

Psychometric properties of the Chinese Quick Delay Questionnaire-Parent version and its network associations with executive function in children with ADHD

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Abstract

Objective The Quick Delay Questionnaire-Parent version (QDQ-P) is a short questionnaire used to assess reactions and attitudes related to delay in children. This study aims to validate the reliability and validity of the Chinese version of the QDQ-P, and to investigate the ecological characteristic of the C-QDQ-P.

Methods and analysis A total of 221 children with ADHD who completed the C-QDQ-P were included in this study. We analysed the reliability and validity of the C-QDQ-P. We used multiple linear regression to examine the association between C-QDQ-P scores, and the core symptoms and behavioral problems of children with ADHD. We used partial correlation network to explore the associations among delay-related traits, executive function, and ADHD symptoms in 185 children with ADHD.

Results The results showed that the test-retest reliability of the C-QDQ-P ranged from 0.69 to 0.77, Cronbach's α coefficients ranged from 0.69 to 0.84, and content validity was 1.0. Exploratory and confirmatory factor analyses indicated a good fit for a two-factor model. The delay aversion score was positively correlated with the severity of conduct problems ($\beta = 0.376, p < 0.001$), and the delay discounting score was positively correlated with the severity of inattention ($\beta = 0.269, p < 0.001$). In the partial correlation network, delay aversion (bridge expected influence = 0.311) and delay discounting (bridge expected influence = 0.433) played prominent bridging roles between ADHD symptoms and executive function.

Conclusions The Chinese version of the Quick Delay Questionnaire-Parent version is an assessment tool with good reliability and validity. In children with ADHD, more severe conduct problems are associated with higher delay aversion scores, and more severe inattention symptoms are associated with higher delay discounting scores. Delay discounting and delay aversion showed relatively high bridge expected influence in the estimated network, suggesting that they may be targets for further investigation of the relationship between ADHD symptoms and executive functioning.

Background

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by significant inattention and hyperactivity/impulsivity as core symptoms, with a global prevalence of approximately 5.3% to 7.2%^[1–3].

The delay aversion hypothesis of ADHD posits that abnormal changes in reward circuits, such as the ventral striatum and amygdala, in individuals with ADHD lead to discounting the value of delayed rewards and a preference for immediate rewards^[4–6]. Children with ADHD demonstrate a tendency to minimize the total waiting time experienced when awaiting future rewards, rather than pursuing maximal rewards or shortening individual waiting intervals^[7]. Furthermore, the accumulation of negative emotions with prolonged waiting exacerbates their preference for smaller, sooner rewards^[8]. In simple choice paradigms and temporal discounting paradigms involving intertemporal choice tasks, children with ADHD exhibited a decision-making preference for smaller, sooner rewards compared with the healthy

children^[9, 10]. For instance, on the Maudsley Index of Childhood Delay Aversion, Children with ADHD choose a greater number of smaller, sooner rewards, while in delay discounting tasks, they exhibit higher delay discounting rates^[11, 12]. Research has found that a tendency to prefer smaller, sooner rewards in adolescence correlates negatively with later outcomes in school performance, health, labor supply, and lifetime income^[13, 14].

In previous researches, scholars usually chose Intertemporal choice tasks to assess the delay aversion and delay discounting characteristics of children. However, this method that requires participants to complete a series of binary choices are not suitable for children with ADHD. The Quick Delay Questionnaire (QDQ) would be a better choice, which is designed to rapidly assess reactions and attitudes related to delay^[15]. The QDQ is composed of two subscales, namely delay aversion and delay discounting. Delay aversion assesses positive or negative emotions that arise when facing delay, while delay discounting assesses attitudes toward future gains. Studies have shown that the self-report and informant-report versions of the QDQ have good reliability and validity^[15–17]. A research in Chinese adults found that the QDQ has good internal consistency, test-retest reliability, content validity, and construct validity^[18]. Hsu et al. conducted confirmatory factor analysis to evaluate the traditional Chinese version of the QDQ among healthy children, and the model was found to have adequate fit^[19]. The QDQ could effectively differentiate between individuals with ADHD and healthy controls^[16]. Whether using self-report or informant-report versions, studies consistently show that children with ADHD exhibit higher scores on QDQ delay aversion and delay discounting than their typically developing peers^[20, 21]. A study supported this finding that revealed a correlation between children's QDQ scores and inattentive symptoms as measured by the Swanson, Nolan, and Pelham Questionnaire, Version IV (SNAP-IV)^[19].

