

Language laterality, handedness and empathy in a sample of parents of children with autism spectrum disorder

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Abstract

Background: First-order relatives of persons with Autism Spectrum Disorder (ASD) exhibit a cognitive pattern which is part of a broader autism phenotype. **Method:** The purpose of the present study was to evaluate whether some neuropsychological features related to the autism phenotype are present in parents of ASD children. To this end, the exploration included a dichotic listening task, handedness and the Empathy Quotient (EQ-60). **Results:** The scores obtained by the total sample (fathers plus mothers) were similar to those of the general population, although there were differences in some parameters of the dichotic listening task depending on the gender. Contrary to expectations, only in fathers, the negative correlation between data from both ears was not statistically significant, which could be evidence of a lack of hemispheric interdependence. **Conclusions:** These results support the possible existence of a genetic susceptibility to an aberrant language asymmetry pattern. Moreover, possible unknown epigenetic factors could act on a vulnerable genotype in some ASD subjects. Nevertheless, due to the small sample size, the present research must be considered a pilot study.

Keywords: Language laterality, broader autism phenotype, autism, parents.

Resumen

Lateralidad del lenguaje, preferencia manual y empatía en una muestra de padres de niños con trastorno de espectro autista. Antecedentes: algunos familiares de primer orden de personas con trastornos del espectro autista (TEA) exhiben un patrón de funcionamiento cognitivo que forma parte del llamado fenotipo ampliado de autismo (FAA). **Método:** el objetivo de este estudio consiste en evaluar si algunos aspectos neuropsicológicos relacionados con un FAA están presentes en progenitores de niños y niñas con TEA. Para ello, se realizó una prueba de escucha dicótica libre, se detectó la preferencia manual y se obtuvo el Cociente de Empatía (CE-60). **Resultados:** los resultados sitúan a la muestra total dentro de parámetros similares a los de la población general, aunque algunos datos de la escucha dicótica revelaron diferencias según el género. Contrariamente a lo esperado, en el subgrupo de padres los datos de ambos oídos no correlacionaron significativamente, lo que revelaría falta de interdependencia hemisférica. **Conclusiones:** nuestros resultados apoyan la posible existencia de cierta vulnerabilidad genética a un patrón anómalo de lateralización hemisférica del lenguaje. Por tanto, factores epigenéticos por determinar podrían estar incidiendo sobre un genotipo vulnerable en las personas con TEA. No obstante, la presente investigación ha de considerarse un estudio piloto debido al tamaño de la muestra.

Palabras clave: lateralización del lenguaje, fenotipo ampliado de autismo, autismo, progenitores.

Currently, Autism Spectrum Disorders (ASD) are considered to be one of the most severe developmental disabilities. The diagnostic criteria according to DSM-V are: qualitative impairment in social interaction and communication (verbal and non-verbal) and presence of restricted, repetitive, stereotyped patterns of behaviour, interests and activities (APA, 2013).

Right-handedness and left-hemisphere lateralization for the control of speech and language are part of the standard pattern of brain lateralization. However, this pattern seems to be altered in individuals with ASD (Hausman & Bayer, 2010; Just, Cherkassky, Keller, Kana, & Minshew, 2007; Kana, Keller,

Cherkassky, Minshew, & Just, 2006). Brain language dominance can be assessed by a dichotic listening test (DL), which usually reveals a right ear advantage. The scarce information available on the implementation of the DL test in subjects with ASD is contradictory. In some reports, no differences have been found between controls and subjects with high-functioning ASD (Arnold & Schwartz, 1983; Bradshaw & Prior, 1979; McCan, 1981). In others, however, left ear preference or no preference has been observed in people with ASD, contrary to what is commonly observed in those with typical neurodevelopment (Hayashi, Takamura, Kohara, & Yamazaki, 1989; Hismjatullina, 2006).

Several studies have revealed genetic influence in first-order family members, who would show an extended phenotype of autism, featuring some of the symptoms or changes characteristic of ASD at subclinical level, namely the so-called Quantitative Autistic Features: difficulties in language and social skills, as well as reduced levels of empathy, which is defined as the ability to

identify the thoughts and emotions of others and put oneself in the other's place, responding with appropriate emotion to the situation (Baron-Cohen, 2003; Constantino, Zhang, Frazier, Abbacchi, & Law, 2010; Schwichtenberg, Young, Sigman, Hutman, & Ozonoff, 2010).

Empathy is considered to be a dimension along which individuals may differ and is the result of innate and learned factors (Wheelwright et al., 2006). The level of empathy may, therefore, vary depending on a variety of situational factors (fatigue, alcohol, mood) and gender (women tend to score higher) (Allison, Baron-Cohen, Wheelwright, Stone, & Muncer, 2011; Baron-Cohen & Wheelwright, 2004; Von Horn, Bäckman, Davidsson, & Hansen, 2010). In various studies, people with ASD, as well as some of their parents, show reduced levels of empathy, as measured by the Empathy Quotient (Baron-Cohen & Wheelwright, 2004; Berthoz, Wessa, Kedia, Wicker, & Grezes, 2008; Johnson, Filliter, & Murphy, 2009; Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004; Romero-Martínez et al., 2011; Wakabayashi et al., 2007; Wheelwright et al., 2006).

