Associations among Symbolic Functioning, Joint Attention, Expressive Communication, and Executive Functioning of Children in Rural Areas

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Introduction

Executive functions (EF) involve higher level cognitive skills that allowed adaptability in order for goal-directed behavior (Hughes & Ensor, 2007).

Carlson, Davis, and Leach (2005) suggested that development of symbolic functioning might play an important role on development of EF skills.

14-month-olds' representational abilities (language comprehension and initiating joint attention) predict better EF performance (Miller & Marcovitch, 2015).

The current tested the relationships among symbolic functioning, language expression, joint attention, and EF skills among children in rural areas.

Aims

The current study examined developmental pathways from symbolic functioning to executive functioning for children from rural counties in the United States.

A model including both a direct pathway from symbolic to executive functioning, as well as indirect pathways through joint attention and expressive communication was tested.

Method

Participants: The Family Life Project (https://doi.org/10.3886/ICPSR34602.v4) recruited a large sample (N = 1292) of low-income families in rural counties in Pennsylvania and North Carolina, and collected data during the first three years of children's lives through home visits, childcare visits, and phone calls (Willoughby et al., 2013).

Of 1008 participants included in the present analysis, 50.2% were males and 49.8% were females; 43.4% were African Americans and 56.6% were from other ethnic groups; 77.6% were from lower-income families and 22.4% were from higher-income families.

After the calculated sampling weights were applied, 51.1% were males and 48.9% were females; 23.4 % were African Americans and 76.6% were from other ethnic groups; 65.8% were from lower-income families and 34.2% were from higher-income families.

Measures:

Symbolic functioning. *CSBS DP* infant child checklist symbolic composite (Wetherby & Prizant, 2002) was used. The symbolic composite contained questions regarding children's reaction when the caregiver said his or her name, children's showing of interest in playing variety of objects, and how many objects children used properly when they were 15 months. Children's standard scores were used for the analysis.

Joint attention. Parents were asked read a book with children as they normally would. The procedure was videotaped. Children's behavior, such as their attention to mother, attention to book, and children's joint attention with the reader were coded using Early Attention to Reading System (Feagans, Kipp, & Blood, 1994). The proportion of children's joint attention with the reader was used in our analyses. The inter-rater reliability of the variables ranged from κ = .73 to κ = .85 with average κ = .79 (Garrett-Peters et al., 2008).

Expressive communication. Children's expressive language was assessed by Preschool Language Scale 4th edition (Zimmerman, Steiner, & Pond, 2002). The expressive communication subscale of Preschool Language Scale 4th edition (Vernon-Feagans, Garrett-Peters, Willoughby, Mills-Koonce, & Family Life Project Key Investigators, 2012), was administered when children were 24 months and 36 months old. The internal consistency was good, with Cronbach's alpha = .89 (De Marco & Vernon-Feagans, 2013).

Executive functioning. Five kinds of EF tasks were used when children were 36 months old:

- Working Memory Span (working memory): A child was shown a line drawn of an animal and a colored dot, which were inside of a house outline. The child was then shown an outline of a house and asked to name the animal that had been in the house.
- Animal Go/No-Go (inhibitory control): the child was shown a series of animal pictures, and asked to press a button when seeing animals but not to press the button when seeing a pig.
- Something's the Same (attention shifting):the child was shown two pictures with similarity along one dimension (e.g. same color). A third picture, which was similar to one of the two previous along one dimension (i.e. size or shape), was then shown along with the previous two pictures. The child was then asked which of the two pictures was the same as the third one.
- Silly Sounds Stroop (inhibitory control): the child was presented with a picture with a dog and a cat. The child was asked to imitate the sounds made by a dog when seeing a cat and vice versa.
- Spatial Conflict (inhibitory control): There was a response card with a picture of a car and a boat. Pictures of cars and boats were used as the stimuli. Initially, the pictures of cars were always put right above the car on the response card, while the pictures of boats were put right above the boat on the response card. The child needed to touch the response card in the position spatially correspondent with the stimuli to respond correctly. Then the picture of cars were put right above the boat on the response card, while pictures of boats were put right above the car. The child needed to touch the response card in the position where the picture was not put right above it.

