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Construct validity of the Coding Interactive Behaviour instrument for fathers of infants

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ABSTRACT

Observational instruments are proposed as the best method to assess the quality of parent–child interaction. However, the psychometric properties and theoretical foundations of these observational tools have been questioned. Further, very few studies have focussed on the construct validity of these instruments for father–child interaction quality. In this study, we examined the construct validity of the Coding Interactive Behavior (CIB) measure in a sample of 320 father-infant dyads. A four-factor model, previously found to fit mother–infant interactions, failed to demonstrate an acceptable model fit for our father-infant sample. Instead, a data-driven three-factor model was indicated to be a better fit. This model consists of the composites, 'Paternal Sensitivity', 'Paternal Positive Affect', and 'Child Engagement'. Interestingly, while these factors bear similarities to those found in maternal interactions, they manifest distinct characteristics for fathers. Our results emphasize the necessity of refining and validating observational tools specifically for diverse parent–child contexts.

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KEYWORDS Father-infant interaction; coding interactive behavior; construct validity

Introduction

While observational instruments are often proposed to be the best approach for assessing parent–child interaction quality, systematic reviews demonstrate that many of these instruments lack validation, particularly construct and predictive validity (Gridley et al., 2019; Lotzin et al., 2015). Additionally, the theoretical dimensions of these instruments have been called into question (Mesman & Emmen, 2013). A particular

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point of contention is the concept of sensitivity. While many tools incorporate behaviours from Ainsworth et al. (1978) original definition of sensitivity – i.e., the parent's ability to notice, interpret, and appropriately respond to the child's signals – some also include parenting behaviours that were not part of Ainsworth's original definition, like parental positive affect (Mesman & Emmen, 2013). Finally, most of these observational instruments were developed and validated based on mother–child dyads, leaving the applicability and validity for father–infant dyads uncertain (Cabrera et al., 2018). Due to increased paternal involvement in childcare and empirical evidence on fathers' unique contribution to child development (e.g., Lucassen et al., 2011; Steenhoff et al., 2019), there is a need to validate observational instruments assessing father–infant interaction quality.

The Coding Interactive Behavior (CIB; Feldman, 1998) is a widely used observational instrument assessing parent–child interaction quality. However, the multiple studies using CIB all create different subscales – or subscales that are supposed to measure the same construct (e.g., parental sensitivity) yet include different items. Some of these studies are not clear on how they formed these subscales (e.g., Feldman et al., 2013; Saxbe et al., 2017; Shimon-Raz et al., 2021; Weisman et al., 2015), while other studies mention they have conducted an exploratory factor analysis without confirming the factor structure (Krijnen et al., 2022, 2023). Feldman (2012) argues that the factor structure will vary depending on sample characteristics, such as culture and child age. Thus, it is important to investigate and validate the use of CIB across cultures, child age, and parental sex. To the best of our knowledge, only three previous studies have investigated its construct validity using confirmatory factor analysis. Feldman (cited in Feldman, 2012) confirmed her suggested factor structure (see Appendix A) in a study of 483 caregiver-child dyads. However, no information is available on the parental sex, child age, or observational setting. Steenhoff et al. (2019) investigated this factor structure within a Danish sample comprising 52 mothers, 41 fathers, and their 5-year-old children. Steenhoff and colleagues' findings revealed some overlap in the factor structure between mothers and fathers. However, there were also distinct differences in which items were loaded on specific aspects of parental behaviour. They argue that the CIB is developed to assess core parental interactive competencies, and thus scores/factor structures should be similar for mothers and fathers, and any observed differences may be due to wider societal

structures (e.g., the possibility of shared parental leave) or the observational setting suiting mothers better. In a recent study, we also failed to confirm Feldman's factor structure in a sample of Danish mothers of infants, and instead found a data-driven model to be the best fitting one (Stuart et al., 2023). The purpose of the present study is therefore to examine whether this data-driven model (Appendix B) also fits in a sample of fathers and, if it does not reach an acceptable fit, to investigate a data-driven model for fathers.

