Descriptive Analysis of Social Interaction and Communication Skills of Autistic Children According to Sibling Status and Characteristics

Se Yeon Kim¹,², Da-Yea Song¹,², Guiyoung Bong¹,², Jae Hyun Han¹,², and Hee Jeong Yoo¹,²

¹Department of Psychiatry, Seoul National University Bundang Hospital, Seongnam, Republic of Korea
²Department of Psychiatry, Seoul National University College of Medicine, Seoul, Republic of Korea

Objective Sibling relationships in early childhood can have a positive impact on children's social interaction and communication skills. Similarly, autistic children can benefit from interactions with their siblings, who can serve as readily available partners for social interaction. However, there is a lack of research on the effects of siblings based on specific characteristics of the sibling. Therefore, the aim of this study is to compare social interactions and communication skills of autistic children based on sibling status and characteristics.

Methods We conducted a retrospective data review involving 895 autistic children and their siblings at Seoul National University Bundang Hospital. Variety of diagnostic assessments or questionnaires were administered. Based on the characteristics of the data, Quade's test for nonparametric analysis of covariance was used to compare autism-related symptoms and levels of functioning of the autistic child according to 1) sibling status, 2) birth order, 3) sex, and 4) diagnosis of the sibling. Pearson correlation was used to explore associations between the sibling age gap and different clinical scores.

Results Having siblings was associated with fewer difficulties in restricted and repetitive behaviors. Based on the comparison of the Autism Diagnostic Interview-Revised scores, autistic children with multiple siblings demonstrated better nonverbal behaviors. Autistic children with autistic siblings experienced greater difficulties in social interactions and communications, such as peer relationships, sharing enjoyment, and engaging in social imitative play.

Conclusion The study revealed differences in social interactions and communication skills of autistic children based on sibling status, birth order, affected sibling, age gap, and sex.

Keywords Autism spectrum disorder; Restricted and repetitive behaviors; Nonverbal communication; Social interaction; Sibling.
comfortable setting. Studies have demonstrated that older siblings can positively influence the cognitive, academic, and communication skills of autistic children, as well as their social playing skills. Additionally, autistic children have shown more initiation responses from their siblings compared to their parents, indicating that siblings can serve as a promising source of social interaction improvement. Moreover, specific characteristics of siblings have been linked to distinct social skill development in autistic children and other psychiatric disorders. According to Ben-Itzchak et al., individuals with older siblings exhibited better social communication skills and adaptive behaviors compared to those without siblings. Similarly, a study done by Montes demonstrated that those with older siblings were less likely to experience mental health or behavioral problems. Having multiple siblings was associated with better social skills due to the increased opportunities for imitation and social interaction, yet the sex of the sibling appeared to have no significant impact on the social functioning of the autistic child. Furthermore, a meta-analysis by Cuskelly et al. delved into the influence of siblings on autistic children. Interestingly, while some studies, like Matthews et al., revealed the benefits of having an older sibling in terms of tasks involving false beliefs or nonverbal tasks, others, such as one by Brewton et al., demonstrated that the adaptive skills were associated with the social skills of the autistic child. In summary, existing research has explored how siblings affect social skills in autistic children, although it has been somewhat limited in the range of variables examined. More notably, inconsistencies in the results have emerged. Some potential explanations for these discrepancies include, include the utilization of different outcome measures evaluated by different diagnostic tools, uncertainties surrounding the diagnosis of certain participants, and the relatively small size of study population. To address these limitations, we designed this study as a single-center investigation involving over 400 participants who were assessed using consistent diagnostic criteria. Our aim was to explore various sibling variables and their effects on the social functioning of autistic children.

This current study aims to examine the manifestation of symptoms in autistic children based on sibling status, birth order, sex, sibling’s diagnosis of autism, and age gap. The study hypothesized that autism-related symptoms, measured by various clinical assessment tools, will differ according to these sibling characteristics. First, given that sibling interaction provides opportunities for social imitation and the practice of play skills, we anticipate that the group with siblings will show less difficulties in social skills compared to autistic children without siblings. Second, children with older siblings, who are expected to show proactive behavior to younger siblings, are likely to present better social communication and interaction skills. Third, similar to previous studies, the sex of the siblings will not significantly affect the social skill development of the autistic child. Fourth, being a “concordant pair,” the case in which the sibling is also diagnosed with autism, may limit active sibling interactions involving identifying social cues, responses, imitation, and/or joint attention. Lastly, sibling pairs with smaller age gaps will be associated with better social interaction skills, as closer age proximity would mean that the sibling may share similar levels of maturity with common interests or day-to-day activities.

