

## Research Article

# Comprehensive Influence Model of Preschool Children's Personality Development Based on the Bayesian Network

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Received 16 March 2014; Accepted 28 April 2014; Published 11 May 2014

Academic Editor: Caihong Li

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It is crucial to ascertain the comprehensive influence factors on personality for making effective cultivating plan. However, most existing literatures focus on the effect of individual factor on the personality. In order to comprehensively investigate the causal influences of preschool children's temperament, school factors (teacher expectation and peer acceptance), and family factors (parental coparenting style, parental education value, and parental parenting style) on the personality and the probability of the dependencies among these influence factors, we constructed the influencing factor model of personality development based on the Bayesian network. The models not only reflect the influence on personality development as a whole, but also obtain the probability relationships among the factors. Compared with other influence factors including family and school factors, temperament has more effect on the personality. In addition, teacher expectation also has an important influence on the personality. The experimental results show that it is a valuable exploration to construct the Bayesian network for comprehensively investigating the causal relationships between preschool children's personality and related influence factors. Further, these results will be helpful to the cultivation of healthy personality.

## 1. Introduction

The preschool stage is the critical period for the formality of children's personality. Therefore, it is very importantly significant to ascertain influence factors of preschool children's personality for cultivating healthy personality and preventing the mental disease.

Individual development is the result of the interaction between genes and environment. The environment impacts on the mode of the development which depends on the expression of the genes. Genes shape the way of development, and some of them are the product of the environment. Therefore, development had better be understood as the relationship between children and the situation and also be understood as a kind of way where these factors work on the results of children's development, such as the quality of the relationship between teachers and students [1–4]. The influence factors of social withdrawal in childhood include difficulties in social emotion (anxiety, low self-esteem, and

depression), in peer interaction (refusal, deception, and poor friendship quality), and in school (poor relation between teachers and students, learning difficulties, and being tired of learning) [5]. For example, peer relationship plays an important role in personality development, which makes the importance of friendship become obvious. Through obtaining and adapting with the social roles, personality can develop [6, 7].

General parenting style relates to the children's development. Authoritative parenting is beneficial to the lifestyle of teenagers. Under the authoritative parenting, teenagers eat more fruit, smoke less, drink less, and have smaller possibility to have marijuana. Furthermore, they will have better psychological development, have greater academic achievement, commit less crime, and have less physical symptoms [8, 9]. However, Harris thinks that the influence of parents on children is very limited [10].

Grist and McCord's study found that there were correlations between temperament and personality in a sample

of preschool children. Significant correlations were found between the temperament trait surgency and the personality trait extraversion, between the temperament trait negative affect and the personality trait neuroticism, and between the temperament trait effortful control and the personality trait conscientiousness [11]. Rothbart thought that temperament was the foundation of personality; for example, high levels of activity may form extraversion in the subsequent development. The interaction among individual interpersonal communication, life experience, and temperament forms the final personality traits [12].

However, Blatny et al.'s study dealt with the prediction of personality in adulthood from behaviors observed in the nursing and toddler stages. Although relationships between dimensions of child temperament and personality characteristics in adulthood have the expected direction, they are rather weak; for example, child negative affectivity is connected to adult hostility. The results only found that children's disinhibition was a significant predictor of adult personality characteristics: child disinhibition was connected to adult extraversion and generalized self-efficacy. The results suggest that it is only a modest connection between child temperament and adult personality characteristic. The reason is the fact that personality formation is largely influenced by social factors [13].

Existing theories of personality development summarize the multiple factors influencing model through microstudies, such as context interaction theories and social ecological model. Some other studies focus on the personality's influence relationship between individual factors. However, up to now, under the integrative framework, the study that focuses on the personality's influence relationship including temperament, family, and kindergarten factors from the same participant has not been found. Therefore, this research plans to construct the model that demonstrates multiple factors comprehensive influence on the children's personality. These factors include children's temperament, family factors (parental education value, parental coparenting, and parental parenting style), and kindergarten factors (teacher expectation and peer acceptance).

## 2. Materials and Methods

*2.1. The Definition and Application of Bayesian Network.* Bayesian network (BN, also called causal network or probabilistic network) is a probabilistic graphical model that represents a set of variables and their probabilistic independencies via a directed acyclic graph (DAG). Each node of BN represents a variable (factor), such as each dimension of the personality, and edges connect some pairs of nodes to represent causal relationships. Bayesian network specializes in the representation and reasoning technology of uncertainty knowledge and is one of popular methods in artificial intelligence, machine learning, and data mining area. Bayesian network is mainly applied in the fault diagnose, expert system, classification, planning, and learning [14–17].