Methods

Sample and procedure

This study is part of the Copenhagen Infant Mental Health Project (CIMHP; Væver et al., 2016) which was conducted in collaboration with the public health visitors in the municipality of Copenhagen. In Denmark, all new families are routinely offered well-visits by public health visitors during the first year postpartum. The health visitor who is a nurse with specialized training assesses infant health and development and conducts screening for postpartum depression. In this study, families were invited to participate by their health visitor if the mothers had elevated symptoms of postpartum depression and/or the infant showed social withdrawal. Following, a psychologist from the project team conducted a home visit where they obtained written and informed consent, conducted interviews, administered questionnaires, and video-recorded a free-play observation with the mother and infant and the father and infant. The project was approved by the local ethical review board (Approval number: 2015–10). Inclusion and exclusion criteria are described in Væver et al. (2016), but for this study, we only included infants aged <6 months since the coding instrument for interaction used in this study changes at this age (cf. Feldman, 1998). Sample characteristics for the fathers are displayed in Table 1.

Measures

Father-infant interaction was coded with the Coding Interactive Behavior (CIB; Feldman, 1998); an observational rating system for social interactions, coded during three minutes of free play at their home with their own toys. The CIB consists of 33 items (18 relating to the parent, eight to the child, five to the dyad, and two focusing

Table 1. Sample characteristics ($N = 320$).

	n	%
Child sex		
Male	169	52.8
Female	151	47.2
Paternal relationship status		
Single	2	0.6
In a relationship	304	95.0
Paternal educational level		
9–12 years (ISCED level 3)	65	20.3
15 years (ISCED levels 4, 5, 6)	108	33.8
17 years (ISCED level 7, 8)	125	39.1
Paternal employment status		
Unemployed	54	16.9
Employed	251	78.4
	M	*SD*
Child age, months	2.63	0.90

on the lead-lag of the interaction) that are rated from 1 (minimal level of behaviour) to 5 (maximum level of behaviour). All coders were trained to attain a reliability of minimum 80% on the certification videos provided by Feldman's lab. Coders had no prior knowledge of the dyads. To avoid coder's drift, there was ongoing test of inter-rater reliability where a set of videos were double-coded by the reliability coder and another coder. In total, 23.1% were double-coded to assess inter-rater reliability. We used Koo and Li's (2016) one-way random effects, absolute agreement model which showed excellent inter-rater reliability (ICC = .97, 95% CI [.969; .974], Cohen's $\kappa = .92$).

Statistical analyses

The confirmatory factor analyses (CFA) were carried out in R (v. 4.3.2), using the lavaan package (v. 0.6–16) (Rosseel, 2012) and the exploratory factor analyses (EFA) in SPSS Statistics 28 (IBM, Chicago, IL). First, we fitted the best-fitting factor structure from our previous study (Stuart et al., 2023; Appendix B) to fathers with CFA maximum likelihood estimation with robust standard errors (MLR). We expected all latent factors to correlate with each other. The fit indices were considered acceptable when $\chi^2/df \leq 3$, comparative fit indices (CFI) and Tucker-Lewis index (TLI) $\geq .90$, and root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR) $<.08$ (Brown, 2015; Shek & Yu, 2014). If acceptable model fit was not observed, we would allow for theoretical meaningful error correlations based on item similarities or

reversed items (cf. Brown & Moore, 2012). When comparing models, the one with the lowest Akaike information criteria (AIC) and Bayesian information criteria (BIC) was the best fitting model.

If this factor structure did not show a good fit, we conducted an EFA with maximum likelihood estimation on a random half of the sample (n = 157). Following Costello and Osborne (2005), we ran multiple EFAs with a fixed number of extracted factors based on the point of inflection on the scree plot. The best fitting EFA was determined based on item loadings on the latent factor being above .30, few cross-loading items with a difference less than .2 between primary and secondary loading, and no factors with fewer than three loading items. Direct oblimin was used as rotation method. The best fitting EFA was confirmed with CFA in the other half of the sample (n = 163). We had no missing data.