However, few studies have examined the reliability and validity of QDQ for Chinese children with ADHD. To promote the application of the QDQ in China, this study aims to validate the reliability and validity of the Chinese version of the Quick Delay Questionnaire-Parent version (C-QDQ-P) among Chinese children with ADHD and to explore the Ecological Characteristics of QDQ. As mentioned above, this study would propose the following three hypotheses: First, the C-QDQ-P would demonstrate good reliability and validity. Second, more severe ADHD core symptoms and behavioral problems would be associated with higher delay aversion and delay discounting scores on the C-QDQ-P. Third, delay-related traits would act as bridge nodes linking ADHD symptoms to executive function.

Methods

Participants

A total of 221 children with ADHD were ultimately included in this study. These children were all from the Child Psychiatry outpatient clinic of Peking University Sixth Hospital. Inclusion criteria: ☐ Age 6 to 16 years; ☐ Diagnosed by a psychiatrist at the attending physician level or above as meeting the DSM-5 diagnostic criteria for ADHD, with the diagnosis verified using the Chinese version of the kiddie-schedule

for affective disorders and schizophrenia-present and lifetime version DSM-5^[22]. Exclusion criteria:

- ☒Currently suffering from serious physical illness, neurological abnormalities, impaired consciousness;
- ☒Unable to cooperate and complete the study for various reasons.

Two weeks after completing the C-QDQ-P, retest questionnaires were randomly distributed, and 23 retest questionnaires were eventually collected.

Measures

Chinese version of the Quick Delay Questionnaire-Parent version (C-QDQ-P) After obtaining authorization from the primary designer of the QDQ, Edmund J.S. Sonuga-Barke, we used a forward-backward translation method to translate and culturally adapt the original scale, forming the Chinese version of the C-QDQ-P. This scale uses a 5-point rating and consists of two subscales: Delay Aversion (DA) and Delay Discounting (DD), each with 5 items. Higher scores indicate more severe delay related deficits^[15].

ADHD Symptom Rating Scale (ADHD-SRS) The parents completed the Chinese version of ADHD-SRS. This is a scale used to assess the severity of ADHD symptoms^[23]. It uses a 4-point rating and consists of two subscales: Inattention (IA) and Hyperactivity-Impulsivity (HI), each with 9 items. Higher scores indicate more severe clinical core symptoms of ADHD .

Conners' Parent Rating Scales (CPRS) The parents completed the Chinese version of CPRS. This is a scale used to assess various behavioral problems in children^[24]. It uses a 4-point rating and includes six dimensions: Conduct Problems, Learning Problems, Psychosomatic, Impulsivity-Hyperactivity, Anxiety, and Hyperactivity Index. Higher scores indicate more severe corresponding behavioral problems in the child .

Two Choice Impulsivity Paradigm (TCIP) This task is a computer-based intertemporal choice task, which has been applied in research on children with ADHD^[25, 26]. The task consists of 50 trials. In each trial, the participant is asked to choose between a circle (earning 5 points, waiting 7 seconds) and a square (earning 15 points, waiting 17 seconds). A lower number of square choices indicates that the participant prefers the smaller, sooner reward. This study recorded the number of square choices for each participant. Fewer square choices indicate a greater preference for smaller, sooner rewards.

Behavior rating inventory of executive function (BRIEF) It is a parent-rating scale (86 items), and was used to assess the impairment of executive function for Children aged 5–18 years. The BRIEF generates two broad indices (eight factors): the Metacognition Index(MI) (including Initiate, Working Memory, Plan/Organize, Organization of Materials, Monitor subscales) and the Behavioral Regulation Index(BRI) (including Inhibit, Shift, Emotional Control subscales)^[27, 28]. Higher scores indicate more severe executive function(EF) impairment^[29]. The Mandarin Chinese version of the BRIEF was also translated by our group and has adequate reliability and validity for school-age children in China^[30].

Data analysis

This study used IBM SPSS Statistics 31, IBM SPSS Amos 23 and R version 4.3.2 for data analysis. $p < 0.05$ was considered statistically significant.

Test-retest reliability was calculated as the Intraclass Correlation Coefficient (ICC) between the original and retest C-QDQ-P. Internal consistency was calculated as Cronbach's α coefficients for the C-QDQ-P. We invited six psychiatric experts to rate the scale items to calculate item-level and scale-level content validity. We randomly divided the children with ADHD into two groups for exploratory factor analysis and confirmatory factor analysis. We analyzed the Pearson correlation between C-QDQ-P scores and the number of square choices in the TCIP to assess the criterion validity of the C-QDQ-P. We used one-way ANOVA to compare C-QDQ-P score differences among ADHD subtypes. If the ANOVA main effect is significant, post-hoc tests were conducted using the Bonferroni method for multiple comparison correction. This study used multiple linear regression to analyze the association between the severity of behavioral problems and ADHD core symptoms and C-QDQ-P scores. The regression models included gender, age, IQ, ADHD-SRS scores, and CPRS scores. Variance Inflation Factor (VIF) was used to control for multicollinearity among predictor variables.