This work is part of a larger research project conducted with 6-year-old children with high-functioning ASD ($n = 16$) who were the offspring of the parents participating in the present study. Their neuropsychological profile was compared with that of control children ($n = 18$). When a DL test was used to evaluate language lateralization, an absence of right ear preference was observed in children with ASD (Martínez-Sanchis, Bernal, Gadea, & Fernández, 2011).

The aim of this present work was to explore neuropsychological aspects related to a broader phenotype of autism in progenitors of children with ASD using a DL test, detection of manual preference (Edinburgh Handedness Inventory), and a questionnaire providing empathy indices (Cambridge Behaviour Scale). Acknowledgement of their own cognitive functioning would enable parents to understand the neuropsychological profile of their children.

Method

Participants

The initial sample consisted of 32 parents (15 fathers and 17 mothers; 15 couples and two single mothers) of children with ASD, aged between 38 and 52 years. Later, 7 subjects were discarded since their children did not present a clear diagnosis of ASD, leaving a final sample of 12 fathers and 13 mothers.

Measuring instruments

Dichotic listening test (DL): This test evaluates hemispheric processing and ear preference, taking into account variables such as attention, concentration or type of information to be processed (Gadea, Gómez, & Espert, 2000). It consists of the presentation of auditory stimuli (monosyllables at the standard frequency of the human voice of 2000 Hz) to both ears simultaneously, using a headset connected to a computer and reproduced by *Windows Media Player* software. This standard Consonant-Vowel DL test has been widely validated through different studies (Hugdahl, 1995; Hugdahl, Carlsson, Uvebrant, & Lundervold, 1997; Hugdahl et al., 2009) and the version used for this study reached a test-retest reliability of .86 (Gadea et al., 2000). Subjects were asked

to report only the syllables which were perceived the most clearly after being informed that they would be presented simultaneously to each ear. The syllables reproduced are TA, KA, GA, PA, BA and DA. At first, they are each paired with themselves in order to check that the individuals are able to recognize them with no problems. All syllables are then paired between themselves, forming 60 pairs (30 initial and homonyms, for example KA-GA, GA-KA). These combinations are made so that each syllable of the pair is heard by each ear, subjects being instructed to verbalize aloud what they hear. Scoring is carried out by taking into account which of the two syllables, presented at the same time, is identified and correctly pronounced. Finally, the number of syllables pronounced in each ear is counted, resulting in two final scores, one for the right ear and one for the left.

Edinburgh Handedness Inventory (Oldfield, 1971): This test assesses handedness through the use of 10 everyday tools (knife, spoon, ball, box, etc.). A laterality quotient was calculated in order to classify subjects according to their handedness: $[(R-L)/(R+L)] \times 100$ (R: right, L: left). Ambidextrous people would get a score ranging between -70 and +70; left-handed subjects in a range between -100 and -71 and, finally, right-handed people between +71 and +100. Dragovic (2004) established these cutoff points depending on statistical criteria.

Empathy Quotient (EQ-60) (Allison et al., 2011; Baron-Cohen & Wheelwright, 2004): The EQ-60 is a self-report questionnaire sensitive to differences in empathy in the clinical and general population which is considered to be an appropriate measure of this construct. It consists of 60 items related to everyday situations and possible responses ranging from 0 (*strongly agree*) to 3 (*strongly disagree*). A score of between 33 and 52 is considered to be within the established measure. Those who obtain scores close to 80 (highest score) are considered "extremely sympathetic". In contrast, an approximate rating of 19 or 20 is considered an average value in people with high functioning ASD (Lawrence et al., 2004).

Procedure

Subjects signed an informed consent form and the study was carried out in accordance with the ethical standards in human research, contained in the Helsinki Declaration of 1975, as revised in 2000. Before the DL test was performed, an audiometry of each of the subjects was carried out in order to check that they showed no hearing loss in the speech frequency (2000 Hz). Only those who met the audiometric inclusion criteria (<10 dB difference between ears 500, 1000, 2000, 3000 and 6000 Hz) were selected. The Edinburgh Handedness Inventory and Empathy Quotient were administered afterwards.

Data analysis

We conducted a 2x2 Mixed ANOVA (ear as an intra-subjects variable and gender as a between subjects variable) to explore auditory preference. To analyse the measures of EQ-60 the sample was divided into two subgroups: fathers and mothers, and we performed a *t test* for independent samples. We obtained Pearson correlation coefficients to relate the scores for the right and left ears, both for the total sample and for the two subgroups. Analysis of data was performed using the SPSS computer statistical program 19.

