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Article

Visual Selective Attention in Letter Processing: a Comparative Study

Atención selectiva visual en el procesamiento de letras: un estudio comparativo

Gilberto Galindo
Universidad Autónoma de Baja California, México
Yulia Solovieva
Benemérita Universidad Autónoma de Puebla, México
Regina Machinskaya
Academia de Educación Rusa, Moscú
Luis Quintanar
Benemérita Universidad Autónoma de Puebla, México

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Contact:
gilberto.galindo.aldana@uabc.edu.mx

Abstract

Selective visual attention maturation in childhood is highly dependent of the development of visual-spatial processing, which at the same time keeps a close relation with learning, ambient, cultural factors and form which reading processes depend. Objective, to compare complex visual object processing in children from urban and rural environments. The study has estimated the ability to recognize global and local aspects of visual patterns by measuring accuracy of response (AR) and reaction time (RT) to hierarchically organized letters. It was found a low level of accuracy in recognition of local features of hierarchical visual stimuli was found in both groups of children. Rural children had peculiarities of hierarchical stimulus recognition, they demonstrated lower AR of global features perception, shorter RT to incongruent stimuli combined with low AR, and absence of global precedence effect. The obtained results suggest quantitative and qualitative differences in responses of children during processing of complex visual characteristics of objects. The results suggest that social differences can influence on specific features of visuo-spatial perception, attention and learning skills of reading in children.

Resumen

La maduración de la atención selectiva visual en la edad infantil depende del desarrollo del procesamiento visuo-espacial, que a su vez guarda una estrecha relación con el aprendizaje y los factores ambientales, culturales y de la que dependen funciones complejas de procesos de lectura. Objetivo, comparar el procesamiento de estímulos visuales complejos, en niños procedentes de entornos culturales rurales y urbanos. Se estimó la habilidad de procesamiento selectivo visual para reconocer los aspectos globales y locales de patrones visuales midiendo agudeza de respuesta (AR) y tiempo de reacción (TR) ante tareas de percepción de letras jerárquicamente organizadas. Ambos grupos mostraron bajo nivel de agudeza en el reconocimiento de aspectos locales de los estímulos visuales. El grupo rural mostró peculiaridades en el reconocimiento de los estímulos, mostrando bajo nivel de agudeza en la percepción de las características globales, tiempos de reacción más cortos combinados con menor AR y ausencia del efecto de precedencia global. Los resultados sugieren presencia de respuestas cualitativamente y que diferencias ambientales pueden influir sobre características de percepción visuo-espacial, atención y habilidades de aprendizaje de lectura en niños.

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Introduction

Human feelings and perceptions are processed by a complex system of brain mechanisms that make the cognition of the world around us possible. The signals of this external World have patterns which are especially important for basic reading processes, as well as for human ontogeny (D'Esposito, 2003; Findlay & Gilchrist, 2003; Gaia, Cornish, Wilding, & Karmiloff-Smith, 2004; Jenkins, Yang, Goh, Hong, & Park, 2010; Piaget, 1997a, 1997b; Posner & Gilbert, 1999). In the course of learning, the properties of objects can be perceived through different visual patterns. Drawing a distinction between these patterns has given rise to three basic questions: 1) does the human brain process visual patters as general structures or as parts thereof?; 2) do these ways of processing change during ontogeny?; and 3) can this influence be affected by social factors and promote or affect the development of more complex functions such as reading?