This research adopted BN to represent the relationship and extent of probabilistic dependence among temperament,

family, kindergarten, and personality. The main advantage of using Bayesian network to model is that the BN is a multivariable model. BN can use a single probability integral to reason and evaluate the relationship and degree of influence among temperament, family, kindergarten, and personality without multiple comparisons. Therefore, this study selected the BN to construct the comprehensive influence model on children's personality development.

*2.2. Dataset.* Personality and most of influencing factors were measured by questionnaires except peer acceptance that was measured by best friend nomination method. The teacher of children filled in questionnaires (including Chinese Children's Personality Questionnaire, Teacher Expectation Questionnaire and Child Temperament Questionnaire). Peer nomination method was used to measure the children's peer acceptance level. Children's parents filled in the questionnaire of parental education value, coparenting, and parenting style. The independent variables include the five dimensions of temperament, kindergarten factors (teacher expectation and peer acceptance), and family factors (parental education value, parental coparenting, and parental parenting style). Dependent variable is the five dimensions of personality. 553 children aged 3 to 6 were selected randomly from 3 kindergartens in Dalian. After eliminating missing value, 520 children (273 boys) measuring results were obtained as dataset. The scores of 520 children questionnaire were adopted as dataset to establish the integrated multifactor Bayesian network of influencing personality. Therefore, the variables of dataset were made up of the questionnaire's scores on the five dimensions of temperament, parental coparenting style, parental education value, parental parenting style, teacher expectation, and peer acceptance and the five dimensions of personality.

*2.3. Preprocess of Experimental Data.* Five dimensions of temperament (emotion, activity, reaction, social inhibition, and attention) and teacher expectation, peer acceptance, parental coparenting style, parental education value, and parental parenting style were defined as independent variables and named as  $x_1, x_2, \dots, x_{10}$ , respectively. Five dimensions of personality (intelligence, conscientiousness, extraversion, prosociality, and emotional stability) were defined as dependent variables and named as  $x_{11}, x_{12}, \dots, x_{15}$ , respectively. There was no evidence of common method bias in our data by using Haman single factor test, which demonstrated that the experimental data was reliable. Therefore, the total score of each questionnaire could be computed and standardized. Homogeneity coefficient and the confidence interval were computed by Delta method, which showed that definition of variables was reasonable. Next, binarization was implemented on the score, which is less than 0 for the low score group and greater than 0 for higher group.

*2.4. Construction of BN.* In this paper, we adopted the  $k_2$  algorithm [18] to construct the BN of comprehensive influence on children's personality development.  $x_i$  ( $1 \leq i \leq 15$ )

are represented as nodes of BN. Each node  $x_i$  is assumed as any state  $\{0, 1\}$ . A strong correlation between two nodes is represented as an edge connecting these nodes.

To obtain a BN from the dataset, we need to define a scoring metric to describe the fitness between the selected BN model and observed dataset using the following equation:

$$\max_{B_s} [P(B_s, D)] = \prod_{i=1}^n \max_{\pi_i} \left[ \prod_{j=1}^{q_i} \frac{(r_i - 1)!}{(N_{ij} + r_i - 1)!} \prod_{t=1}^{r_i} \alpha_{ijt}! \right], \quad (1)$$

which was proposed in literature [18]. Here,  $B_s$  is the structure of BN and  $\alpha_{ijt}$  is the number of cases in the dataset for which  $X_i = t$  and  $\pi_i = j$ . Consider  $N_{ij} = \sum_{t=1}^{r_i} \alpha_{ijt}$ , and  $\pi_i$  is the parent node of  $x_i$ . We let  $\phi_i$  denote a list of the unique parents of  $x_i$ , as shown in the dataset. If  $x_i$  has no parent, then we define  $\phi_i$  as the list  $\phi$ , where  $\phi$  represents the empty set of parents. Then,  $q_i = |\phi_i|$ .

We computed the score of each BN by using (1). In the experiment, heuristic search strategy was applied to find the optimal results of the BN. The aim of heuristic search was to maximize  $P(B_s, D)$ . The algorithm began by assuming that a node has no parents and then added incrementally parent node with the most increasing probability of the resulting structure. When the addition of any node could not increase the probability, we stopped adding node to the network. Thus, we got the most optimal BN in local scope. Finally, the BN models of children personality influence factors were constructed by repeating the procedure.

### 3. Experimental Results

**3.1. The Model of BN.** Figures 1, 2, 3, 4, and 5 are BN models of children personality's influencing factors. The five figures show the influencing factors on five dimensions of personality, respectively.

