# Maternal responsive-didactic caregiving in play interactions with 10-month-olds and cognitive development at 18 months

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ABSTRACT

Maternal responsive-didactic caregiving (RDC) and infant advanced object play were investigated in a sample of 400 mothers and their 10-month-old infants during video-recorded semi-structured play interactions. Three maternal behaviours: contingent response, cognitively stimulating language and autonomy promoting speech were coded and infant object play. Factor analysis confirmed the three maternal behaviours loaded onto one underlying factor, labelled RDC. Based on ecological and transactional theories of development, associations between RDC and infant (advanced object play), maternal (age, education, ethnicity and first language) and family (size and home adversity) factors were investigated. Multiple regressions (1) explored the predictors of maternal RDC; (2) tested the possible role of maternal RDC in predicting infant intellectual development at 18 months. At 10 months infants showing higher levels of play maturity experienced more maternal responsive and didactic feedback. All mother and family characteristics predicted variations in maternal RDC. Predicting 18-months cognitive development, RDC had significant effect over and above maternal education, home adversity and infant play. Mother's first language remained significant, reflecting that RDC, in this investigation, relies heavily on language input. The findings highlight the importance of both contingent response and didactic contributions in interactions to subsequent cognitive development, as early as the first year.

## INTRODUCTION

Mother-infant interactions are commonly thought of as the 'building blocks' for child development, their quality and content influencing infant engagement and subsequent learning (Bornstein, 2002). Responsiveness, defined as the appropriate, contingent, prompt and reliable reactions to infants' signals (Ainsworth, 1979; Bornstein, 1989) is said to be a key aspect of high quality mother-infant interactions (Svanberg, Barlow & Tigbe, 2013). More responsive interactions have been linked with enhanced language development (Tamis-Lemonda, Kuchirko & Song, 2014; Topping, Dekhinet & Zeedyk, 2013), higher cognitive abilities (Fuligni et al., 2013; Landry, Smith & Swank, 2006; Page, Wilhelm, Gamble & Card, 2010) and, in particular, more advanced executive functions (EF; Cuevas, Deater-Deckard, Kim-Spoon, Watson, Morasch & Bell, 2014; Bernier et al., 2012).

Didactic caregiving, the way in which parents stimulate and engage their infant with the surrounding environment, is said to play a unique role in enhancing cognitive development (McFadden & Tamis-LeMonda, 2013). This behaviour is expected to increase in quantity and complexity in relation to child skills (Bornstein, 2002), involves elaborating on and interpreting the external world outside the dyad, focusing the infant's attention on the surrounding environment, supporting child autonomy and providing opportunities for learning.

### *Responsiveness*

Some theorists consider didactic caregiving to be one aspect of responsiveness (Tamis-LeMonda, Kuchirko & Tafuro, 2013; Tamis-LeMonda et al., 2014). To illustrate, the lexical content of parents' language that follows infants' gestures and explorations, such as: labelling objects and describing situations, can be thought of as a contingent response (see Tamis-LeMonda et al., 2014 for review). Maternal didactic

(or referential) language, related to children's cognitive development (Song, Spier & Tamis-Lemonda, 2014), is also responsive to infant behaviour, likely to increase following infant object exploration and gestures (Tamis-LeMonda et al., 2013). One study found that mothers' cognitively stimulating language at 10 months predicted child cognitive abilities at the same time point (Page et al., 2010) while responsivity did not, suggesting that responsiveness and didactic behaviour, though related, may represent two separate constructs.

Contradictory to Page and colleagues (2010), others have shown that when combined, responsive-didactic behaviours are relevant for predicting infants' cognitive abilities. For example, McFadden and Tamis-LeMonda (2013) found that maternal responsive-didactic behaviours predicted infant cognitive ability at 15 and 25 months over and above child, mother and context characteristics. Additionally, instruments such as the Emotional Availability Scales (EAS; Biringen, 2008) aimed at assessing the affective quality of mother-child interactions can be considered to incorporate both responsive and didactic aspects of caregiving (Biringen, Derscheid, Vliegen, Closson & Easterbrooks, 2014). The EAS records maternal sensitivity, non-hostility and non-intrusiveness alongside maternal structuring behaviours that are pedagogical in nature, facilitate learning and promote of child autonomy (Biringen et al., 2014). More emotionally available interactions were found to relate to infants' ability to better interpret human action as goal-directed at 7-months (Licata, Paulus, Thoermer, Kristen, Woodward & Sodian, 2014), as well as language development in 2 year-olds (Moreno, Klute & Robinson, 2008).

The present study explored the role of maternal responsive-didactic caregiving in infancy in predicting subsequent cognitive abilities. In light of previous contrasting research findings (McFadden & Tamis-LeMonda, 2013; Page et al., 2010)

the first aim was to determine whether maternal responsiveness and didactic behaviours represented a single factor or were three separate aspects of maternal behaviour. Mothers and 10 month olds were observed playing with several toys that would present a challenge for the infants. Thus, these mother-infant interactions were expected to operate in the Zone of Proximal Development (ZPD; Vygotsky, 1978), likely to yield variations in maternal scaffolding of infant play and their problem-solving strategies.

*Scaffolding*

Scaffolding is observed during learning-based interactions when parent interventions are adjusted according to children's observed abilities, with the goal of encouraging and enabling the child to work independently (Wood, Bruner & Ross, 1976; Wood & Middleton, 1975). Parental scaffolding in infancy has been associated with children's subsequent EF (Bernie et al., 2010; Hammond, Müller, Carpendale, Bibok & Liebermann-Finestone, 2012), cognitive and socio-emotional development (Landry et al., 2006; Lowe, Erickson, MacLean, Schrader & Fuller, 2013) and attachment security (Bigelow et al., 2010). It is argued that scaffolding consists of three core dimensions: contingent response, cognitive stimulation and promotion of autonomy (Mulvaney, McCartney, Bub & Marshall, 2006; Neitzel & Stright, 2003). These are interlinked and likely to operate in a feedback loop; the parent responds to the child's activity in a contingent manner, providing the child with task-related cognitive stimulation that is followed by encouragement of autonomous play/task completion. The present study is designed to look at theoretically linked precursors of scaffolding labelled responsive-didactic caregiving.