An approach to the responses to these questions can be obtained with the help of tests involving the introduction of hierarchically organised and previously developed stimuli (large letters or shapes made up of smaller elements) (Kimichi, 1992; Navon, 1977, 2003). Formerly, it was believed (Krakowski, Borst, Pineau, Houdé & Poirel, 2015; Machinskaia, Krupskaia, Kurganskiĭ & D'Iachenko, 2009; Navon, 2003; Volberg, Kliegl & Greenlee, 2007), which it was an advantage to study visual perception by using hierarchical stimuli (Figure 1), letters and shapes organised in two visual patterns. The global pattern involves the presence of one large letter made up of small letters of the same kind, while in the case of the local pattern the large letter is made up of small letters of a different kind. These stimuli can be perceived by some participants as different objects under the conditions of experimental approaches according to instructions provided previously. Recognising different aspects of hierarchical stimuli requires different types of processing visual information, such as the holistic analysis for global recognition and the analysis of the parts that make up the structure to recognise the local aspects. Navon (1977, 2003) used audio signals to draw the attention and alert of the individual that was the subject of study before providing the objective stimulus. According to Navon's original paradigm (1977), the stimuli were introduced in one of the four corners (upper left, upper right, lower left or lower right) in a random order to avoid drawing the attention on the small letters when they appeared in the centre of the screen. Other researchers presented Navon's hierarchical stimuli in a different way, in the left and right visual fields (Han & Jiang, 2006) or in the centre of the screen with a fixation point (Heinze, Hinrichs, Scholz, Burchert & Mangun, 1998; Weissman & Woldorff, 2005; Yamaguchi, Yamagata & Kobayashi, 2000). In these previous studies, both on adults and older children, the effect of the global precedence was shown and observed through the presentation of stimuli which are hierarchically organised and located in the central area of the participant's visual field (Krupskaya & Machinskaya, 2005). In view of this kind of condition, faster responses at a global level compared to the local one are expected (Lachmann, Schmitt, Braet & van Leeuwen, 2014).

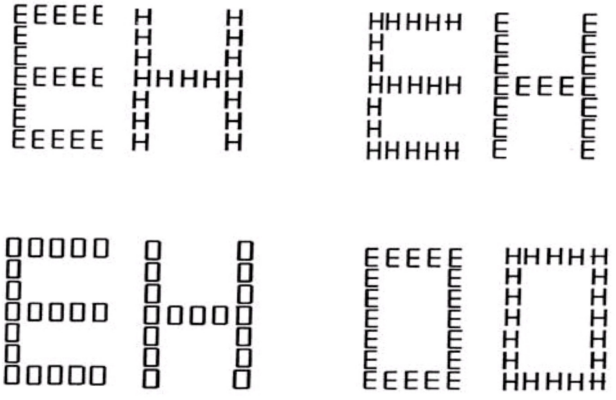


Figure 1. Examples of stimuli presented in this study.

Note: A - congruent stimulus for both conditions; B- incongruent stimulus for both conditions; C - neutral stimulus for the global condition; D - neutral stimulus for the local condition

Source: Navon (1977).

In the case of reading processes, this kind of analysis of stimuli perception is useful to study holistic visual recognition in a differentiated way, in detail in different populations and during ontogenetic development. According to Navon's global precedence hypothesis (1977), the perception of the global aspect of hierarchical stimuli occurs in first place (or faster), what the author defines it as "pre-attentive processing". Likewise, there is a hypothesis based on the fact that recognising local aspects of hierarchical letters takes longer in incongruent situations, when the stimulus' global aspect conflicts the local stimulus. It has been proved that when an individual's attention focuses on the global aspect of an inconsistent stimulus, the response time (RT) is not increased substantially. Recent studies (Kimichi, 1992; Navon, 2003) show that the law of the global precedence effect (GPE) -whereby the visual scheme is mainly processed through its global components- is a global-local response pattern. This GPE is not invariable and depends on the stimuli's factors, such as their location, size, exposure time, shape and meaning. There is also evidence of differences in GPE in adults (Yovel, Revelle & Mineka, 2005).

Multidisciplinary studies show that the starting period of primary education is characterised by the functional maturity of brain structures that provides modulation from top to bottom from specific areas of the frontal lobes (Machinskaya & Semenova, 2007). Nevertheless, there is evidence that shows that functional brain immaturity cannot be limited to the areas of the frontal lobes and thus to executive functions only (Machinskaya, 2006; Semenova, Machinskaya, Akhutina & Krupskaya, 2001), but to other difficulties too, such as those related to the processing of visual and visual-spatial information, among others.(Krupskaya & Machinskaya, 2006; Machinskaya & Semenova, 2007) These difficulties can compromise or result in sub-optimal development of reading processes. In children aged between 7 and 8 these deficits can also result in learning difficulties (Machinskaya & Semenova, 2004). In a recent study, it has been found that severe difficulties when processing visual-spatial information characterise children aged between 5 and 6 with attention deficit and reading development delay (Quintanar, Solovieva & Bonilla, 2006; Solovieva, Machinkaya, Bonilla & Quintanar, 2007; Solovieva, Machinskaya, Quintanar, Bonilla & Pelayo, 2009).