To explore the associations among delay-related traits, executive function, and ADHD symptoms in children with ADHD, we analyzed a subsample of 185 children with complete data on the C-QDQ-P, ADHD-SRS, and BRIEF. A partial correlation network was estimated using EBICglasso ($\gamma = 0.5$). According to the dual pathway model^[4], nodes were assigned to three theory-based communities (ADHD symptoms, delay-related traits, and executive function), and bridge centrality (the degree to which a node links its own community to other communities) was computed for each node, as indexed by bridge strength and bridge expected influence. The 95% confidence intervals of edge weights and bridge centrality were evaluated using nonparametric bootstrap with 5,000 resamples, and the stability of centrality ordering was assessed with case-dropping bootstrap using the correlation-stability (CS) coefficient. The values of $CS \geq 0.5$ are considered acceptable^[31].

Results

Sample Characteristics and Preliminary Analysis

This study included 221 children with ADHD (186 boys, 35 girls), aged 9.41 ± 2.35 years, with a Wechsler IQ of 110.75 ± 16.4 . Among them, there were 120 children with ADHD Combined Type (ADHD-C), 96 children with ADHD predominantly Inattentive Type (ADHD-I), and 5 children with ADHD predominantly Hyperactive-Impulsive Type (ADHD-HI). For the network analysis sample, we excluded children with missing values in the BRIEF scale, resulting in a final sample of 185 participants included in the network analysis. Participants included in the network analysis did not differ significantly from those excluded with respect to age, sex, IQ, ADHD symptoms, or QDQ scores (Table 1).

Table 1
Demographics and clinical characteristics of the study participants

Age, years	Total sample (N = 221)	Network analysis sample (N = 185)
	9.41 ± 2.35	9.35 ± 2.30
IQ	110.75 ± 16.36	111.47 ± 16.41
Gender		
boys	186(84.2%)	154(83.2%)
girls	35(15.8%)	31(16.8%)
ADHD subtype, n (%)		
ADHD-I	96(43.4%)	96(51.9%)
ADHD-HI	5(2.3%)	4(2.2%)
ADHD-C	120(54.3%)	85(45.9%)
ADHD-SRS		
Inattention	27.40 ± 4.44	27.24 ± 4.55
Hyperactivity-Impulsivity	21.56 ± 6.30	20.90 ± 5.96
Total score	48.97 ± 8.60	48.15 ± 8.36
CPRS		
Conduct Problems	13.78 ± 6.44	13.57 ± 6.62
Learning Problems	6.85 ± 2.21	6.85 ± 2.26
Psychosomatic	1.44 ± 1.94	1.36 ± 1.89
Impulsivity–Hyperactivity	6.09 ± 2.93	5.90 ± 2.90
Anxiety	2.75 ± 2.19	2.74 ± 2.17
Hyperactivity Index	14.67 ± 5.07	14.45 ± 5.20
TCIP		
Square choices	25.99 ± 17.64	26.53 ± 17.64
Data are presented as mean ± standard deviation or n (%). IQ: Intelligence quotient; ADHD-I: ADHD predominantly Inattentive Type; ADHD-HI: ADHD predominantly Hyperactive-Impulsive Type; ADHD-C: ADHD Combined Type; ADHD-SRS: ADHD Symptom Rating Scale; CPRS: Conners' Parent Rating Scales; TCIP: Two Choice Impulsivity Paradigm; C-QDQ-P: Chinese version of the Quick Delay Questionnaire-Parent Version; DA: delay aversion; DD: delay discounting; BRIEF: Behavior Rating Inventory of Executive Function; BRI: Behavioral Regulation Index; MI: Metacognition Index		

Age, years	Total sample (N = 221)	Network analysis sample (N = 185)
	9.41 ± 2.35	9.35 ± 2.30
C-QDQ-P		
DA	14.47 ± 4.33	14.16 ± 4.42
DD	15.59 ± 3.44	15.57 ± 3.55
total score	30.06 ± 6.35	29.72 ± 6.48
BRIEF		
Inhibit	/	18.45 ± 4.63
Shift	/	12.61 ± 2.88
Emotional Control	/	16.58 ± 4.36
Initiate	/	15.09 ± 3.18
Working Memory	/	21.97 ± 3.18
Plan/Organize	/	26.72 ± 4.55
Organization of Materials	/	14.16 ± 2.89
Monitor	/	19.35 ± 3.07
BRI	/	47.64 ± 9.65
MI	/	97.3 ± 13.66
Total score	/	144.95 ± 20.30
Data are presented as mean ± standard deviation or n (%). IQ: Intelligence quotient; ADHD-I: ADHD predominantly Inattentive Type; ADHD-HI: ADHD predominantly Hyperactive-Impulsive Type; ADHD-C: ADHD Combined Type; ADHD-SRS: ADHD Symptom Rating Scale; CPRS: Conners' Parent Rating Scales; TCIP: Two Choice Impulsivity Paradigm; C-QDQ-P: Chinese version of the Quick Delay Questionnaire-Parent Version; DA: delay aversion; DD: delay discounting; BRIEF: Behavior Rating Inventory of Executive Function; BRI: Behavioral Regulation Index; MI: Metacognition Index		