Results

Table 2 (Model 1) shows the results of the CFA of the best-fitting factor structure for mothers. The model fit was not acceptable even when allowing for theoretical meaningful error correlations (Model 1a).

The scree plot (Figure 1) shows the inflection point to be at four, resulting in three EFAs with three, four, and five factors being run. For the three-factor EFA (EFA-3), 'Parent Negative Affect', 'Parent Gaze' and 'Parent Hostility' did not load on any factors, three items had cross-loadings below .2, and there were no unstable factors with fewer than three loading items. For EFA-4 'Child Negative Emotionality' did not load on any factors, four items had cross-loadings below .2, and no unstable factors. EFA-5 had four non-loading items (the same as EFA-3 as well as 'Parent Affectionate Touch'), two items with cross-loading below .2, and one factor only consisting of 'Child Negative Emotionality'. Thus, the best fitting model was EFA-3 (Table 3) that was fitted in our subsequent CFA.

Table 2. Fit of the CFA models on fathers of infants ($N_{\text{model 1}}$ = 320, $N_{\text{model 2}}$ = 163).

	χ2	χ2/df	CFI	TLI	RMSEA	SRMR	AIC	BIC
Model 1	2258.02	5.66	.77	.75	.12	.11	18419.98	18668.48
Model 1a	1793.83	4.82	.83	.80	.11	.10	17957.84	18308.00
Model 2	1651.57	4.11	.72	.70	.14	.12	9657.20	9851.72
Model 2a	836.88	2.33	.90	.87	.09	.10	8887.62	9214.91

Note. CFI = Comparative Fit Indices, TLI = Tucker-Lewis Index, RMSEA = Root Mean Square Error of Approximation, SRMR = Standardized Root Mean Square Residual, AIC = Akaike Information Criteria, BIC = Bayesian Information Criteria.

Model 1 = maternal-based model, Model 1a = maternal-based model with error correlations, Model 2 = paternal data-driven model, Model 2a = paternal data-driven model with error correlations.

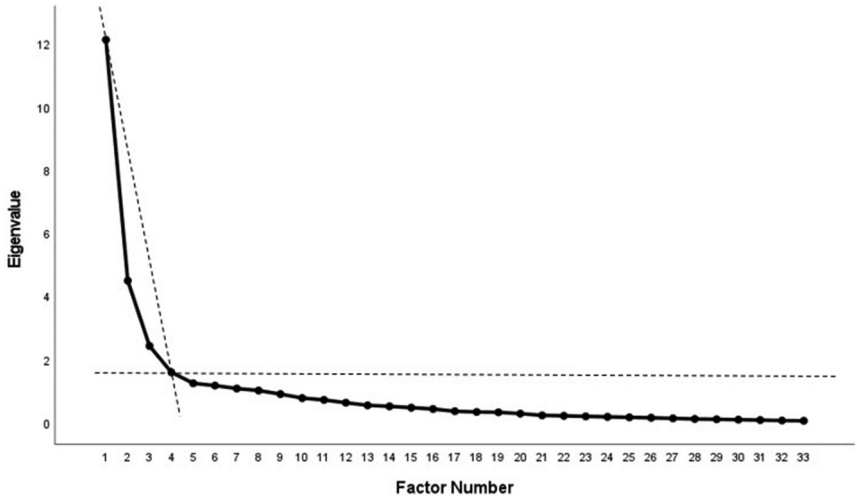


Figure 1. Scree plot.

Table 2 (Model 2 and 2a) shows the results of CFAs. When allowing for 44 theoretical meaningful error correlations (see Table 4), we reached acceptable model fit for the paternal data-driven model (i.e., Model 2a) according to the χ^2/df and CFI indices, but not according TLI, RMSEA, and SRMR. The internal consistency was good for all three factors ($\omega_{\text{Paternal Sensitivity}} = .95$, $\omega_{\text{Paternal Positive Affect}} = .95$, $\omega_{\text{Child Engagement}} = .94$).