On the other hand, the social factors are an important variable that probably has an impact on the organisation and consolidation of perception and visual attention during ontogeny. Luria (1992) stated that the neutral form of attention with non-arbitrary inappropriate forms for an organised and stable behaviour is not enough to meet the demands of social behaviour. Therefore, it is necessary to develop an arbitrary artificial behaviour, also called civilised attention, which is an essential component of any function (Luria & Vygotsky, 1992). This interdependence between perception and attention -depending on the cultural forms of education- is related to the development of specific mechanisms that enable the child to control his/her attention and perceive complex situation in different types of activities (Luria, 1992). This way, the development of visual attention in its most complex forms during childhood is closely linked to the external organisation of the activity with objects, the participation of objects themselves, the educational techniques and the special attention training tasks (Rueda, Rothbart, McCandliss, Saccomanno & Posner, 2005). All these factors may depend on specific socio-economic and family circumstances. It can be assumed that brain maturity is an essential condition but insufficient to explain the formation of complex cognitive processes, such as reading, cultural forms perception and visual attention. As a second condition, in line with Vigotsky's contributions, the children's life in society as the starting point of the development of specific forms of cultural interaction is identified (Solovieva & Quintanar, 2013). Some recent studies show that there is a close relation

between a specific cultural situation and visual recognition in children (Faye, Boland & Nisbett, 2005; Goh et al., 2013; Roberson, Davidoff & Shapiro, 2002; Roberson & O'Hanlon, 2005; Segall, Campbell & Herskovits, 1968). As far as attention is concerned, there are also data suggesting that it can be culturally modelled by cultural variation (Masuda, 2001).

The maturity of visual-spatial processing mechanisms of the brain with different levels of complexity is substantially related to the future development of psychological functions such as reading. It is suggested that the social environment of certain contexts can define or model the development characteristics of these brain analysers. To that end, the main objective of this study is characterising the properties of selective visual recognition of complex stimuli at a global and local level (Navon, 1977) in first-grade children from urban and rural areas in Mexico.

Method

Design

A comparative and descriptive study was conducted. The origin of the population -urban or rural- was selected as an independent variable. What is more, the following parameters were used: 1) response time (RT) of the correct recognition of visual stimuli and 2) performance accuracy (number of right responses) in each one of the groups studied as grouping variables.

Participants

56 children, with an average age of 6.39 years and 0.351 years of standard deviation participated in this study. They were selected at random according to the inclusion criteria of the study: right handedness, without any history of neurological diseases or vision problems, from urban areas and public schools (average age = 6.35, SD = 0.279 years, n = 27: 14 boys, 13 girls) and from rural areas (average age = 6.43, SD = 0.411 years, n = 29: 15 boys, 14 girls). All the children were first-grade students of primary education and were assessed during the first term of their early education. They were grouped in three different levels of school success: high (grades between 10 and 9), intermediate (grades between 7 and 8) and low (grades between 6 and 0).The participants from urban areas were familiar with computers, unlike those from rural areas. Nevertheless, none of the two groups used computers systematically at home or at school. In order to avoid any potential understanding problems related to the instructions, several training sessions were conducted so that the children could know the team and use the keyboard properly. The informed consent of the school's administration and the parents was obtained before the assessment. The verbal consent of the minors involved was also obtained. None of the phases of the study involved any risk to the participants and both the ethical guidelines and the General Act on Health were taken into account for this research.

Instruments

The selective visual recognition was studied by using three types of stimuli of hierarchically organised letters: congruent, incongruent and neutral. All the stimuli represented a large letter (6.4 x 2.4 angular degrees) made up of small letters (0.8 x 0.3 angular degrees) (Figure 1). The tests were applied by using a laptop and the "Butterfly" software (Pulkin, 1996). The visual stimuli were presented in black on a grey background at 45 cm distance of the individual 17 inch monitor. The responses were registered by using a keyboard.

Proceeding

Two keys of the keyboard were used to register the children's alternate responses depending on the objective stimulus: "1" and "0". Individuals were requested to recognise one of the two letters ("H" or "E") in the global situation (large letter) or local situation (small letter) in two different blocks of 60 series presented in ABBA order. Different types of stimuli were

used to match probability in random order. An interval between 5 and 7 minutes between blocks was allowed. Participants responded by pressing the "0" key with their right hands for letter "H" or the "1" key and with their left hands for letter "E". It was necessary to use both hands to avoid automatic or customary responses due to tactile proximity.

