lacks an explanation for the causes of its appearance.

Symmetrical neglect is typically observed pattern of line bisection performance in children (Andonova-Tsvetanova, 2015; Asenova & Andonova-Tsvetanova, 2019; Dobler et al., 2001; Failla, Sheppard & Bradshaw, 2003), which is considered to be due to the immaturity of the corpus callosum insufficient myelination during the period of childhood (Hausmann, Waldie & Corballis, 2003).

Although the switching from symmetrical neglect to pseudoneglect takes place in childhood or adolescence, the literature is inconsistent when exactly this happens. Not all researchers have observed symmetrical neglect in children under 10 years of age. For example, De Agostini and co-workers (1999) studied healthy subjects of different ages and found that at the group level preschool children, 5-6 years old, demonstrated the typical for adult pseudoneglect and not symmetrical neglect.

Patro, Nuerk and Brugger (2018) studied visuospatial biases in children aged 3-6 years with bisection of lines placed on the sheet horizontally, vertically, or radially, and found that as a total group, children bisected horizontal lines to the left of the center. However, the researchers pointed out that this pattern of bias became prominent with advancing age and was not demonstrated in early childhood.

In a study on the influence that hand preference and sex could have on line-bisection in 5-7 years old children, Asenova and Andonova-Tsvetanova (2019) also found that symmetrical neglect was typical for this age and that sex and handedness had no significant influence on the mean deviation scores. Nevertheless, the authors found higher incidence of symmetrical neglect among the female group than the male group.

On the basis of a meta-analysis of line bisection and landmark task performances in typically developing children, 16 or under 16 years of age Kaul, Papadatou-Pastou and Learmonth (2021) concluded that age and handedness had no significant moderating effects on line-bisection biases, but gender had a slight effect on line-bisection error, with more leftward bias in studies including a higher proportion of males than girls.

Inconsistency of the previous studies' results on the lateralization of spatial attention in childhood inspired the present study. Its main objective was to examine the impact of age, gender and their interaction on lateralization of visual spatial attention.

Method

A total of 178 children, divided into two age group: a younger group consisting of 81 children aged 3,4 – 4,2 years (44 girls and 37 boys), and an older group (97 children aged 5,11 – 6,7 years; 50 girls and 47 boys), were examined with a line bisection task. At the time of sampling all participants were attended all-day preschool classes in the public sector on the territory of Chania (in Greek Χανιά), the island of Crete, Greece. All studied children were typically developing children and Greek native speakers and participated in the study voluntary and with the permission of their parents.

The task used in the study includes 17 horizontal lines which length range from 100 to 260 mm. Seven lines are presented in the middle of the sheet, five are aligned to the left and five lines are aligned to the right of the sheet.

A child was given a black pen and was instructed by the experimenter to place a mark at the center of each line. The experimenter covered each bisected line, with the aim to prevent the possible influence of the child's previous choice on the following bisections. Each child performed the task twice, one time with the right hand and one time with the left hand. No time limitation existed to complete the task.

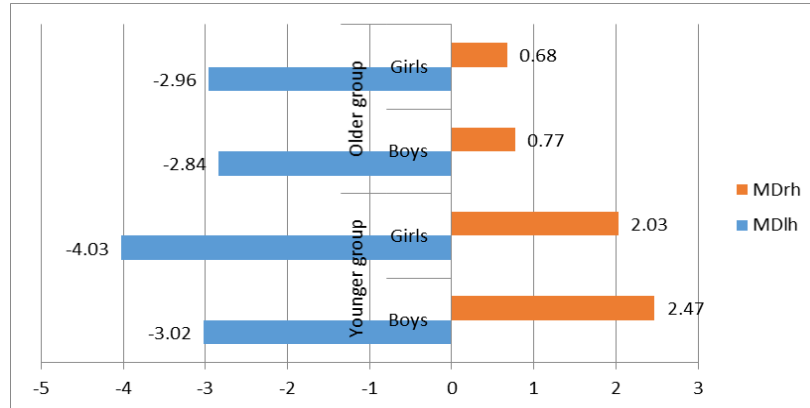
The percentage of deviation for each line was calculated using the following formula: (measured mean from the left - the real mean)/real mean) x 100. After that, the average percentage of deviation for the left and the right hand separately was calculated. The negative values reflected a leftward bias and the positive values reflected a rightward bias of the real center (Scarlsbrick et al., 1987).

Results

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Mean deviation scores for the left hand (MDlh) and the right hand (MDrh) during the line-bisection in the male and female subgroups of the two age groups are illustrated in figure 1.