The main advantage of adopting BN is that it supports effective reasoning. For example, given measuring results of some factors, we can obtain a series of posterior probability distribution of the query variables. Figures 1 to 5 are the BN of 15 variables including temperament, family, kindergarten, and personality. We can obtain the causality among factors from five figures. In the experiment, we used the junction tree algorithm for inference. Tables 1 and 2 are the conditional probability tables among variables. Because of limited space, we randomly selected part of the conditional probability to show. The conditional probability of other variables can be obtained in the same way.

From Figures 1 to 5, we can find that family factors (parental coparenting style, parental education value, and parental parenting style) have small impact on personality and weak relationship with kindergarten and temperament factors. Therefore, three variables of family do not appear in the comprehensive graph of influence factors.

**3.2. Conditional Probability Distribution.** In Table 1,  $P(x_{11} = 1 | x_3 = 2, x_4 = 1) = 0.0921$ ,  $P(x_{11} = 2 | x_3 = 2, x_4 = 1) =$

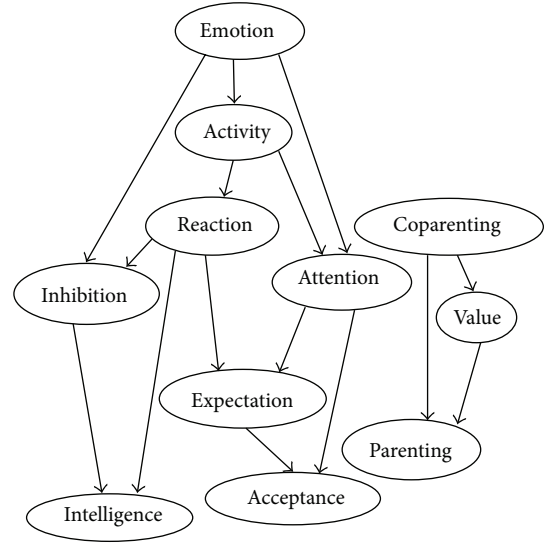


FIGURE 1: The BN of intelligence.

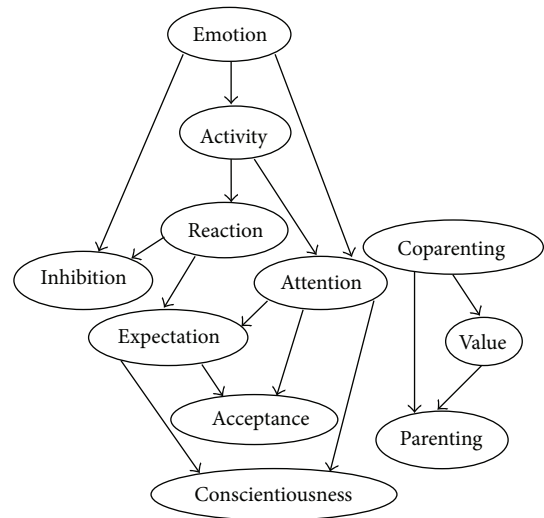


FIGURE 2: The BN of conscientiousness.

0.9079. Through this expression we can draw the following conclusions. If the score of a child's reaction is high and inhibition is low, we can infer that the possibility is 0.0921 for the child's intelligence being low score and the possibility is 0.9079 for the child's intelligence being high score. According to the same rules, from Table 1, we can draw the following expression:  $P(x_{11} = 1 | x_3 = 1, x_4 = 2) = 0.7207$ ,  $P(x_{11} = 2 | x_3 = 1, x_4 = 2) = 0.2793$ . If the score of a child's reaction is low and inhibition is high, we can conclude that the possibility is 0.7207 for the child's intelligence being low score, and the possibility is 0.2793 for the child's intelligence being high score.

Similarly, we can also draw the following expression from Table 2:  $P(x_{12} = 1 | x_3 = 2, x_5 = 2, x_6 = 1) = 0.2369$ ,  $P(x_{12} = 2 | x_3 = 2, x_5 = 2, x_6 = 1) = 0.7631$ . If the score of a child's reaction is high, attention is high, and teacher expectation is

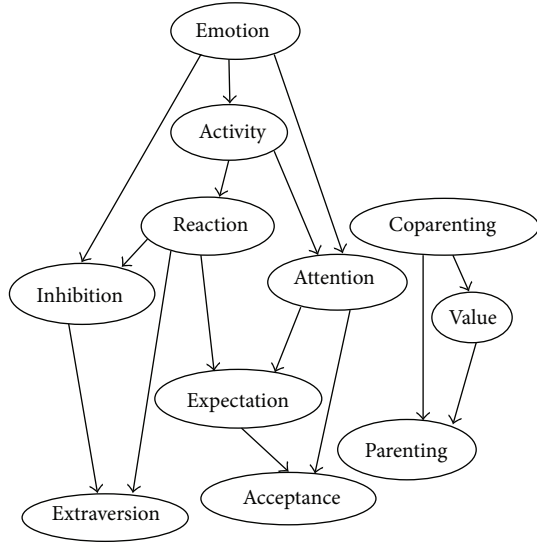


FIGURE 3: The BN of extraversion.