Each participant was assessed individually and requested to watch the centre of the screen. All stimuli appeared with duration of 100 ms in intervals of 1,500 ms. An alert audio signal (587 Hz) was presented in each series, starting 500 ms before the stimulus' presentation. The sequence restarted upon obtaining the individual's response or after 10 seconds.

Before applying the test, the experimenter made sure that the child could distinguish between the small and the large letters, the letter type ("H" and "E") and that the child could recognise the keys of the keyboard and become familiar with the PC. A series of training stimuli made up of 20 stimuli equal to those of the experiment was presented.

Statistical analyses

The RT and the accuracy were analysed in both cultural groups: urban and rural-independent variable-, and intra-groups for 2 repeated factors, which were experimental condition (local and global) and type of stimulus (congruent, incongruent, and neutral.)The data were weighted individually upon eliminating the RT classified as very long (more than 1,500 ms) considered as responses not related to the stimulus presented by the forget factor and very short (less than 100 ms), considered as impulsive responses that take place before the stimulus was processed by the visual sensory analysers (Machinskaya, 2006). The statistical assessment of school success and the number of right responses was conducted with repeated measures based on the General Linear Model, for the statistical inter-subjects and intra-subjects using the grouping factors in different analyses. T-tests of repeated measures to assess the condition's influence (two levels: local, global) and type of stimulus (three levels: congruent, incongruent, neutral) as well as intra-subject factors and type of school (group) (two levels: urban and rural) for the inter-group factor.

Results

Response Time

The analysis showed a significant influence as main effect the type of global and local condition (F [1. 54] = 4.19, p = .046). In both groups, the TR the recognition small letters, in the case of local condition, took longer compared to the recognition of large letters under the global condition in all types of stimuli (Table 1 and Figure 2). The significant differences in the intra-subject RTs are also shown in Table 1.

When analysing the influence of the group of origin, significant results were found in "condition urban-rural group" (F [1. 54] =4.63, p = .036), but not in the "type of stimulus urban-rural group" interaction (F [1. 54] =.88, p = .415) (table 1). The RT data shown in Figure 2 show shorter RT in the rural group compared to the urban one, under the local condition.

This effect turned out to be more marked on presenting the incongruent stimulus. Similarly, when analysing the type of stimulus factor (three levels), the intra-subject effects showed RTs significantly shorter for the recognition of incongruent stimuli in the global situation in the rural group (F [1. 54] = 3.58, p =.032). The results of the t-tests showed that in this group the RT to incongruent stimuli is significantly shorter (they respond faster) compared to the neutral stimuli in the local situation (t [28] = -2.07, p = .048).

The opposite but significant effect of incongruent stimuli was found in the urban group. The RTs to the recognition of incongruent stimuli in the local situation were longer compared to the RTs of the other types of stimuli (Figure 2A, Table 2). These remarks show that the "global precedence" effect is reverted (Navon, 1977) in the group of children from

rural schools, but not in the group of children from urban schools.

Under the global condition, the RT to the congruent stimuli was longer in the rural group, but these differences did not turn out to be significant (Figure 2B). These findings are consistent with the statistically significant differences between groups in the results of response accuracy (Figure 3). The rural group had a lower performance during the recognition of the congruent and incongruent stimuli under the global condition.

Table 1. Results of the analysis of the RTs in ms of the measures of the groups under different conditions to the different types of stimuli

Factors	lf	F	p
Condition**	1	4.19	.046
Condition**-school*	1	4.63	.036
Stimulus***	2	.784	.459
Stimulus***-school*	2	2.36	.099
Condition**-stimulus***	2	.888	.415
Condition**-stimulus***-school*	2	3.58	.034

Note: RT: response time; ms: milliseconds; *lf:* levels of freedom; *F:* test of *F*; *p:* significance; *urban/rural school;**global/local condition;***congruent/incongruent/neutral stimulus.