METHODS

Participants

This was a retrospective study that included 895 autistic children and their siblings, aged between 2 and 13 years, who were part of a larger genetic study conducted at Seoul National University Bundang Hospital. Various questionnaires were sent via post prior to the appointment and collected during the families’ visit to the clinic, where diagnostic and various examinations to measure the level of functioning (i.e., intelligence) were administered. The same evaluation process was conducted for both the autistic child and their sibling. The diagnostic assessments, including the Autism Diagnostic Observation Schedule (ADOS or ADOS-2) and the Autism Diagnostic Interview-Revised (ADI-R), were administered by trained researchers. All the evaluations were video-recorded and reviewed for reliability and supervision. Based on all the acquired information, child and adolescent psychiatrists confirmed the diagnosis using the best clinical estimate diagnosis. The use of fully anonymous data for this study was approved by the Institutional Review Board at Seoul National University Bundang Hospital (IRB no: B-2301-807-102).

Measures

ADI-R

The ADI-R is a structured caregiver interview used to diagnose autism. The interview consists of four large domains and subdomains: reciprocal social interaction (use of nonverbal behaviors, peer relationships, shared enjoyment, socio-emotional reciprocity), communication (nonverbal: use of gestures, play skills: verbal: conversational interchange, stereotypes or idiosyncratic speech), RRBs (circumscribed pattern of interest, routines or rituals, stereotyped or repetitive motor movements, preoccupations with part of objects), and the presence of abnormal behavior before 36 months. The verbal and nonverbal domains are evaluated separately, based on the expressive language skills of the child. Higher scores on
the ADI-R indicate greater severity of autism.

**ADOS-2**

ADOS-2 is a standardized observational assessment used to evaluate social interaction and communicative skills of a child. Trained administrators interact with the child, and there are five different modules based on age and expressive language ability. Each module has its own diagnostic algorithm, and the calibrated severity scales (CSS) are used for comparison between different modules, ranging from 1 to 10. The summation of the two domains, social affect (SA) and RRB, results in a total score. Higher ADOS-2 SA, RRB, and total CSS scores indicate greater symptom severity.

**Vineland Adaptive Behavior Scale, Second Edition**

The Vineland Adaptive Behavior Scale, Second Edition (VABS-II) is a parent-rating questionnaire that measures adaptive functioning. It includes four domains: communication, daily living skills, socialization, and motor skills. A total composite score is calculated based on these domains. Higher scores on the VABS-II indicate better adaptive behavior, while lower scores may suggest developmental delay.

**Social Communication Questionnaire**

The Social Communication Questionnaire (SCQ) is a caregiver-completed questionnaire with 40 questions. Higher scores on the SCQ indicate greater symptom severity. While there are two versions of the questionnaire, the current version, which asks caregivers to base the ratings on the past three months, was utilized. In this study, the Korean translated and validated version of the SCQ was used.

**Child development questionnaire**

To obtain information on the child’s developmental history, the research team created a questionnaire to gather information about perinatal and prenatal factors. This questionnaire, completed by parents, asked about events during pregnancy (e.g., age of parents, complications, illnesses, and medication use) and after birth (e.g., newborn conditions, post-birth treatments, history of education and interventions). For this study, only the question items regarding the child’s sibling status and birth order were used.