To compare differences in C-QDQ-P total score, delay aversion score, and delay discounting score among the three ADHD subtypes, one-way ANOVA was conducted. The main effects of ADHD subtype were all significant, as shown in Table 2. Bonferroni post-hoc tests indicated: The C-QDQ-P total score for ADHD-C was higher than for ADHD-I ($p < 0.001$) and ADHD-HI ($p = 0.023$); the difference between ADHD-I and ADHD-HI was not statistically significant. The delay aversion score for ADHD-C was higher than for ADHD-I ($p < 0.001$); the differences between ADHD-HI and ADHD-C or ADHD-I were not statistically significant. The delay discounting score for ADHD-C was higher than for ADHD-I ($p = 0.018$) and ADHD-HI ($p = 0.018$); the difference between ADHD-HI and ADHD-I was not statistically significant.

Table 2
Differences in C-QDQ-P scores across ADHD subtypes

C-QDQ-P total score	ADHD-I	ADHD-HI	ADHD-C	F	p
	28.0 ± 6.1	24.6 ± 5.2	32.0 ± 6.0	13.935	< 0.001
Delay aversion score	13.0 ± 4.1	12.6 ± 2.5	15.7 ± 4.2	12.132	< 0.001
Delay discounting score	15.0 ± 3.5	12.0 ± 3.2	16.2 ± 3.2	6.802	0.001
Data are presented as mean ± standard deviation. Post hoc comparisons were performed using the Bonferroni method when the omnibus test was significant. ADHD-I: ADHD predominantly Inattentive Type; ADHD-HI: ADHD predominantly Hyperactive-Impulsive Type; C-QDQ-P :Chinese version of the Quick Delay Questionnaire-Parent Version; DA: delay aversion; DD : delay discounting					

Reliability of C-QDQ-P

Test-retest Reliability: The ICC for the C-QDQ-P total scale was 0.77 ($p < 0.001$), for the delay discounting subscale was 0.71 ($p < 0.001$), and for the delay aversion subscale was 0.69 ($p < 0.001$).

Internal Consistency: The Cronbach's α coefficient for the C-QDQ-P total scale was 0.79, for the delay discounting subscale was 0.69, and for the delay aversion subscale was 0.84.

Validity of C-QDQ-P

Content Validity: Six psychiatric experts rated each item of the C-QDQ-P as 3 or 4 points(3 points indicating relevant but needs minor adjustment; 4 points indicating completely relevant). Therefore, both the item-level content validity index and the average scale-level content validity index for the C-QDQ-P were 1.0.

Construct Validity: Exploratory factor analysis ($n = 111$) yielded a Kaiser–Meyer–Olkin (KMO) index of 0.765, and Bartlett's test of sphericity was significant ($\chi^2(45) = 280.807, p < 0.001$). The factor loadings for all items on their respective factors exceeded 0.50 (Table S1 in Appendix). Confirmatory factor analysis ($n = 110$) modeled the 10 items of the C-QDQ-P as observed variables and the two factors (delay aversion and delay discounting) as latent variables. After modification based on modification indices, the fit indices (χ^2/df , CFI, SRMR, RMSEA, and PClose) indicated that the modified model was acceptable (Table S2 in Appendix). The final modified model was presented in Supplementary Material (Figure S1 in Appendix). The Average Variance Extracted (AVE) for the delay aversion factor was 0.55, and the Composite Reliability (CR) was 0.86 (Table S3 in Appendix). The AVE for the delay discounting factor was 0.52, and the CR was 0.84. The correlation between the delay aversion and delay discounting factors was statistically significant ($r = 0.40, p < 0.01$).

Criterion Validity:The correlations between the C-QDQ-P total score, delay aversion score, delay discounting score, and the number of square choices were not statistically significant (C-QDQ-P total

score: $r=-0.084$, $p = 0.225$; Delay aversion score: $r=-0.058$, $p = 0.403$; Delay discounting score: $r=-0.082$, $p = 0.236$).

Multiple Linear Regression Analysis: C-QDQ-P and ADHD Symptoms

Collinearity statistics indicated that multicollinearity was not a concern (VIF 1.084–8.237, tolerance 0.121–0.922). The predictor variables explained 23.5% of the variance in delay aversion scores (adjusted $R^2=0.235$, $F = 7.039$, $p < 0.001$). Only the Conduct Problems score from the CPRS had a significant independent predictive effect ($\beta = 0.376$, $p < 0.001$); other variables did not have significant independent predictive effects on delay aversion. The predictor variables explained 8.3% of the variance in delay discounting scores (adjusted $R^2=0.083$, $F = 2.781$, $p = 0.002$). Only the Inattention score from the ADHD-SRS had a significant independent predictive effect ($\beta = 0.269$, $p < 0.001$); other variables did not have significant independent predictive effects on delay discounting scores. The results of the multiple linear regression analyses can be found in Table 3.