Source: Prepared by the authors.*fig. 2*

Table 2. Results upon comparing the RTs in ms between groups to the three types of stimuli under global and local conditions

	Urban group	Rural group
Condition/type of stimulus	Average (SD)	Average (SD)
Global/congruent	758 (171)	874 (232)
Global/incongruent	802 (212)	889 (246)
Global/neutral	807 (210)	830 (257)
Local/congruent	989 (406)	864 (230)
Local/incongruent	1044 (404)	822 (272)
Local/neutral	1007 (471)	891 (284)

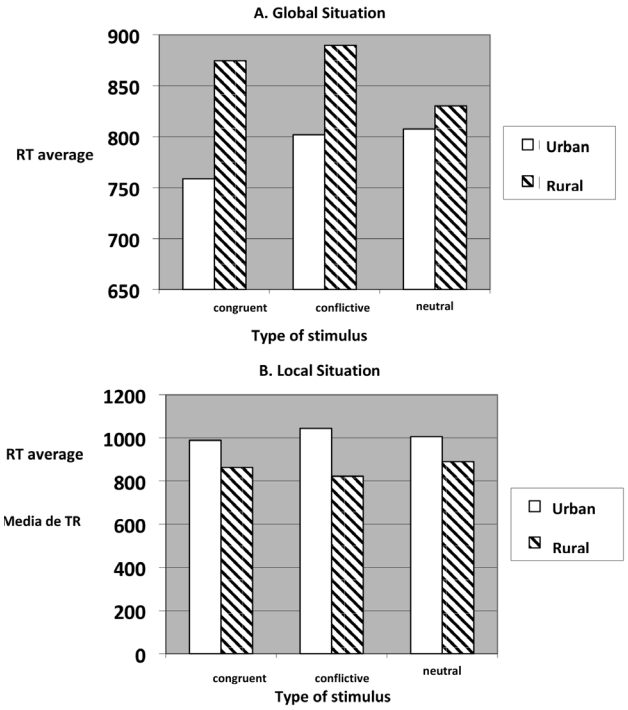
Note: RT: response times; ms: milliseconds; SD: standard deviation.

Source: Prepared by the authors.

Performance Accuracy

The number of right responses under the different experimental conditions and to the different types of stimuli was analysed by using statistics of repeated measures (RMs),

Figure 2. Averages of the RTs (in ms) of the right responses before the hierarchically organised stimuli of the urban and rural group



Note A. Global Situation, B. Local Situation, rural group shown in striped bars.

Source: Prepared by the authors.

whereby the average is used to measure the central tendency. The results obtained in both groups are shown in Table 3. The number of stimuli was even (n = 20) in both blocks for all types of stimuli. The results of the inter-subject statistics based on the General Linear Model of the t-test parametric tests showed that the number of right responses depends largely on the type of stimulus. The lowest accuracy level was observed in the incongruent stimulus (Figure 3, Table 3 and Table 4) in both groups and under both conditions. As far as the type of stimulus is concerned, the following significant effects were found. In the urban group under the global condition congruent average = 17.92, incongruent average = 16.96 and neutral average = 17.75, $p < .000$, under the local condition congruent average = 14.46, incongruent average = 9.88 and neutral average = 11.75, $p < .000$. On the contrary, in the rural group under the global condition congruent average =

13.19, incongruent average = 12.43 and neutral average = 14.96, p = .018, under the local condition congruent average = 14, incongruent average = 8.11 and neutral average = 11.64, p = .018.

Table 3. Results of the analysis of response accuracy of the measures of the groups under different conditions to the different types of stimuli

Factors	lf	F	p
Condition**	1	387	<.001
Condition**-school*	1	6.29	.015
Stimulus***	2	31.7	<.001
Stimulus***-school*	2	2.31	.105
Condition**-stimulus***	2	16.8	<.001
CCondition**-stimulus***-school*	2	.511	.601

Note: lf: levels of freedom; *F*: test of *F; p*: significance. *urban/rural school;**global/local condition;***congruent/incongruent/neutral stimulus.

Source: Prepared by the authors.

