Examining Phenotypical Heterogeneity and its Underlying Factors in Gesture Skills of Chinese Autistic Children: Clustering Analysis

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Autistic children exhibit individual variations in verbal and nonverbal skills. The heterogeneity of speech ability in autism is well documented (Song et al., 2021; Wittke et al., 2017), but few studies have studied the heterogeneity of gesture production ability in autistic children. It is commonly found that gestures and speech are integrated into a single system (McNeill, 1992, 2005). We may speculate that gesture use is related to the heterogeneity of language ability in autistic children.

The present study aimed to identify subgroups of autistic children who displayed heterogeneous gesture production abilities and explore the underlying factors, including autism characteristics, intellectual ability, and speech ability, that were associated with the heterogeneity. A total of 65 Chinese autistic children (mean age = 5;3) participated. Their autism characteristics and intellectual ability were assessed using standardized measurements. Language output and gesture production were captured from a parent-child interaction task. We calculated the mean length of utterance (MLU) of children's language output as an indicator of speech ability. We conducted a hierarchical cluster analysis and identified four distinct clusters. The elbow method graph (See Figure 1) showed that the four-cluster option had the smallest within-cluster variance. Figure 2 shows the individual cases in four clusters. Figure 3 visually displays autism severity, intellectual ability, speech, and gesture profiles by subgroups on standardized scores. ANOVA shows that the main effects of all assessments were significantly different among the four clusters (See Table 1). Tukey's HSD post-hoc was conducted to compare variables between any two of the clusters.

• Cluster 1: Children with high levels of autism characteristics, low intellectual ability, low language ability, and low gesture production.

• Cluster 2: Children with moderate levels of autism characteristics, high intellectual ability, high language ability, and low gesture production.

• Clusters 3 and 4: Children with low levels of autism characteristics, moderate intellectual ability, and high gesture production; children in Cluster 4 have higher language ability than those in Cluster 3.

Tukey's HSD post-hoc results showed that Cluster 1 and Cluster 2 both had low gesture production whereas Cluster 3 and Cluster 4 had high gesture production. Both Clusters 1 and 2 had relatively strong autism characteristics, in comparison to Clusters 3 and 4. Thus, children with stronger autism characteristics may gesture less often than those with weaker characteristics. Our findings did not show a clear relationship between language output and gesture production. For example, children in Clusters 2 and 4 (who exhibited large spoken outputs) had diverse gesture rates. Regarding intellectual ability, our study did not find it to be linearly related to gesture production. Children with low and high intellectual ability (Clusters 1 and 2) had a lower gesture rate than those with moderate intellectual ability (Clusters 3 and 4). These findings shed light on the directions of intervention on gesture production for autistic children, especially those with stronger autism characteristics.

Index Terms: autism spectrum disorder, heterogeneity, cluster analysis

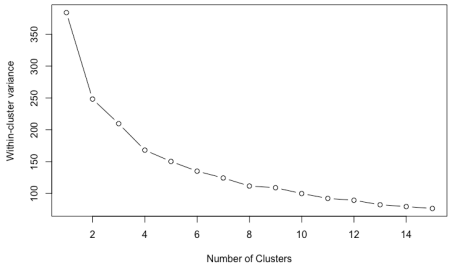

Figure 1. *Elbow method graph shows that the four-cluster solution exhibited significantly smaller within-cluster variance than both the three-cluster solution and the five-cluster solution.*

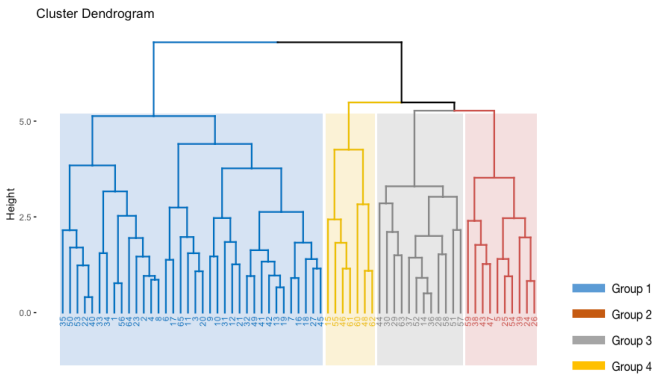

Figure 2. *Dendrogram of hierarchical clustering*

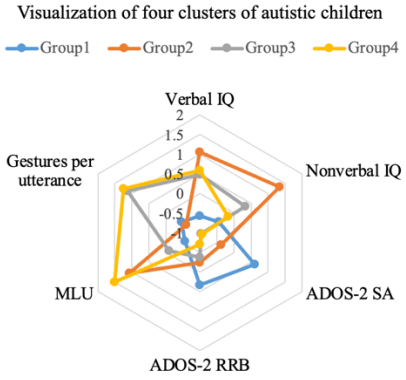

Figure 3. *Radar plot for the means of z-scores*

Table 1. *The ANOVA test for scores of ADOS-2, IQ, language ability, and gesture ability in four clusters*

	Cluster1 (n = 36)		Cluster2 (n = 10)		Cluster3 (n = 12)		Cluster4 (n = 7)		F-value	p-value
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*		
Age in months	63.58	16.91	62.7	9.62	61.58	16.48	70.43	18.81	0.49	0.694
Verbal IQ	75.67	20.56	117.1	19.25	102.67	19.24	105.29	12.00	16.14	<0.001
Nonverbal IQ	79.06	19.84	126	17.29	99.42	23.04	86.43	22.30	14.78	<0.001
Overall IQ	75.39	20.43	122.8	17.45	102.58	20.02	100.71	18.11	18.11	<0.001
ADOS-2 SA	13.75	4.88	8	4.19	4.5	2.47	4.71	2.69	20.32	<0.001
ADOS-2 RRB	2.67	2.23	1.5	1.72	1.25	1.29	0.57	0.79	3.61	0.018
ADOS comparison score	7.53	2.48	5.4	2.99	3	1.76	3.14	1.86	14.63	<0.001
MLU	2.09	0.54	3.50	0.53	2.49	0.49	3.88	0.73	31.72	<0.001
Gestures per utterance	0.05	0.05	0.03	0.02	0.21	0.08	0.22	0.14	27.44	<0.001

Notes: ADOS-2 autism diagnostic observation scale-second edition, SA social affect, RRB restrictive and repetitive behaviors.

References

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