The Development of Gesture Skills in Chinese Autistic Children: The Predictive Roles of Age and Language Ability

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Gestures are spontaneous hand and head movements produced while speaking (McNeill, 1992). Gesture delay in autistic infants and toddlers has been widely reported and been considered an early sign of autism diagnosis. However, it is uncertain whether they catch up in terms of gesture production in early childhood. Relatively little research examines the development of gesture production over time and the underlying factors that may affect it. Language development in autistic children is heterogeneous (Song et al., 2021). There is no consensus on the relationship between gesture production and language ability among preschool-age autistic children. The present study aimed to document the development of gesture production in autistic children and examine whether child-based factors (chronological age and initial language skills) predict gesture development.

A total of 33 Chinese-speaking autistic children (M*ean* age = 56.39 months, *SD* = 8.54 months) played with their parents at four time points over a nine-month period. At each time, the child was presented with a standardized set of age-appropriate toys (e.g., train, blocks, puzzle, cash machine, firefighter doll, etc.) and each parent was instructed to play with their child as they normally would at home for 15 minutes. Child-based factors were assessed at first meeting. Their autism characteristics was assessed using Autism Diagnostic Observation Schedule, Second Edition. Mullen Scales of Early Learning was used to measure children's initial expressive and receptive language ability. Their gestures were coded from parent-child interaction following McNeill's (1992) coding system.

Multilevel modeling analysis was used to measure gesture development and how child-based factors affect it. We aimed to model the growth curve trajectories of gesture production in autistic children and to identify its significant predictors (age, autism characteristics, and receptive and expressive language ability). Predictors were added to the random slope and intercept models, as follows.

Level 1 Model:

$$\text{Child Total Gesture Number}_{tj} = \beta_{0i} + \beta_{1j}(\text{Time}_{tj}) + e_{oj}$$

Model 1 was a null model testing whether there were differences among individuals at the first time point (i.e., Time Zero). If so, we entered the data into Model 2 and Model 3, the two unconditional growth models.

Model 2, the first unconditional growth model, included random intercepts and a fixed slope. It examined whether the time effect was significant for children's gesture performance.

Model 3, the second unconditional growth model, included random intercepts and a slope. It examined whether the time effect was significant and whether there were individual variations in growth.

Level 2 Model:

$$\beta_{0i} = \gamma_{00} + \gamma_{01}\,(\text{Age}) + \gamma_{02}\,(\text{Expressive Language Ability or Receptive Language Ability}) + \gamma_{03}\,(\text{Autism Characteristics}) + r_{oj}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}\,(\text{Age}) + \gamma_{12}\,(\text{Expressive Language Ability or Receptive Language Ability}) + r_{ij}$$

Multilevel modeling analysis showed that the total number of gestures produced by autistic children decreased over time (See Table 1). Among different factors, children's initial age significantly and negatively predicted children's gesture production, while initial language positively predicted children's gesture production (See Table 2). Previous research has shown that gestures are a procurer to language abilities at an early age (Özçalışkan et al., 2016). Our findings revealed that as children grow up, gesture production declines and the speed of the decline could be affected by their age and language abilities. These findings support the suggestion that gesture delay persists in middle childhood and shed light on the difficulties surrounding gesture use in autistic children.

Index Terms: autism spectrum disorder, longitudinal study, gesture development.

Table 1. *Multilevel Modeling Analysis of the Time Effect on Autistic Children's Gesture Use*

	Null model	Unconditional growth models	
Gesture number		Random intercept	Random intercept and slope
	(Model 1)	model (Model 2)	model (Model 3)
Fixed effects	β (*SE*)	β (*SE*)	β (*SE*)
Intercept	-0.00 (0.11)	0.21 (0.15)	0.21 (0.20)
Time	-	-0.14 (0.07) *	-0.14 (0.08)
Random effects	σ2 (*SD*)	σ2 (*SD*)	σ2 (*SD*)
Between-person variance	0.21 (0.45)	0.22 (0.46)	0.89 (0.94)
Time variance	-	-	0.08 (0.29)
Residual variance	0.79 (0.89)	0.75 (0.87)	0.61 (0.78)
Model comparisons			
ICC	0.21	0.22	0.59
Log likelihood	-183.2	-181.0	-174.4
Model 1 vs. Model 2:		$\chi^2(1) = 4.39, p < 0.05$	
Model 1 vs. Model 3:		$\chi^2(1) = 17.74, p < 0.001$	
Model 2 vs. Model 3:		$\chi^2(1) = 13.35, p < 0.01$	

Table 2. *Multilevel Modeling Analyses of Children's Gesture Use (Receptive Language Ability as Predictor)*

Fixed effect	Coefficient	*SE*	Confidence	*t*	*p*
For intercept, β_0					
Intercept, γ_{00}	0.21	0.16	[-0.12, 0.55]	1.31	0.20
Age, γ_{01}	-0.61	0.18	[-0.98, -0.24]	-3.29	0.0024
Receptive language ability, γ_{02}	0.43	0.19	[0.05, 0.81]	2.29	0.028
Autism characteristic, γ_{03}	0.43	0.19	[-0.34, 0.053]	-1.54	0.13
For time slope, β_1					
Intercept, γ_{10}	-0.14	0.07	[-0.28, 0.0034]	-2.04	0.048
Age, γ_{11}	0.21	0.08	[0.05, 0.37]	2.64	0.012
Receptive language ability, γ_{12}	-0.18	0.08	[-0.34, -0.025]	-2.32	0.025

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