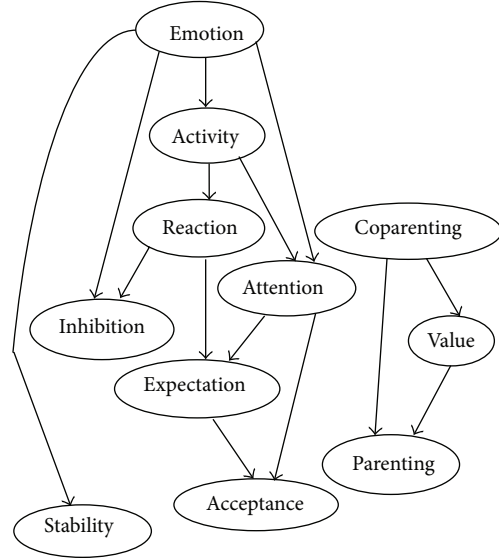


FIGURE 5: The BN of emotional stability.

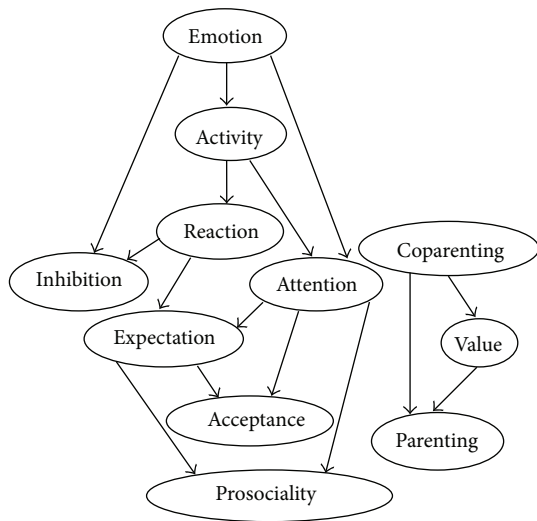


FIGURE 4: The BN of prosociality.

TABLE 1: Conditional probability of intelligence.

Reaction $x_3$	Inhibition $x_4$	Intelligence $x_{11}$	
		1	2
1	1	0.5549	0.4451
2	1	<b>0.0921</b>	<b>0.9079</b>
1	2	0.7207	0.2793
2	2	0.5575	0.4425

low, the probability of the child’s conscientiousness being low score is 0.2369. The probability of being high score is 0.7631.

3.3. *The Joint Probability Distribution.* Another advantage of constructing the Bayesian network for personality’s influence factors is that the probability of dependencies among variables can be obtained.

In Table 3, for example,  $P(x_3 = 1, x_4 = 2, x_{11} = 1) = 0.0769$ ,  $P(x_3 = 1, x_4 = 2, x_{11} = 2) = 0.7580$ . That means that the probability of  $x_3 = 1$ ,  $x_4 = 2$ , and  $x_{11} = 1$  is 0.0769, and the probability of  $x_3 = 1$ ,  $x_4 = 2$ , and  $x_{11} = 2$  is 0.7580. From this expression, we can draw the following conclusions. When a child’s reaction is low score and his (or her) inhibition is high, we can infer that the possibility of intelligence being low score is only 0.0769, and the possibility of intelligence being high score is 0.7580.

Because of limited space, we can only show Table 3 that is one of randomly selected results; the joint probability among other variables can be obtained in the same way.

3.4. *The Importance of Temperament in the Development of Personality.* From Figures 1 to 5 we can draw the following conclusion that the reaction and inhibition of the temperament have a direct effect on intelligence and extraversion of the personality. Teacher expectation and attention of temperament have a direct effect on conscientiousness and prosociality of personality. Emotion of the temperament has a direct impact on the emotional stability of the personality. From the above results, we can find that temperament has significant impact on personality. Teacher expectation is the secondary important variable that has influence on children’s personality. However, the above results do not mean that other factors have no influence on the personality. It means that other factors’ influence on personality is weak compared with temperament and teacher expectation. For example, peer acceptance and parental coparenting style also have influence on the intelligence. But this influence is much smaller. Therefore, the causalities among peer acceptance, parental coparenting style, and intelligence are not shown in Figure 1.