Procedure: A sequence of home visits took place when children were 2, 6, 15, 24, and 36 months old (Willoughby et al., 2013). Home visits lasted about 2 to 3 hours. A variety of interviews, caregiver-child interactions, questionnaires, and direct child assessment were administered.

Analysis: The 7.31 Version of Mplus was used to conduct structural equation modeling with calculated sampling weights. Joint attention and expressive communication were included as mediators while the main focus was on the direct and indirect effects of symbolic functioning on EF.

Results

The measurement model was tested first with 973 participants. The results indicated a good model fit, with CFI = 1.000; RMSEA = .000; and $\chi 2$ = 1.344, p = .93.

The structural model indicated children's symbolic functioning at 15 months was predictive of EF at 36 months directly and indirectly through joint attention at 24 month, expressive communication at 24 months, and expressive communication at 36 months (see figure 1.).

The direct effect of symbolic functioning at 15 months on EF at 36 months was significant (β = .127, p < .05). The indirect effect of symbolic functioning at 15 months on EF at 36 months through joint attention at 24 months was significant (β = .022, p < .05).

There was also a significant indirect effect of symbolic functioning at 15 months on EF at 36 months through joint attention at 24 months, expressive communication at 24 months, and expressive communication at 36 months (β = .008, p < .01). The fit indices suggest a good model fit, $\chi 2$ (22) = 38.406, p < .05, CFI = .975, TLI = .959, and RMSEA = .027.

Children's symbolic functioning in the second year of their lives had a direct positive effect on children's later EF skills when they were 3 years old. Children's joint attention at 2 years and expressive communication at 2 and 3 years partially accounted for how children's early symbolic functioning was related to their own EF 21 months later.

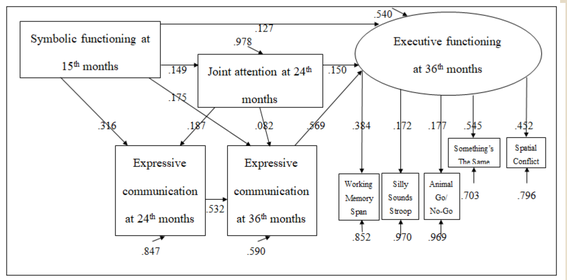

Figure 1. The model showed how symbolic functioning, joint attention, expressive communication, and executive functioning were related to one another. All path coefficients were significant.

Conclusions

Consistent with previous literature, the relationships between the major variables were significant. There was a direct effect of symbolic functioning at 15 months on EF at 36 months.

According to Carlson and Beck (2009), when encountering cognitive interference, symbolic functioning makes control over impulsive response possible and enables reforming of representations of the stimulus, which allows correct responses. Children's symbolic functioning might therefore play an important role on the improvement of EF skills. According to Carlson, Davis, and Leach (2005), psychological distancing might be elicited as children's symbolic functioning develops. Distancing may serve help children cognitively detach from immediate stimuli to prevent pre-potent responses.

Consistent with Quinn and Kidd's (2019) findings, children's symbolic functioning was related to communicative development. 18-month-olds engaged in more joint attention and gesture use during symbolic play than functional play. Because symbolic play requires more communicative exchanges and negotiations of meanings, symbolic play may promote the development of communicative skills. Engaging in activities that required symbolic functioning may provide opportunities for children to practice communicative skills.

The present results were also consistent with previous findings of previous that language abilities and joint attention are related to EF skills (Miller & Marcovitch, 2015).

The results of this study suggest that children's joint attention and expressive communication play a role in explaining the relationship between symbolic functioning and EF. The underlying mechanism should be examined to further understand how EF develops.

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