Table 4. Results upon comparing RA between groups to the three types of stimuli under global and local conditions

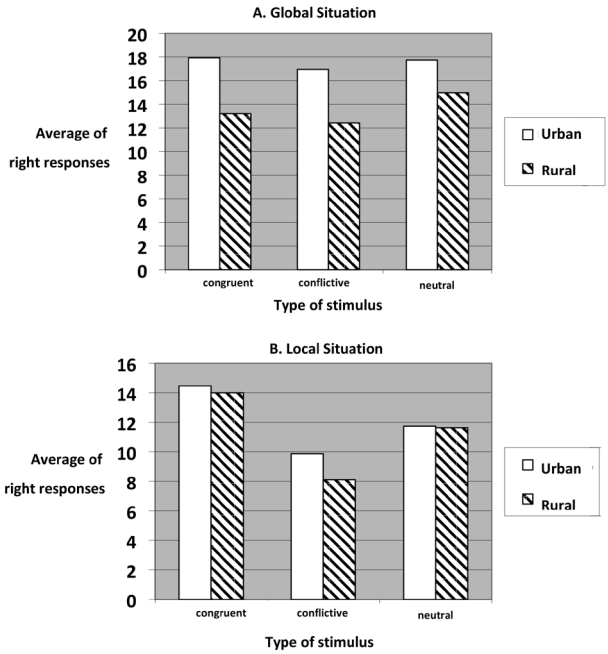
	Urban group	Rural group
Condition/type of stimulus	Average (DE)	Average (DE)
Global/congruent	17.92 (1.44)	13.19 (3.91)
Global/incongruent	16.96 (1.78)	12.43 (3.88)
Global/neutral	17.75 (1.39)	14.96 (3.55)
Local/congruent	14.46 (5.11)	14 (4.46)
Local/incongruent	9.88 (5.9)	8.11 (5.32)
Local/neutral	11.75 (4.9)	11.64 (4.37)

Note: RA: response accuracy in number of right responses SD: standard deviation.

Source: Prepared by the authors.

The experimental condition (local vs. global) also turned out to be a significant factor that has an impact on the recognition of hierarchical stimuli. The paired t-tests showed that, in the urban group, the number of right responses depends significantly on the global or local situation for the congruent stimulus (t = 3.38, p = .003), for the incongruent stimulus (t = 6.04, p < .000) and for the neutral stimulus (t = 6.42, p < .000). This way, situation turns out to be a factor that influences the ability of the participants from the urban area to respond, because there are differences between the recognition of the congruent and the incongruent stimulus. Something different happened in the rural group, the condition turned out to have a significant impact on the recognition of the incongruent stimuli (t = 3.27, p = .005) and the neutral stimuli (t = 3.27, p = .003) in this group, but not of the congruent stimuli (t = -0.76, p = .452). No significant differences were found between the congruent, the neutral and the incongruent stimuli, and this fact shows the lack of recognition of both congruent and incongruent stimuli. In other words, there are difficulties when processing both visual patterns (local and global).

Figure 3. Recognition accuracy (average of the number of right responses) of the stimuli hierarchically organised in children from the urban and rural group



Note: A. global condition, B. local condition, rural group shown in striped bars.

Source: Prepared by the authors.

Discussion

The analysis of the experimental condition and the type of stimulus on the performance accuracy shows similar results for both groups: the difference between the global and local aspects of the stimuli evidences a significantly

lower performance when recognising the local aspect of the stimuli. This means that the recognition of the local reading pattern of letters is far more complicated for both groups than the global one. These results are compatible with the data obtained in other studies in adults (Hübner & Malinowski, 2002; Nayar, Franchak, Adolph & Kiorpes, 2015; Yovel, Levy & Yovel, 2001) and in children aged between 7 and 8 (Dukette & Stiles, 2001; Galindo, Machinskaya, Basilio & Solovieva, 2013; Galindo, Solovieva, Machinskaya & Quintanar, 2013; Krupskaya & Machinskaya, 2005).

The results also showed that the children from the rural group have a significantly lower level of performance accuracy when recognising the global characteristics compared to the urban group, both when reading conflictive and congruent stimuli. In other studies (Moses et al., 2002; Poirel et al., 2011), results of neuropsychological assessments were presented, showing difficulties when perceiving the large figures made up of small elements in preschool children under 6 years old. Therefore, it is a critical age in the development of mechanisms of selective visual recognition which is necessary for reading. Preschool age has been studied by other authors with similar methods and showed changes in the development of the recognition of hierarchically organised stimuli. Difficulties in the recognition of the global characteristics compared to the recognition of the local ones have also been identified (Dukette & Stiles, 2001; Poirel, Mellet, Houdé & Pineau, 2008; Porporino, Larocci, Shore & Burack, 2004). A sample of early school age was used in this study's results. These data allow to conclude that the differences between groups in the recognition of global characteristics obtained in this study may be due to differences in the functioning of the neuropsychological mechanisms of visual-spatial synthesis of the group of children from rural schools when they are exposed to this type of complex stimuli, compared to the urban group, which can also be verified through methods of neuropsychological assessment (Hadad & Kimichi, 2006; Kimichi, 1993; Quintanar et al., 2006; Scherf, Luna, Kimichi, Minshew & Behrmann, 2008).

