Abstract

The present meta-analysis surveyed the literature on the neurological foci that have been associated with the autism spectrum disorder (ASD) in order to align those foci with the known cognitive functions and dysfunctions of those brain areas. Additionally, with the forthcoming fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), American Psychological Association (APA), 2011), the present paper used the proposed DSM-5 diagnostic criteria for ASD as part of the alignment with known cognitive functions and dysfunctions. To date, the authors were unaware of any meta-analysis that has aggregated studies investigating the neural bases for aberrant behaviors associated with ASD using any DSM version or the proposed DSM-5 diagnostic criteria for ASD. Thus, this paper intends to conglomerate all current, salient research that has assessed the neurological foundations of ASD.

Introduction

The DSM-5 (see American Psychiatric Association [APA], 2011) is expected to combine the current DSM-IV-TR (APA, 2000) diagnoses of autistic disorder, Asperger’s disorder, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified under a single category, autism spectrum disorder (ASD). APA’s website specifies that the rationale for the combination for these four disorders is that literature regarding their differentiation has been unreliable (APA, 2011). Additionally, it states the combination of these disorders into ASD in the DSM-5 was subject to common diagnostic symptomatology, with individual differences expressed in degrees of severity. Thus, an ASD diagnosis in the DSM-5 will include a level of severity, ranging from Level 1 (Requiring support) to Level 3 (requiring very substantial support) with diagnosable behaviors in two domains: (1) social communication and (2) restricted interests and repetitive behaviors (APA, 2011).

The first domain, persistent deficits in social communication and social interaction, is proposed to consist of three criteria: (1) deficits in social-emotional reciprocity, (2) nonverbal communicative behaviors, and (3) difficulty in establishing and maintaining peer relationships; all three criteria will be necessary for a diagnosis of ASD. The second domain, repetitive patterns of behavior, is proposed to require two of the following four diagnosable patterns of behavior for a diagnosis of ASD: (1) stereotypes in speech and motor movements, (2) ritualized patterns of behavior and the inability to vary in response to (3) fixed interests, and (4) hyper- or hypo-sensitivity to environmental stimuli.

The current paper illustrates the neurological dysfunctions found in persons with an ASD diagnosis. Specific neurological foci implicated with ASD have been aligned according to these seven DSM-5 (APA, 2011), proposed diagnostic criteria. Additionally, these specific cognitive functions and dysfunctions have been linked to their respective neurological foci and neural connections, which in turn, were connected to their particular behavioral manifestations in ASD.

Method

For each diagnostic criterion, a separate meta-analysis was conducted using distinct keywords in the Boolean search for the available literature. For example, the keywords “Asperger” “childhood disintegrative disorder” “autism.” “PDD-NOS” “MRD,” “PET,” “neuro,” “social,” “emotional,” and “reciprocity” were input into a Boolean search using multiple combinations of these keywords for the criterion of deficits in social-emotional reciprocity. In addition, references cited for each category were also examined (hand searched).

Coding the Data

Articles which used appropriate controls in their data analysis were included in the current study. Additionally, measures of effect size, p values, confidence intervals, sample size, and measures of variance were recorded.

Inclusion Criteria

Studies were selected and agreed by authors through initially reviewing abstracts and fulfilling of the appropriate inclusion criteria: original studies, studies published before 2011, studies with healthy controls (diagnosis of a control group, and standard neuropsychological and cognitive testing methods. Articles were excluded if participants were simultaneously diagnosed with additional psychopathologies besides ASD or if identical samples were used in earlier studies.

Preliminary Results

Table 1

<table>
<thead>
<tr>
<th>Neurological Foci Associated with DSM-Ill-Diagnostic Criteria for ASD</th>
</tr>
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<tbody>
<tr>
<td>General Abnormalities</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Increased Gray Matter Density</td>
</tr>
<tr>
<td>Left Inferior Frontal Gyrus</td>
</tr>
<tr>
<td>Right Superior Frontal Gyrus</td>
</tr>
<tr>
<td>Hypothesized Foci</td>
</tr>
</tbody>
</table>

Hypotheses

It was hypothesized that specific regions of interest within the brain would be associated with behavioral manifestations of ASD. For example, perseverative errors, which have been associated with execution functions of the frontal lobe, were hypothesized to show differences between persons with ASD and persons with no evident developmental disorders. Additionally, even though neurodevelopmental correlates within the studied sample have been extensively, a large scale systematic review of the literature and meta-analysis has not been conducted to date. Therefore, the current meta-analysis allowed for less stringent exclusion criteria, leaving an overarching, non-specific hypothesis that there are general aberrations within the brain of persons afflicted with an ASD.

Conclusions

This meta-analysis illustrates that multiple neural foci are involved in cognitive functions and disorder, for ASD. Table 1 presents the seven ASD criteria and their associated anatomical brain region variations, as well as the general aberrations not specifically linked to these diagnostic criteria. The modality, persistent deficits in social communication and social interaction, has been largely studied as evidenced by the number of studies investigating neural foci of the three diagnostic criteria. The second modality, repetitive patterns of behavior, has been less intensely examined. The third modality, social-emotional reciprocity, may simply be an artifact of a more narrow representation of the listed criteria. The neural networks associated with the specific criteria of this modality may simply utilize fewer cortical structures than the first modality. The present findings suggest that more emphasis be focused upon the neurological underpinnings of stereotypes in speech and motor movements, ritualized patterns of behavior and the inability to vary in response to, fixed interests, and hyper- or hypo-sensitivity to environmental stimuli in ASD. Additionally, same specific regions (e.g., anterior cingulate cortex) affect multiple diagnostic criteria (e.g., social-emotion reciprocity and peer relationships). Furthermore, the anterior cingulate cortex was shown to contain increased gray matter density over control groups with varying in this region may affect ASD more than others. Many studies have also found disrupted interconnectivities within the brain, which also affects many of the diagnostic criteria (e.g., communication, flexibility, perseverative errors).

ASD is a neurological disorder that presents itself with deficits in social communication and repetitive patterns of behavior. The findings of this meta-analysis show that ASD is a global disorder with multiple neural foci, and there is evidence that there is disruption in the connectivity among these foci. Future ASD neurological studies should assess the interconnectivity of the brain regions found in this meta-analysis for disruptions and examine other possible neural underpinnings to the diagnostic criteria.

References


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