Discussion

The present study was not able to validate the factor structure found in mother-infant dyads from the same sample (Stuart et al., 2023). Instead, we found mixed indications of a validated three-factor structure consisting of 'Paternal Sensitivity, 'Paternal Positive Affect', and 'Child Engagement'. Feldman (2012) argues that the factor structure may depend on the context, mentioning culture and child age, and we may add parental sex to the list as an explanation for the different factor structures. Like Steenhoff et al. (2019) who also found different factors for mothers and fathers on the CIB, there are still many similarities between the factor structures for mothers in the Stuart et al. (2023) study and the present study of fathers. For both mothers and fathers, the factor structures reveal that sensitivity and positive affect are distinct dimensions of parenting, aligning with Mesman and Emmen's (2013) theoretical delineation of the sensitivity construct.

Table 3. Factor loadings on the 3-factor EFA paternal model.

	Factor 1, 'Paternal Sensitivity'	Factor 2, 'Child Engagement'	Factor 3, 'Paternal Positive Affect'
P Overriding – Intrusiveness	−.95		
Parent-led	−.94		
Child-led	.73		
D Adaptation Regulation	.72		.33
P Acknowledging	.68		.32
P Consistency of Style	.68		.30
P Forcing	−.54		
P Supportive Pressence	.54		.44
P Resourcefulness	.48		.44
P Affectionate Touch	.35		
C Alert		.85	
D Reciprocity		.84	
D Fluency		.75	
C Positive Affect		.72	
C Vocalization		.71	
D Constriction		−.70	−.36
C Withdrawal		−.68	
C Initiation		.63	
C Fatigue		−.57	
C Gaze		.56	
P Imitating		.50	
C Negative Emotionality		−.34	
P Elaborating		.33	
P Positive Affect			.86
P Enthusiasm			.81
P Depressed Mood			−.80
D Tension			−.63
P Vocal Appropriateness			.61
P Appropriate Range of Affect	.45		.55
P Anxiety			−.44

Note. $N = 157$. Bold shows strongest loadings. p = parent codes. C = Child codes. D = dyadic codes.

'Maternal Controlling Behavior' is reversely included in 'Paternal Sensitivity', perhaps suggesting a more child-led approach in father-child free-play interactions, a pattern similarly observed in play studies with older children (John et al., 2013). The 'Child Engagement' factor includes the same items for both mothers and fathers, demonstrating that the child 'organizes' the interactions similarly regardless of whether they are engaging with the mother or father. Though unable to establish measurement invariance for the full factor structure of the CIB between mothers and fathers, future studies could investigate the measurement invariance on the child factor. The present study has only investigated the construct validity of the CIB using factor analyses; however, previous reviews have highlighted how interaction measures also lack predictive validity (Gridley et al., 2019; Lotzin et al., 2015). More research is thus needed to further our understanding of the validity of the CIB when assessing father–infant interaction quality.

Table 4. Correlated errors in the confirmatory factor analysis (paternal model). *p* = parent codes, C = child codes, D = dyadic codes.

P Overriding – Intrusiveness	P Depressed Mood
	P Enthusiasm
	P Consistency of Style
	Parent-led
	P Appropriate Range of Affect
	P Forcing
	D Adaptation Regulation
	P Positive Affect
	P Resourcefulness
C Alert	C Fatigue
	P Positive Affect
	C Negative Emotionality
	P Supportive Pressence
	P Anxiety
	P Imitating
	P Elaborating
Parent-led	Child-led
	P Enthusiasm
	P Depressed Mood
	P Appropriate Range of Affect
P Positive Affect	P Enthusiasm
	C Vocalisation
	P Appropriate Range of Affect
	C Initiation
P Depressed Mood	P Appropriate Range of Affect
	P Consistency of Style
	P Positive Affect
	P Enthusiasm
D Tension	P Anxiety
	P Depressed Mood
	C Withdrawal
C Initiation	C Vocalisation
	D Constriction
P Imitating	P Elaborating
	P Acknowledging
P Consistency of Style	P Forcing
	D Fluency
P Appropriate Range of Affect	P Enthusiasm
	D Adaptation Regulation
D Constriction	C Vocalization
	C Withdrawal
P Forcing	P Resourcefulness
C Withdrawal	C Fatigue