Table 3
Results of the multiple linear regression analyses

Outcome variable	Delay aversion			Delay discounting		
	b	β	p	b	β	p
Constant	14.250		< 0.001	10.304		< 0.001
Sex	-0.716	-0.061	0.329	-0.245	-0.026	0.702
Age	-0.125	-0.068	0.321	-0.100	-0.068	0.365
IQ	-0.015	-0.057	0.366	-0.002	-0.008	0.910
ADHD-SRS						
IA	-0.051	-0.052	0.425	0.208	0.269	< 0.001
HI	0.040	0.058	0.501	-0.034	-0.061	0.514
CPRS						
Conduct Problems	0.251	0.376	< 0.001	0.112	0.210	0.063
Learning Problems	-0.170	-0.087	0.322	0.119	0.076	0.427
Psychosomatic	0.144	0.065	0.320	0.081	0.046	0.520
Impulsivity–Hyperactivity	0.006	0.004	0.975	0.152	0.129	0.350
Anxiety	-0.112	-0.057	0.387	-0.039	-0.025	0.732
Hyperactivity Index	0.145	0.171	0.319	-0.106	-0.157	0.402
IQ: Intelligence quotient; ADHD-SRS: ADHD Symptom Rating Scale; IA: Inattentive; HI: Hyperactive-Impulsive; CPRS: Conners' Parent Rating Scales						

Network Analysis

A partial correlation network was estimated with the 12 subscale scores as nodes (IA and HI of the ADHD-SRS; DA and DD of the C-QDQ-P; eight executive function subscales of the BRIEF). The network comprised 41 nonzero edges (density = 0.621, Fig. 1), and the 95% bootstrap confidence intervals of these edge weights are shown in Figure S2. The correlation-stability (CS) coefficient was 0.71 for node strength and 0.68 for bridge expected influence, indicating acceptable stability.

Inhibit showed the highest bridge expected influence (BEI = 0.660, 95%CI [0.481, 0.747]), followed by DD (BEI = 0.433, 95%CI [0.231, 0.657]), IA (BEI = 0.421, 95%CI [0.221, 0.635]), HI (BEI = 0.372, 95%CI [0.261, 0.568]), and DA (BEI = 0.311, 95%CI [0.167, 0.525]). Monitoring, organization of materials, and working memory showed only marginal bridging (lower CI bounds close to zero). Planning/organizing, emotional control, initiation, and shifting showed no reliable bridging, with CIs including zero (Fig. 2, and Table S4 in Appendix).

Inhibit showed the highest node strength (1.339), followed by planning/organizing (1.219), initiation (1.124), emotional control (1.013), and monitoring (1.012). Notably, several executive function subscales—planning/organizing, initiation, emotional control, and monitoring—showed high strength but low bridge expected influence, indicating that they are central within the executive function community but do not bridge across communities (Fig. 2, and Table S5 in Appendix).

Discussion

We validated the reliability and validity of the C-QDQ-P in Chinese children with ADHD and explored the correlation between QDQ scores and the severity of ADHD core symptoms and behavioral problems.

We found that the ICC for the C-QDQ-P total scale was greater than 0.75, and for the subscales, it was between 0.6 and 0.75, indicating good two-week test-retest reliability for the C-QDQ-P^[32]. The Cronbach's α coefficient for the C-QDQ-P total scale was greater than 0.7, and for both subscales, it was greater than 0.6, consistent with previous research, indicating good internal consistency^[15, 19]. After evaluation by six psychiatric experts, we found the C-QDQ-P has good content validity^[33]. We used exploratory factor analysis and confirmatory factor analysis to assess the construct validity of the C-QDQ-P. We found that the two-factor model of the C-QDQ-P is consistent with the original scale's design structure, with all factor loadings greater than 0.5. The AVE for both factors was greater than 0.5, CR was greater than 0.7, and the correlation between the two factors was less than the square root of their respective AVEs, indicating that the C-QDQ-P has good convergent validity and discriminant validity^[34, 35]. We did not find correlations between the C-QDQ-P total score, delay aversion score, delay discounting score, and choice preference in the TCIP. One study using a delay discounting task within intertemporal choice tasks also found no correlation between QDQ scores and task-measured intertemporal choice preferences^[16]. Another study showed that methylphenidate improved self-reported delay aversion in individuals with ADHD but did not improve task-measured delay aversion^[36]. This suggests that the C-QDQ-P and intertemporal choice tasks measure different aspects of intertemporal choice characteristics^[37]. C-QDQ-P scores reflect the traits of children with ADHD in daily life from the parent's perspective, while performance on intertemporal choice tasks reflects the state of children with ADHD when facing such choices. This finding may reflect differences between parent-rated delay-related tendencies in daily life and laboratory-based task performance. However, this interpretation requires confirmation using multiple behavioral paradigms.