Halverson et al.’s study found that 32 percent of children’s personality variation came from early temperament, which indicated that children’s early temperament had important

TABLE 2: Conditional probability of conscientiousness.

Reaction $x_3$	Attention $x_5$	Teacher expectation $x_6$	Conscientiousness $x_{12}$	
			1	2
1	1	1	0.7854	0.2146
2	1	1	0.6736	0.3264
1	2	1	0.4195	0.5805
2	2	1	<b>0.2369</b>	<b>0.7631</b>
1	1	2	0.5728	0.4272
2	1	2	0.5086	0.4914
1	2	2	<b>0.2190</b>	<b>0.7810</b>
2	2	2	0.1252	0.8748

TABLE 3: The joint probability of intelligence.

Reaction $x_3$	Inhibition $x_4$	Intelligence $x_{11}$	
		1	2
1	1	0.0283	0.0227
2	1	0.0550	0.0213
1	2	<b>0.0769</b>	<b>0.7580</b>
2	2	0.0211	0.0168

relationship with follow-up personality development [19]. How did children’s temperament develop into stable personality traits? Shiner and Caspi attributed the development mechanism to the learning process, environmental excitation, environmental construction, environmental choice, and control [20].

Caspi and his colleagues found that there were significant links between child temperament and adult personality through studying the behavior styles at age 3 and their personality performance in adolescence and young adulthood (at ages 18, 21, and 26). For example, adult personality of children who were initially diagnosed with low effort control was characterized by impulsivity, unreliability, and antisocial behaviors. And those children who have inhibition temperament manifest unassertive or depressive personality in adulthood [21–23].

In addition, the study of Zawadzki and Strelau has shown that temperament has more direct impact on the neuroticism and extraversion of personality [24]. The study of Minaya et al. has shown that patients with anxiety disorders have higher persistence, which indicates that there are close relationships between personality and temperament [25]. The study of Safarzadeh et al. also showed that there is a relationship between people’s temperament and personality. People with irritable fiery temperament have the highest openness. In people with melancholic temperament, the greatest impact can be seen with regard to conscientious personality. In people with phlegmatic temperament, the least impacts are seen on extraversion. In people with sanguine temperament, the greatest impacts are to be observed on agreeableness of individuals [26]. Furthermore, The Big Five personality theory even thought that all personality traits were based on temperament. For example, extraversion or neuroticism is

the temperamental nature [27]. Some theories even thought that temperament could be classified as personality characteristics [28].

From the above facts, we can draw a conclusion that the relationship between temperament and personality is very close. This conclusion strongly supports the opinions of this paper: compared with other factors, temperament’s influence on personality is more direct.

*3.5. The Importance of Teacher Expectation in the Development of Personality.* On the other hand, there is agreement among researchers that the quality of young children’s relationships with teachers predicts social and academic performance in school [29, 30]. Teacher-child relationships are important for children’s development; it is necessary to understand the mechanisms underlying their successful formation [31]. In general, the higher teacher expectation is, the higher level of teacher-child relationship is. Therefore, the opinion agrees with our find that teacher’s expectation is the secondary factor on the preschool children’s personality except for the temperament.

## 4. Conclusions

In order to comprehensively investigate the causal influences among temperament, school factors (teacher expectation and peer acceptance), and family factors (parental education value, parental coparenting, and parenting style) on the preschool children’s personality and the probability of the dependencies among these influence factors, we constructed the influence factor model of personality development based on the Bayesian network. From this model, the following

results can be obtained: the direct influence factors of intelligence and extraversion are social inhibition and reaction of the temperament; the direct influence factors of conscientiousness and prosociality are the teacher expectation and attention of the temperament; emotional stability is directly affected by emotion of temperament.

On the whole, the impact of temperament is larger and more direct than kindergarten and family factors on personality. Specifically, the impact of family factors is much smaller than the impact of temperament and kindergarten on the preschool children's personality. Therefore, there is not any link between the five dimensions of personality and family factors in the results, which indicates that the impact of family is weak on early childhood's personality. We also find that teacher expectation has more direct impact on preschool children's personality except for temperament's influence. These are consistent with the existing evidences. The above results provide an important basis for making the preschool children's training programs on personality and the healthy development of young childhood.

### Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

### Acknowledgments

This work is supported by the Education Fund of Liaoning Province (no. L2012381), Liaoning Province Education Science "Twelfth Five-Year" Plan Project (no. JG12CB114), and the Major Projects of National Social Science Funds (11&ZD151).

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