**Data analysis**

Based on the child development questionnaire, autistic children were grouped according to sibling status (i.e., no sibling, sibling) and birth order (i.e., older sibling, younger sibling, twin, or having multiple siblings). Basic demographics of autistic children based on sibling groupings were compared using independent t-tests or univariate analysis of covariance for continuous variables (i.e., age) and chi-square for categorical variables (i.e., sex). Clinical characteristics represented by the autistic child’s total or domain scores of the ADI-R, ADOS-2, VABS-II, and SCQ were compared according to sibling status and birth order. Given the non-normal distribution of dependent variables based on Shaprio–Wilk and the violations of homogeneity of variances or homogeneity of regression slopes, nonparametric tests were performed. Quade’s rank of covariance was used to explore group differences while controlling for the age of the autistic child. The same analyses were performed according to the sibling’s diagnostic status (concordant and non-concordant pairs) and the sibling’s sex. For both the comparison based on sibling status or sibling characteristics (e.g., birth order, sex, autism diagnostic status), the subdomain and individual item analyses of the ADI-R were further explored when there was significant score differences between groups in the preceding domain. Our analysis focused on the ADI-R because of its detailed breakdown into subdomains and individual items. By doing so, specific analysis of individual actions and behaviors could be analyzed in greater detail. Post-hoc analyses were conducted to identify specific differences between groups. Pearson correlation was used to explore potential associations between sibling age gap and ADI-R scores. Statistical analyses were performed using IBM SPSS version 26.0 (IBM Corp., Armonk, NY, USA).

**RESULTS**

Our study included 895 children ranging from 2 to 13 years old, and the majority of participants were male (81.3%). Among the children, 51.0% had siblings, with 37.2% having older siblings, 39.9% having younger siblings, 8.1% being twins, and 14.7% having multiple siblings. Autistic children who had siblings diagnosed with autism were analyzed as a separate subgroup. The participant demographics are presented in Table 1.
providing further details.

In terms of the ADOS-2, there were no significant differences in ADOS-2 total CSS, social affect CSS or RRB CSS scores. However, in terms of ADI-R scores, autistic children with siblings scored higher in social interaction domain ($F=3.013$, $p=0.038$), while they scored lower in RRB domain ($F=4.079$, $p=0.044$). Further subdomain analysis of the RRB domain revealed significant differences in preoccupation and unique interests ($F=5.370$, $p=0.021$), as well as routine following ($F=4.957$, $p=0.027$) (Table 2) with children with siblings scoring lower than children without siblings.

When analyzing ADI-R subdomains under the social interaction domain according to sibling birth order, it was found that those with multiple siblings performed better in using nonverbal behaviors compared to those with twin siblings ($F=3.791$, $p=0.005$) and when analyzed by items, those with younger siblings performed better in eye contact ($F=2.683$, $p=0.031$) and social smiling ($F=3.948$, $p=0.003$) compared to twins. Sharing enjoyment abilities were better in those with younger siblings ($F=3.473$, $p=0.008$) compared to those with twin siblings. In terms of items, those with younger siblings were best at showing and directing attention ($F=5.131$, $p<0.001$). Socioemotional reciprocity was also best seen in those with younger siblings ($F=2.458$, $p=0.044$) compared to twin siblings. When analyzing socioemotional reciprocity by breaking it down into items, children with younger siblings were best at using other’s body to communicate ($F=4.132$, $p=0.003$) and quality of social overtures ($F=4.196$, $p=0.002$). When analyzing communication skills of autistic children, instrumental gesture ($F=2.452$, $p=0.045$) were also found to be better in autistic children with younger siblings than those with older siblings (Table 3).

When analyzing the data based on the autism spectrum disorder (ASD) diagnostic status of the sibling, it was found that autistic children with siblings who were also autistic scored higher in the social interaction domain ($F=8.541$, $p=0.004$). This difference was seen in subdomains such as peer relationships ($F=7.458$, $p=0.006$), sharing enjoyment ($F=8.625$, $p=0.003$), and socioemotional reciprocity ($F=5.458$, $p=0.020$). In the communication domain, probands with autistic siblings

<table>
<thead>
<tr>
<th>Table 2. Clinical scores according to sibling status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>ADOS-2 total CSS</td>
</tr>
<tr>
<td>Social affect CSS</td>
</tr>
<tr>
<td>RRB CSS</td>
</tr>
<tr>
<td>ADI-R social interaction domain</td>
</tr>
<tr>
<td>Use of nonverbal behaviors</td>
</tr>
<tr>
<td>Peer relationships</td>
</tr>
<tr>
<td>Shared enjoyment</td>
</tr>
<tr>
<td>Socioemotional reciprocity</td>
</tr>
<tr>
<td>ADI-R communication domain</td>
</tr>
<tr>
<td>Use of gestures</td>
</tr>
<tr>
<td>Play skills</td>
</tr>
<tr>
<td>ADI-R RRB domain</td>
</tr>
<tr>
<td>Circumscribed patterns of interests</td>
</tr>
<tr>
<td>Adherences to routines or rituals</td>
</tr>
<tr>
<td>Stereotyped or repetitive motor movements</td>
</tr>
<tr>
<td>Preoccupations with part of objects</td>
</tr>
<tr>
<td>VABS-II total scores</td>
</tr>
<tr>
<td>Communication skills</td>
</tr>
<tr>
<td>Socialization skills</td>
</tr>
<tr>
<td>Daily living skills</td>
</tr>
<tr>
<td>Motor skills</td>
</tr>
<tr>
<td>SCQ current</td>
</tr>
</tbody>
</table>