This study has some limitations to consider. There are a number of factors that may limit the generalizability of our results: First, participants were recruited based on screening for maternal postpartum depressive symptoms, and paternal participation was not a requirement for the mother to participate. Thus, father data is likely influenced by a self-selection bias. Future studies validating instruments on father–child interactions should actively sample fathers to ensure a more balanced and representative sample. Second, the sample may be characterized as at-risk

since the fathers were partners to mothers who were included in the study due to showing postpartum depressive symptoms and/or infant social withdrawal. This may have influenced the father–infant interactions, thus influencing the factor structure. Our results need to be replicated in other clinical, at-risk, and community samples to understand how much this factor structure is liable to change. Third, the sample was only from the capital municipality in Denmark with the participants being very well-resourced (i.e., high educational level and living with the partner). While it is a strength that we randomly partitioned the data to conduct separate EFA and CFA, this approach reduced our sample size. Therefore, our findings warrant validation in larger more representative samples to understand the generalizability of our results. Furthermore, error correlations were needed to reach acceptable fit, which may indicate a bias in parameter estimates, and the model fit may be due to sampling error (Hermida, 2015). We only allowed for theoretical meaningful error correlations (e.g., items that almost mirror each other or are each other's reverse), the amount of error correlations needed to reach an acceptable fit may be an indication of the CIB consisting of too many items with a high degree of similarity. Future studies should investigate if it is possible to reduce the number of items to improve the validity of the CIB. Finally, the observational setting, i.e., free play, may also have affected the factor structure. Krijnen et al. (2022, 2023) found two different factor structures depending on whether the setting was free-play or structured. It is therefore likely that our results could be similarly influenced, and future studies should investigate the robustness of the factor structure of the CIB depending on the observational setting.

In conclusion, our study discards an initial four-factor model based on mother–infant interactions and instead indicates a three-factor structure of the CIB in father–infant interactions, encompassing 'Paternal Sensitivity', 'Paternal Positive Affect', and 'Child Engagement'. When comparing scores, it is crucial to acknowledge the potential qualitative differences in mothers' and fathers' interactive behaviours. Future studies should validate our findings as well as investigate optimal methods for capturing maternal and paternal interactions with their infants.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author.

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Appendices

Appendix A. Feldman's (1998) own proposed factor model

Parent composites:	
Parental sensitivity (10 items)	Acknowledging, Imitating, Elaborating, Parent Gaze, Positive Affect, Vocal Appropriateness, Appropriate Range of Affect, Resourcefulness, Affectionate Touch, and Parent Supportive Presence
Parental intrusiveness (5 items)	Overriding, Forcing, Parent Negative Affect/Anger, Hostility, and Parent Anxiety
Child composites	
Child involvement (6 items)	Child Initiation, Child Gaze, Child Positive Affect, Alert, Fatigue (reversed), and Child Vocalization
Child withdrawal (2 items)	Negative Emotionality and Withdrawal
Dyadic composites	
Dyadic reciprocity (3 items)	Reciprocity, Adaptation-Regulation, and Fluency
Dyadic negative states (2 items)	Constriction and Tension

Appendix B. Stuart et al. 2023 best-fitting data-driven model for the mothers

Parent composites:	
Maternal sensitivity (9 items)	Adaptation Regulation, Resourcefulness, Consistency of Style, Parent Supportive Presence, Overriding (reversed), Acknowledging, Appropriate Range of Affect, Anxiety (reversed), Tension (reversed)
Maternal social withdrawal (5 items)	Parent Depressed Mood, Parent Positive Affect (reversed), Enthusiasm (reversed), Vocal Appropriateness (reversed), Parent Gaze (reversed)
Maternal controlling behaviour (3 items)	Parent-led, Child-led (reversed), Forcing
Child composites	
Child engagement (13 items)	Reciprocity, Child Positive Affect, Child Gaze, Constriction (reversed), Alert, Initiation, Fluency, Child Vocalization, Withdrawal (reversed), Imitating, Negative Emotionality (reversed), Elaborating, Fatigue (reversed)