Figure 1. Mean Percentage of Deviation scores from the true center according to the age-gender subgroups



As seen, at a group level all four subgroups demonstrated symmetrical neglect, i.e. leftward error in bisection with the left hand and rightward error in bisection with the right hand.

Between-group comparisons of Mean Deviation scores for the two hands revealed no significant differences for the left hand ($F_{/3,174/} = .744, p = .527$) and close to statistically significant differences for the right hand ($F_{/3,174/} = 2.496, p = .061$).

Next table 2 presents the results from the applied Paired-Samples T Test which performs within-group comparisons of the MDlh and MDrh and informs us about the effect of hand used for the line-bisection performance.

Table 1. Within-group comparisons of the MDlh and MDrh of the age-gender subgroups

Age groups	Gender groups	N	MDlh (SD)	MDrh (SD)	<i>t</i> ; <i>p</i>
Younger group	Boys	37	-3.02 (5.93)	2.47 (4.13)	$t_{/36/} = -4.357$ $p < .000$
	Girls	44	-4.03 (4.69)	2.03 (3.86)	$t_{/43/} = -7.753$ $p < .000$
Older group	Boys	47	-2.84 (3.26)	0.77 (3.50)	$t_{/46/} = -5.838$ $p < .000$
	Girls	50	-2.96 (2.91)	0.68 (3.48)	$t_{/49/} = -5.987$ $p < .000$

According to the results, the differences between the MDlh and MDrh were significant in all subgroups, which confirmed the significant effect of hand use on the performance of line-bisection in 3 to 6-year-olds regardless of their gender.

Next table 2 presents the distribution of the participants in the four subgroups according to the demonstrated type of neglect during the performance of line-bisection test.

As can be seen, the highest percentage of the participants in all four subgroups demonstrated symmetrical neglect and the between-group differences were slight and statistically insignificant ($\chi^2_{/9/} = 9.494, p = .393$; Cramer's $V = .231$).

Table 2. Distribution of participants in the age-gender subgroups according to the type of neglect

	Type of neglect			
	RPnN	LPnN	SN	RevSN

	N	%	N	%	N	%	N	%
Younger boys	7	18.9	7	18.9	20	54.1	3	8.1
Younger girls	9	20.5	6	13.6	27	61.4	2	4.5
Older boys	19	40.4	5	10.6	22	46.8	1	2.1
Older girls	17	34.0	7	14.0	25	50.0	1	2.0

RPN – Right pseudoneglect (left bias with both hands);

LPN – Left pseudoneglect (right bias with both hands);

SN – Symmetrical neglect (left bias with the left hand and right bias with the right hand);

RevSN – Reversed symmetrical neglect (right bias with the left hand and left bias with the right hand).

Conclusion

Present study's results showed that both at the group level (Mean Deviation scores) and at the individual level (distribution of the studied children according to the demonstrated type of neglect) the four age-gender groups of 3 to 6-year-olds demonstrated symmetrical neglect i.e. they transected the lines to the left of the real center with the left hand and to the right with the right hand. Moreover, the effect of hand use on the performance of line-bisection was significant in 3 to 6-year-olds regardless of their gender.

Therefore, in agreement with the data of previous studies, our results confirmed the effect of the hand that made the transection on the error as a task-related factor with a significant impact on line-bisection performance (Andonova-Tsvetanova, 2015; Asenova & Andonova-Tsvetanova, 2019; Dobler et al., 2001; Failla, Sheppard & Bradshaw, 2003; Hausmann, Waldie & Corballis, 2003; Kaul, Papadatou-Pastou and Learmonth, 2021). However, two of our findings of between-age group differences in line-bisection performance – the observed close to significant reduction of the size of bisection error with the right hand in the groups of the 5-6 year olds in comparison to the groups of the 3-4 year olds, may be considered as indicator of the beginning of a gradual shift with age of the pattern of line-bisection performance from the typical for children symmetrical neglect to the typical for adults right pseudoneglect. These findings are consistent with the relevant literature data (Andonova-Tsvetanova, 2015; Dobler et al., 2001; Failla, Sheppard & Bradshaw, 2003).

The observation of slight gender differences in the performance of line-bisection suggests no significant modulating effect of gender on the pattern of asymmetry of visual spatial attention in children aged 3,4 to 6,7 years – a finding, that is in agreement with the reports of Asenova, and Andonova-Tsvetanova (2019), as well as with the meta-analyses of the literature on the issue, conducted by Jewell and McCourt (2000), and Kaul, Papadatou-Pastou and Learmonth (2021).