Values are presented as mean±standard deviation. *p<0.05. ADOS-2, Autism Diagnostic Observation Schedule; CSS, Calibrated Severity Score; ADI-R, Autism Diagnostic Interview-Revised; RRB, repetitive, restricted behaviors; VABS-II, Vineland Adaptive Behavior Scale, Second Edition; SCQ, Social Communication Questionnaire.
showed greater deficits in social imitative play ($F=13.463$, $p<0.001$) (Table 4).

Additional analysis was conducted based on sibling sex and age gap. The scores on the ADI-R, ADOS-2, VABS-II, and SCQ did not differ according to the sex homogeneity of the sibling (Supplementary Table 1 in the online-only Data Supplement). However, a greater age gap with the sibling was negatively correlated with higher scores in the ADI-R social interaction ($r=-0.264$, $p<0.001$) and ADI-R verbal communication ($r=-0.293$, $p<0.001$) domains (Supplementary Table 2 in the online-only Data Supplement).

**DISCUSSION**

This retrospective cohort study aimed to explore the social skills of autistic children according to sibling status and characteristics such as birth order or the affected status of the sibling.

One of the primary findings of this study was that autistic children with siblings showed fewer difficulties RRBs. These findings are consistent with previous studies that have highlighted the positive influence of typically developing siblings on the social communication and social responsiveness of autistic children in various environments, including intervention and natural settings such as home or school.21-23 Autistic children often lack opportunities to interact with peers, making siblings crucial partners for practicing social skills.

In terms of RRB, RRBs are considered an inherent diagnostic feature of autism, and preoccupations or unique interests are thought to be less influenced by social or environmental factors. However, our study found that autistic children with siblings exhibited fewer RRBs on both evaluation scales of ADI-R and ADOS-2. While the interaction with siblings itself may contribute to reducing these behaviors, it is also possible that a change in parenting style associated with having multiple children could influence how children adhere to routines and schedules. A previous study by Gass et al.24 revealed that parents who had raised an older typically developing child exhibited lower levels of anxiety in their parenting styles. Stressful
or authoritative parenting style have been associated with increased child anxiety, and some studies have suggested a link between higher anxiety levels and more pronounced RRBs. Therefore, considering that parenting style can affect the autistic child's stress levels, there may be a correlation between parenting style and the severity of RRBs. Furthermore, RRBs not only impact the autistic individual but also require family accommodation behaviors (FAB). FABs encompass the actions taken by the family to help the autistic child adjust to their environment by implementing routines that assist the child in coping with different situations. FAB often necessitate modifying family plans and interests to support the affected child and require substantial effort from all family members. Such accommodations may pose challenges in families with multiple children, potentially requiring the autistic child to adapt to situations where RRBs cannot be carried out.

When exploring the relationship between specific social skills and sibling birth order, we found that difficulties in nonverbal behaviors were most prevalent in children with twin siblings and least prevalent in children with multiple siblings. For those with younger siblings, it is possible that the close proximity between the social age of autistic child and the chronological age of the younger sibling provided an opportunity for the autistic child to learn from a similar level of social maturity. While for children with older siblings, as one by Ben-Itzchak et al. have also emphasized, older siblings may help in terms of communication and adjustment to socially stressful settings. While having a twin sibling, the unaffected sibling may be much more mature socially, but at the same time may not be mature enough to provide a positive influence as older siblings do. Furthermore, through item analysis it was found that children with younger unaffected siblings showed less deficits in enjoyment sharing and socioemotional reciprocity compared to those with older siblings. However, interestingly, when including the group with no siblings, those with no siblings performed better in nonverbal behavior, enjoyment sharing and socioemotional reciprocity than children with older siblings. This may perhaps be due to greater investment and emotional support given to the only child compared to those with older siblings. Further research is suggested in child investment patterns of single versus multiple children families.