We found differences in C-QDQ-P scores among children with different ADHD subtypes, with ADHD-C having higher total scores, delay aversion scores, and delay discounting scores. This reflects that children with ADHD-C are more averse to delay in daily life and more unwilling to wait for larger future gains. This also suggests that QDQ scores may be associated with different ADHD symptoms^[15]. Therefore, we used multiple linear regression analysis and further found that delay aversion scores were primarily positively correlated with the severity of conduct problems. As a study has found that children's delay aversion scores are associated with conduct problems assessed by the Strengths and Difficulties

Questionnaire^[17]. Furthermore, unlike previous studies suggesting that delay aversion scores are associated with the severity of ADHD core symptoms^[15, 16], our regression model showed that hyperactivity-impulsivity symptoms did not independently predict delay aversion scores. We also found that delay discounting scores were primarily positively correlated with the severity of inattention. While a prior study found an association between the total QDQ score and inattentive symptoms, our research extends this finding by demonstrating that the link is primarily attributable to the delay discounting subscale, not the delay aversion subscale^[19]. However, one adult study suggested that delay discounting is not associated with the severity of ADHD core symptoms^[16]. Although our regression model showed no association between age and delay discounting in children with ADHD, considering that adults have lower delay discounting rates than children^[38], the inconsistent findings suggest that there may be different delay discounting characteristics between adults and children with ADHD.

We found inhibitory control showed the highest bridge expected influence, suggesting that it was the executive-function node most strongly connected with the ADHD symptom and delay-related communities in the estimated network. DD showed a higher bridge expected influence than delay aversion, indicating a relatively stronger pattern of cross-domain association with ADHD symptoms and EF difficulties. DA also showed a non-negligible bridge estimate, although its value was lower. These findings suggest that the two QDQ dimensions may not contribute identically to the broader pattern of clinical characteristics in children with ADHD. The above findings are consistent with previous studies^[39, 40]. Recent study also supported a multi-pathway account of ADHD traits, suggesting that motivational and executive mechanisms jointly contribute to suboptimal decision-making under risk^[41]. Several BRIEF dimensions, including Plan/Organize, Initiate, Emotional Control, and Monitor, showed relatively high within-community node strength but limited or imprecisely estimated bridge expected influence. This pattern suggests that these executive-function domains may be central to the internal structure of parent-rated executive dysfunction without necessarily serving as reliable links between executive-function difficulties and ADHD or delay-related traits^[42]. Furthermore, in ADHD related networks, bridge nodes are often specific behavioral symptoms or functional impairment domains, rather than broad EF factors^[43]. The findings are broadly compatible with theoretical models proposing partially overlapping motivational and executive pathways in ADHD. Our results support the dual-pathway model of ADHD, and suggest association between the motivational and executive pathways.

The limitations of this study are as follows: First, the proportion of children with ADHD Predominantly Hyperactive-Impulsive Type and girls with ADHD in this study was relatively small, limiting the representativeness of the sample. Second, this study only used the TCIP task. Future research should employ various intertemporal choice tasks to further explore the potential relationship between the QDQ and different intertemporal choice tasks. Third, the study was cross-sectional and based largely on parent-report measures, so the observed network associations cannot be interpreted as causal or temporal effects and may be influenced by shared method variance. Furthermore, the network was estimated using a theory-based community structure rather than data-driven community detection, and the stability and generalizability of the bridge estimates still require replication in independent samples.

Finally, our study did not comprehensively control for medication status, comorbid conditions, or other clinical covariates that may affect delay-related traits and executive function. Future longitudinal and multi-method studies combining questionnaire data with performance-based EF tasks and experimental measures of delay processing are needed to further test these relationships.

Conclusion

The Chinese version of the Quick Delay Questionnaire-Parent version is an assessment tool with good reliability and validity. In children with ADHD, more severe conduct problems are associated with higher delay aversion scores, and more severe inattention symptoms are associated with higher delay discounting scores. Delay aversion, delay discounting, and inhibitory control showed notable bridge associations in the estimated network, which is broadly compatible with the dual-pathway model of ADHD.