Results

There was a significant advantage of the right ear as compared to the left in all cases, $F(1, 23) = 42.77$, $MSE = 1717.385$, $p < .001$. As for the variable gender and the interaction between the variables ear and gender, no significant differences were observed, $F(1, 23) = 2.318$, $MSE = 93,065$, $p = .142$. In the total sample, the correlation between the data from both ears was non-significant ($r = -0.375$, $p = 0.065$). When we divided the sample by gender we found the same pattern in the group of fathers ($r = -0.209$, $p = 0.515$), while in the group of mothers, results from the right ear showed a significant negative correlation with those from the left ear ($r = -0.612$, $p < 0.05$).

According to the Inventory of handedness, all subjects included in the sample were totally or preferably right-handed with the exception of one mother who was left-handed and a father and a mother who were ambidextrous.

The results found in the EQ-60 were within the average population for both mothers ($M = 46.31$, $SD = 14.64$, range = 15 to 67) and fathers ($M = 40.83$, $SD = 7.02$, range = 29 to 51) and no significant differences were observed between either subgroup. However, some extreme values below means were obtained (two mothers and two fathers).

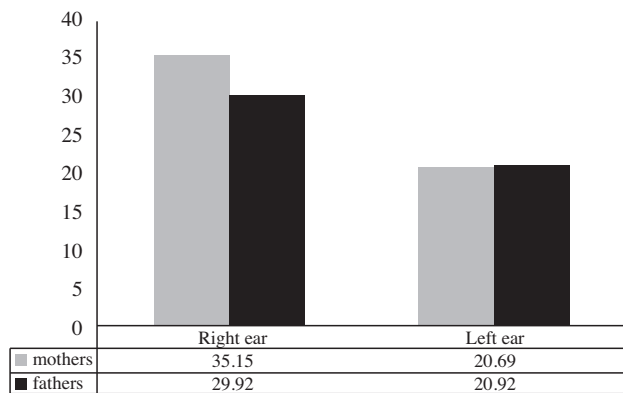


Figure 1. Mean correct responses for both ears obtained for the dichotic listening task

Discussion

Data from the DL test, preference of handedness and EQ-60 test place our sample, when taken as a whole group, within the average parameters of the general population. Dividing the sample according to gender, a negative correlation between data from both ears was found in the group of mothers, as would be expected in the general population (Gadea et al., 2000). These results reveal the presence of hemispheric interdependence in the auditory processing of verbal information. However, in the group of fathers, this relationship was not found, which could indicate a lack of interhemispheric integration of the information. This pattern is observed in the population with a family history of ASD. The physiological basis of these alterations may be explained

by means of theories that refer to cortical hypoconnectivity, according to which, people with ASD would show impairments in the interaction between several brain areas involved in top-down processes of integrating information. The most affected brain zones are the fronto-parietal circuit, the corpus callosum and other areas implicated in language (Kana et al., 2006; Just et al., 2007). Therefore, the data found in the subgroup of fathers from this study would support the existence of some genetic vulnerability in this regard.

With respect to empathy, the data obtained in our sample are within the population mean, except for four of them (two mothers and two fathers), who showed lower scores. However, previous studies show a low degree of empathy among ASD relatives (Baron-Cohen et al., 2006; Sucksmith, Allison, Baron-Cohen, Chakrabarti, & Hoekstra, 2013).

The central focus of the study has been on some characteristics related to the broader phenotype of autism as an indirect marker of a possible vulnerable genome. However, genetics does not always imply inheritance, as the impact of some epigenetics or environmental factors which could be influencing the mutation of certain genetic patterns should be taken into account (Baird et al., 2006; Bernard, Enayati, Roger, Binstock, & Redwood, 2002; Chakrabarti et al., 2009; Freitag, Staal, Klanuck, Duketis, & Waltes, 2010; Gal, Abiri, Reichenberg, Gabis, & Gross, 2011; González-Pardo & Pérez Álvarez, 2013; Maenner & Durkin, 2010; Newschaffer et al., 2007; Ozgen, Hop, Hox, Beemer, & Van Engeland, 2010). In fact, the interaction between the variables that explain the brain asymmetry expressed by fathers could increase the vulnerability of their offspring to the environmental factor impact, such as the action of certain viruses or presence of gonadal axis disruptors (bysphenol-A, phthalates, PCBs, nonyl-phenol and DDT) (Ratajczak, 2011). Multiple investigations have found concordance of between 60 and 90% in monozygotic twins, who share all of their genotype. This may suggest the role of environmental variables in this disorder; otherwise, the correlation between them would be 100% (Freitag et al., 2010; Lichtenstein, Carlström, Råstam, Gillberg, & Anckarsäter, 2010; Muhle, Stephanie, Trentacoste, & Rapin, 2004). The prevalence of neurodevelopmental impairment has increased during the decade of the 90s in more than 500% (Muhle et al., 2004). The reasons attributed to this increase are not clear and could range from the advent of more inclusive diagnostic criteria to the presence of these new epigenetic or environmental factors such as viruses and/or toxics, which could be influencing the mutation of different genetic patterns. In summary, it could be concluded that detecting epigenetic factors could be an interesting issue in the genetics of ASD research.

As a general conclusion, it could be stated that there is a potential genetic basis for language lateralization abnormalities in autism populations, although, due to the small sample size and lack of controls, our results could be considered a pilot study.

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