The comparison of concordant to non-concordant pairs revealed differences in social interactions and communic-
tion, such as sharing enjoyment and social imitation. Sharing enjoyment and imitation require mutual interest, and having a less social sibling may hinder the development of mutual interest by providing fewer opportunities for imitation and practicing sharing enjoyment. These results align with a previous study that highlighted the lack of imitation in pairs of autistic children due to deficits in joint attention.26 Furthermore, concordant pairs are more likely to be syndromic, where the autistic presentation is caused by a chromosomal abnormality. Autistic children with syndromic autism, such as Fragile X syndrome or tuberous sclerosis, are likely to have other conditions, such as intellectual disability, which further present challenges in developing social skills.27

In alignment with the findings of the study conducted by Ben-Itzchak et al.,10 the sex of the sibling did not influence the social functioning of the autistic child. A larger age gap was correlated with lower ADI-R scores. However, interpretation of these results should be done with caution as we did not analyze the age gap according to the birth order of the sibling. For instance, when the age gap of the autistic child and sibling is smaller, both participants are expected to be at a similar level of development and so when the autistic child shows delay in development, this difference could be exaggerated due to direct comparisons in parental reports. On the other hand, when the age gap between the autistic child and sibling is larger, the comparison between the two participants may be less pronounced. For future studies, it may be more helpful to analyze the age gap based on the birth order of siblings.

This study is novel in its approach to exploring multiple sibling characteristics and their effects on social functioning of autistic children, which may pave the way for more individualized sibling-mediated interventions. However, it also has several limitations. First, the study heavily relied on caregiver-reported results, which are susceptible to overestimation or underestimation of their children's abilities and are prone to recall bias. Secondly, as mentioned earlier, the heterogeneity of the study population necessitates further analysis after classifying them into subgroups based on other traits, such as language ability or comorbidities. Thirdly, a larger sample population would be beneficial to accurately examine the results of concordant sibling pairs. Finally, a longitudinal analysis of the sibling pairs could provide valuable insight into how sibling relationships evolve over time and how these changes influence both the autistic child and their siblings.

This study explored how siblings and four different characteristics of siblings including birth order, affected status, sex, and age gap, are associated with the social functioning and communication skills of autistic children. As hypothesized social skills differed according to sibling status and ASD diagnosis status of the sibling. In addition, as expected social skills did not differ according to the sex of siblings. However, while the study hypothesized children with older siblings to show less deficits in social skills similar to previous studies, in our study, children with younger, older, and multiple siblings displayed better outcomes compared to twin siblings, especially nonverbal behaviors. In terms of age gap, unlike the hypothesis, larger age gap was associated with better results in social skills. This may be due to several reasons, one of which is that the optimal age gap may be different for children of different age ranges. The optimal age gap may be different for children of different age ranges. Nonetheless, the findings suggest that siblings may offer opportunities to enhance social and communication skills in autistic children. Based on these results, we urge clinicians to consider providing more individualized sibling interventions for autistic children, involving their siblings, and encourage researchers to investigate the long-term influences of such interventions.

Supplementary Materials
The online-only Data Supplement is available with this article at https://doi.org/10.30773/pi.2023.0209.

Availability of Data and Material
The datasets generated or analyzed during the study are not publicly available as the IRB approved the data to be used within the research team but could be available from the corresponding author on reasonable request.

Conflicts of Interest
The authors have no potential conflicts of interest to disclose.

Author Contributions

ORCID iDs
Se Yeon Kim https://orcid.org/0009-0004-8595-2509
Da-Yea Song https://orcid.org/0000-0002-7144-4739
Guiyoung Bong https://orcid.org/0000-0001-8630-9399
Jae Hyun Han https://orcid.org/0000-0003-3994-3463
Hee Jeong Yoo https://orcid.org/0000-0003-0521-2718

Funding Statement
This research was supported by the Bio & Medical Technology Development Program of the National Research Foundation (NRF), funded by the Korean government (MSIT) (No. 2021M3E5D9021878).

REFERENCES
2. Lee HJ, Cho S. Sibling relationships and children's social competence.
16. Lops EB. The role of the sibling experience in the social development of children with high functioning autism spectrum disorder (HFA/ASD) [dissertation]. Orono: The University of Maine; 2015.