Abbreviations

ADHD	Attention Deficit Hyperactivity Disorder
C-QDQ-P	Chinese version of the Quick Delay Questionnaire-Parent version
SNAP-IV	Swanson, Nolan, and Pelham Questionnaire, Version IV
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
DA	Delay Aversion
DD	Delay Discounting
ADHD-SRS	ADHD Symptom Rating Scale
CPRS	Conners' Parent Rating Scales
TCIP	Two Choice Impulsivity Paradigm
BRIEF	Behavior rating inventory of executive function
ICC	Intraclass Correlation Coefficient
VIF	Variance Inflation Factor
MI	Metacognition Index
BRI	Behavioral Regulation Index
EF	Executive Function

ADHD-I ADHD predominantly Inattentive Type

ADHD-HI ADHD predominantly Hyperactive-Impulsive Type

ADHD-C ADHD Combined Type

Declarations

Supplementary Information

The uploaded additional file contains supplementary materials.(Supplementary Material 1)

Author contributions

HHH, LL, and QJQ conceived and designed the study. HHH, ZYY, CCL and HML performed data collection, data curation and statistical analyses. HHH, ZYY wrote the main manuscript. YFW, LL, and QJQ edited the manuscript. YFW, LL, and QJQ co-supervised this project. All authors read and approved the final manuscript.

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Data availability

Data availability statement The data from this study are available from the corresponding author upon reasonable request.

Competing Interest

The authors have declared that they have no competing or potential conflicts of interest.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and approved by the ethics board of the Peking University Sixth Hospital on November 26, 2022. All participants provided their informed consent prior to participation.

Consent for publication

Not applicable.