RTs were longer in the case of both groups under the local condition compared to the local one. This result confirms the difficulties in perceiving elements of complex stimuli, as shown by performance accuracy assessment in both social groups, which is in line with the results obtained in other studies (Hübner & Malinowski, 2002; Mondloch, Geldart, Maurer & Schonen, 2003). The analysis of the impact of the condition and the stimulus on RTs in this study showed differences between the urban and the rural group: in the case of the urban group, the longest RTs occurred when recognising the incongruent stimulus, while in the case of the rural group the conflictive nature of the stimuli did not modify the RTs (in the global situation) or resulted in shorter RTs (in the local situation). The children from the rural group responded faster to the incongruent stimuli but made a greater number of mistakes (Figure 2). Therefore, a reduced RT does not correspond to a better performance in the task but instead it reveals difficulties to focus on the significative level of the incongruent visual stimuli (for example, recognising any letter in any level incorrectly, which draws their exogenous attention). According to Posner's definition of attention (1990), the reaction to incongruent stimuli reflects the executive functions' effectiveness. Other authors (Posner & Rothbart, 1998; Vales & Smith, 2015) showed that low performance accuracy in children may be combined with short RTs, because the stimulus' conflictive perception may be hampered by their functional attention immaturity. According to the foregoing, it can be suggested that the performance of executive attention to different aspects of hierarchically organised visual-spatial stimuli in children from rural schools reveals some deficiencies compared to the urban group. This theory also suggests that reading, attention and visual-spatial processes cannot be analysed separately, because they depend on the object types processed. Our study deals with perception and recognition of

complex visual-spatial stimuli. Another explanation to the result of the short RTs in the rural group to the incongruent stimuli in the local situation is the absence of the global precedence effect due to a deficient differentiation of the stimuli's global characteristics. Again, we are facing the primary aspect of visual-spatial difficulties marked in rural population. This stands in line with the low response accuracy and the tendency to longer RTs in the global situation in this group compared to the urban one.

Therefore, the substantial differences in the executive processes and the characteristics of visual-spatial perception between the urban and the rural group suggest that the social precedence factor may have some impact on the cognitive activity of children in their early school age. The urban and rural conditions are different of the underlying education, the complexity of visual stimuli, the amount of information received and the parents' education. The specific effects of the different social factors require further research.

The results reveal a connection between attention regulation of a higher-lower level and the development of information processing in children. In previous studies in children with attention-deficit disorder (Quintanar et al., 2006), it was found that the low level of development of the visual-spatial processes is related to deficiencies in the executive functions. Those children with attention-deficit diseases, disorders that affect the regulation and control of the kinetic organisation of movements and actions, showed more marked difficulties in the performance of visual tasks: processing of visual-spatial dimensions, copying and drawing pictures and their elements.

The results of this study may guide spatial educational proposals to promote the psychological development and preparation for reading in school environments in rural areas, in the sense of including activities to support the acquisition of visual-spatial synthesis.

Conclusions

In general terms, both groups of children had a low level of performance accuracy when recognising the local characteristics of the hierarchically organised stimuli. Nevertheless, the rural group showed the following levels of visual selective development when recognising the letters hierarchically organised: low level of performance accuracy when perceiving the stimuli's global characteristics, short RTs to incongruent stimuli combined with low level of performance accuracy, as well as absence of Navon's global precedence effect (1977). Identifying these differences suggests that the basic processes of visual-spatial analysis and synthesis, which result in attention and learning, have different characteristics in the groups studied. In last place, it is found that the results obtained suggest that social development may have an impact on the characteristics of visual-spatial perception, attention and learning skills in children. It is thus recommended to submit the sociocultural factors that may have an impact on the maturity of this type of processes for further analysis.

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