The main limitation of the present study is the non-matched size of the age-gender groups since impacts the statistical power of between-group comparisons.

Conclusion

The following conclusions can be done on the basis of the obtained results:

1. When performing line-bisection task, 3,4 - 6,7 years old children tend to demonstrate symmetrical neglect, which suggests a weak and incomplete lateralization of the processes of visual spatial attention.
2. The pattern of line-bisection performance undergoes slight developmental changes during the preschool age period.
3. There are slight gender-related differences in the performance of line-bisection task, suggesting no modulating effect of gender on the pattern of asymmetry of visual spatial attention in children aged 3,4 to 6,7 years.

References

Andonova-Tsvetanova, Y. R. (2015). *Ontogenetic dynamics of lateralization of attention at school age: effects on academic performance and intelligence*. PhD thesis, Blagoevgrad. [in Bulgarian]

- Asenova, I. (2014). Lateralization of Visual Spatial Attention in Right-handers, Left-handers and Converted Left-handers: A Comparative Investigation with Line-bisection Task. *MEDIMOND-Monduzzi Editore International Proceedings* (pp. 5-8).
- Asenova, I. (2009). *Neuropsychology*. Publisher: Sanin N& N - OOD, Blagoevgrad. [in Bulgarian]
- Asenova, I. V., & Andonova-Tsvetanova, Y. R. (2019). Examining handedness and sex-related effects on line-bisection in childhood. *Psychological Thought*, 12(1), 111-119.
- Beste, C., Hamm, J., & Hausmann, M. (2006). Developmental Changes in Visual Line Bisection in Women Throughout Adulthood. *Developmental Neuropsychology*, 30(2), 753-767.
- Bowers, D., & Heilman, K. M. (1980). Pseudoneglect: Effects of hemispace on a tactile line bisection task. *Neuropsychologia*, 18(4-5), 491-498. [https://doi.org/10.1016/0028-3932\(80\)90151-7](https://doi.org/10.1016/0028-3932(80)90151-7)
- Corbetta, M. (2014). Hemispatial neglect: clinic, pathogenesis, and treatment. *Semin Neurol*, 34(5), 514-23. doi: 10.1055/s-0034-1396005.34(5), 514-23.
- De Agostini, M., Curt, F., Tzortzis, C., & Dellatolas, G. (1999). Comparing left and right hand in line bisection at different ages. *Developmental Neuropsychology*, 15(3), 379-394. <https://doi.org/10.1080/87565649909540756>
- Dobler, V., Manly, T., Atkinson, J., Wilson, B. A., Ioannou, K., & Robertson, I. H. (2001). Interaction of hand use and spatial selective attention in children. *Neuropsychologia*, 39(10), 1055-1064.
- Failla, C., Sheppard, D., & Bradshaw, J. (2003). Age and responding-hand related changes in performance of neurologically normal subjects on the line-bisection and chimeric-faces tasks. *Brain and Cognition*, 52(3), 353-363.
- Hausmann, M., Waldie, K. E., & Corballis, M. C. (2003). Developmental changes in line bisection: A result of callosal maturation? *Neuropsychology*, 17(1), 155-160. <https://doi.org/10.1037/0894-4105.17.1.155>
- Jewell, G., & McCourt, M. E. (2000). Pseudoneglect: a review and meta-analysis of performance factors in line bisection task. *Neuropsychologia*, 38, 93-110. doi:10.1016/S0028-3932(99)00045-7
- Kaul, D., Papadatou-Pastou, M. & Learmonth, G. (2021). A meta-analysis of line bisection and landmark task performance in children. *Laterality: Asymmetries of brain, behaviour, and cognition*, <https://doi.org/10.1080/1357650X.2022.2147941>
- Parton, A., Malhotra, P., & Husain, M. (2004). Hemispatial neglect. *J Neurol Neurosurg Psychiatry*, 75, 13-21.
- Patro, K., Nuerk, H.-Ch., & Brugger, P. (2018). Visuospatial biases in preschool children: Evidence from line bisection in three-dimensional space. *J Exp Child Psychol.*, 173,16-27.
- Scarisbrick, D., Tweedy, J., & Kuslansky, G. (1987). Hand preference and performance effects in line bisection. *Neuropsychologia*, 25, 695-699. doi: 10.1016/0028-3932(87)90061-3
- Varnava, A., & Halligan, P. (2007). Influence of Age and Sex on Line Bisection: A Study of Normal Performance with Implications for Visuospatial Neglect. *Aging, Neuropsychology and Cognition*, 14(6), 571-585.