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Figures

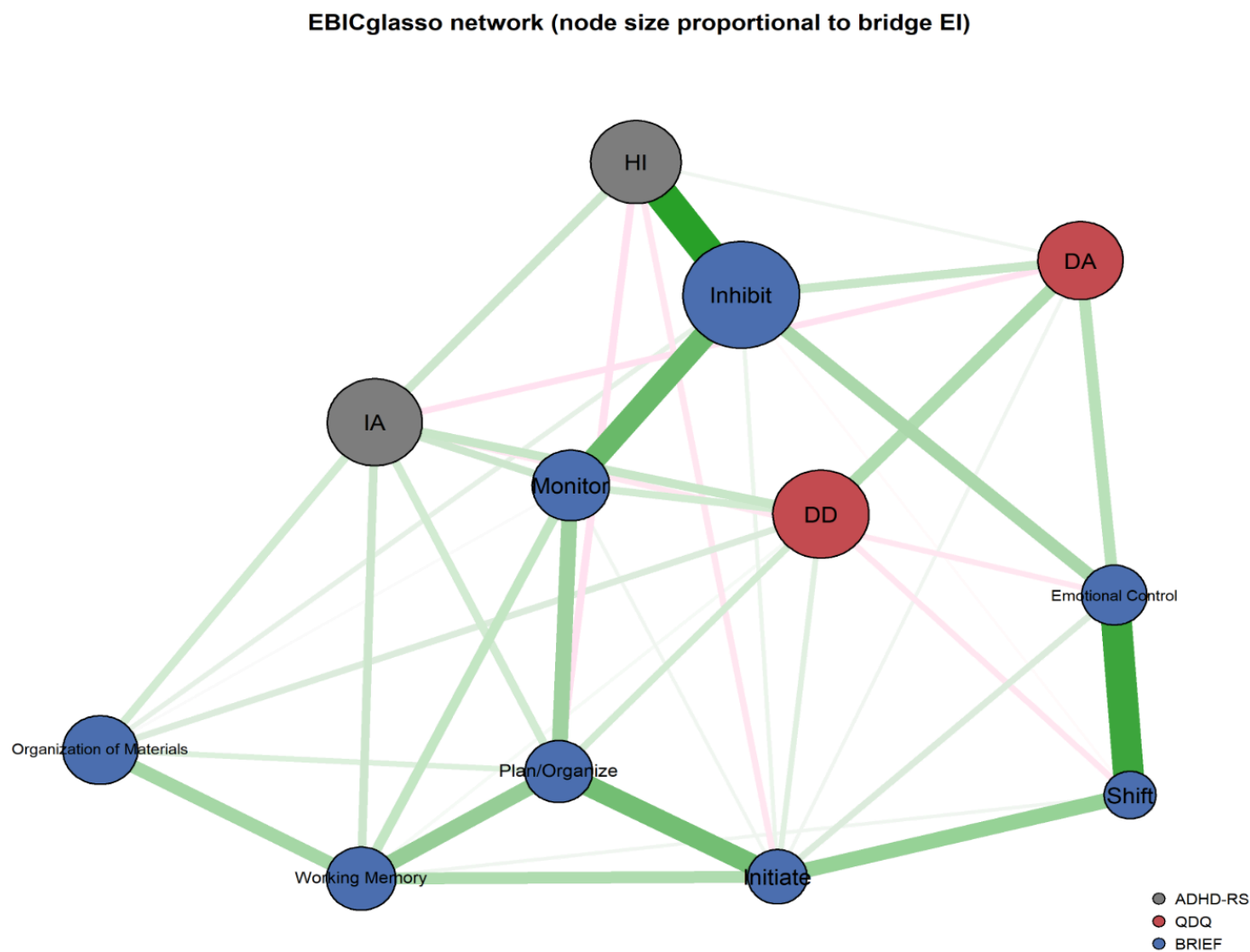


Figure 1

Partial correlation network. Node size is proportional to bridge expected influence, and edge thickness is proportional to the absolute value of the partial correlation. Green edges denote positive partial correlations, and pink edges denote negative partial correlations. Node colors represent the three communities: gray = ADHD-SRS, red = QDQ, and blue = BRIEF. IA: Inattentive; HI: Hyperactive-Impulsive; DA: Delay Aversion; DD: Delay Discounting

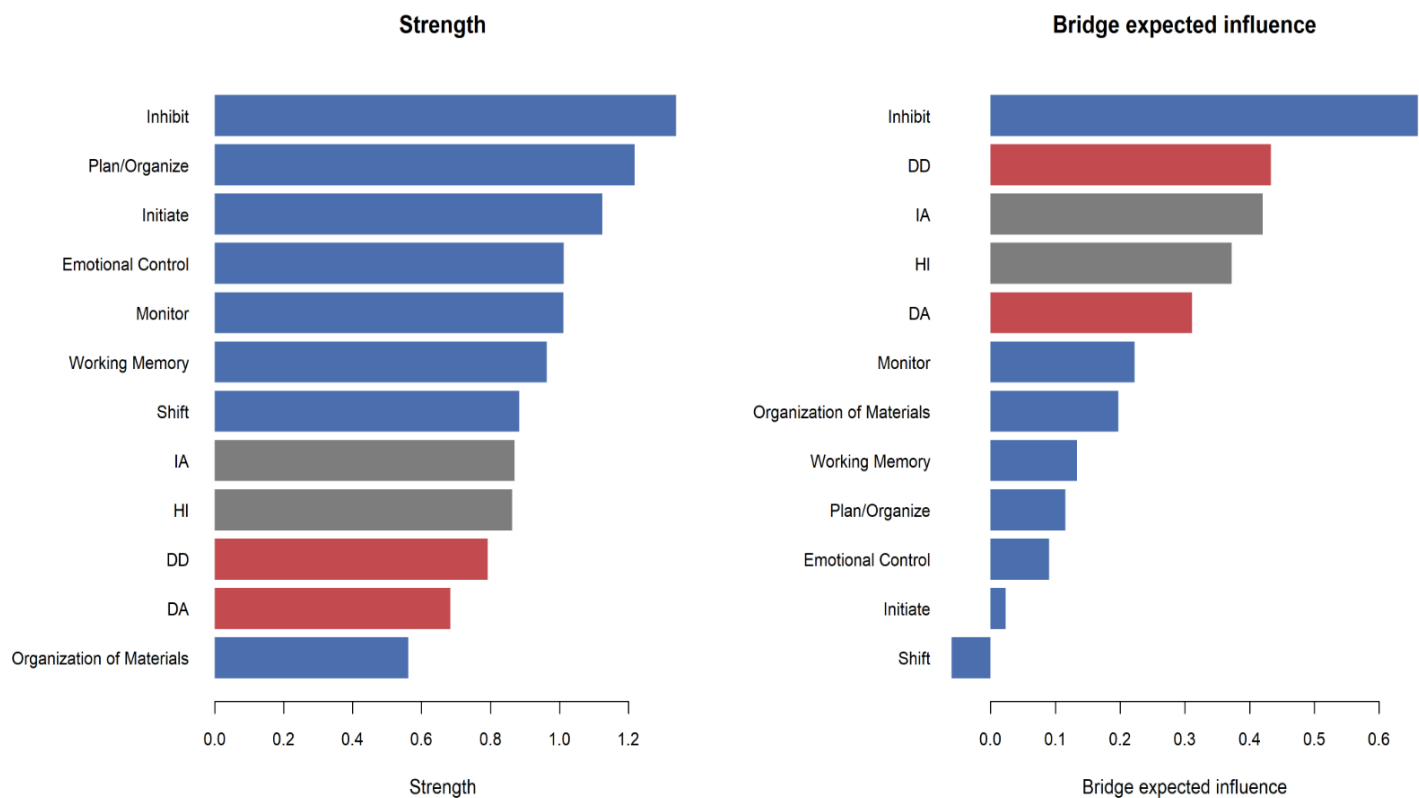


Figure 2

Rankings of node strength (left) and bridge expected influence (right).

IA: Inattentive; HI: Hyperactive-Impulsive; DA: Delay Aversion; DD: Delay Discounting

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