*Contingent response* refers to caregiver communications about objects or the environment when the infant is giving full attention, able to receive and process such

information (Tamis-LeMonda, et al., 2014; Topping et al., 2013), representing one specific aspect of responsivity which can also be more general in terms of responding to moods, emotions or distress. Responding contingently is said to be especially important from the end of the first year throughout the second year when language is emerging and as activity and exploration increase (Tamis-LeMonda et al., 2013). At that age, play tends to transform from being indiscriminate and non-functional to being more functional and relational (Bigelow, MacLean & Proctor, 2004).

*Cognitive stimulation* refers to parental didactic input, or behaviours associated with effortful teaching designed to facilitate child cognitive development (Fuligni & Brooks-Gunn, 2013). This has two functions: describing, interpreting and directing attention to the world surrounding the infant; and encouraging the baby to become involved with the environment by creating learning opportunities through observation and imitation (Bornstein, 2002). In the current investigation, both the quantity and quality of task-related cognitively stimulating language were recorded, since previous studies have found that more complex language in interactions with infants promoted the development of cognitive abilities (Lowe et al., 2013), language skills and emotion knowledge (Merz, et al., 2015), and vocabulary size (Song et al., 2014).

*Promotion of autonomy* entails activities such as pacing the interaction in accordance to infants' signals, providing encouragement and showing flexibility (Bernier et al., 2010; Bigelow et al., 2004; Bigelow et al., 2010), representing steps towards encouraging independent play. Parents' abilities to promote autonomy in interactions with older children are said to relate to children's academic attainment (Grolnick & Ryan, 1989), and self-regulatory abilities (Neitzel & Stright, 2003). Promoting autonomy and responding contingently conceptually overlap to some

extent, though it could be argued that contingent response precedes promotion of autonomy, in turn leading to transfer of responsibility from parent to child. As infant play at the end of the first year is largely exploratory and not 'end-producing' (Bornstein, 2002), transfer of responsibility from mother to infant may not be clearly observed but language might explicitly encourage independent play.

*Infant play and maternal responsive-didactic caregiving*

Evidence suggests that both responsive and didactic caregiving influence child cognitive outcomes (McFadden & Tamis-LeMonda, 2013; Page et al., 2010; Song et al., 2014). Yet, the role of the infant in eliciting specific patterns of caregiving is not entirely clear. McFadden and Tamis-LeMonda's (2013) study is limited in that it did not take account of infant behaviour during the interaction, an aspect addressed in this investigation. According to Bornstein (2002), in infancy the caregiver makes greater contributions, playing a more salient and active role in shaping infants' early experiences. In support of this Bigelow and Power (2014), observed that, in the first 3 months, maternal responsiveness was predictive of infant concurrent and future responsiveness in interactions, which in turn facilitated infant's engagement in social interactions. In a different study, Bigelow and associates (2004) found a transactional relationship between maternal scaffolding and child functional play. When mothers presented a range of behaviours such as modelling, facilitating the child's efforts and engaging in turn taking, the child was more likely to engage in more advanced play, than when mothers presented fewer scaffolding strategies. However, they also found that maternal skill at following infant activities was associated with more advanced play, meaning that maternal scaffolding also occurred in response to infant play.

Even though infants may play a less active role in early interactions with a caregiver, it is expected that their behaviour will yield feedback likely to influence

subsequent development (Bornstein, Hendricks, Haynes & Painter, 2007; Henning, Striano & Lieven, 2005; Lugo-Gil & Tamis-LeMonda, 2008; Tamis-LeMonda et al., 2013; 2014). For instance, Bornstein and associates (2007) found that children's language abilities at 20 months predicted maternal sensitivity and child responsiveness, noting that children with extended vocabulary may be more communicative, in turn eliciting more sensitive caregiving, and promoting language acquisition. Similarly Lugo-Gil and Tamis-LeMonda (2008) showed significant reciprocal effects between maternal behaviours and child cognitive abilities in the first three years suggesting that, although parenting behaviours may remain largely stable over time, parents tend to adapt their behaviour in accordance with their child's current abilities.

In keeping with Tamis-LeMonda and associates' (2013) assertion that mothers' verbal response is contingent on infant play, and given that scaffolding is used as the guiding framework, it was assumed for the current study that maternal responsive and didactic behaviours would be presented as a reaction to infant play. Thus the second aim was to test whether child advanced object play predicted a higher level of maternal responsive-didactic caregiving, which in turn predicted more advanced infant cognitive abilities 8 months later. Significant associations found between infant advanced object play and RDC, would be consistent with (but not necessarily indicative of) the hypothesised child effect.

*Maternal responsive-didactic caregiving and infant cognitive development in context*

Child and parent behaviours during interactions are likely to be influenced by a complex system of family, child and environmental factors (Bornstein et al., 2007; McFadden & Tamis-LeMonda, 2013). Maternal effective scaffolding strategies have been related to higher maternal educational level and more positive parenting style

(Carr & Pike, 2012; Lowe et al., 2013; Neitzel & Stright, 2004). Associations between maternal age and responsive and didactic behaviours were also observed; Keown, Woodward and Field (2001) showed that teenage mothers were likely to be less responsive and less cognitively stimulating to their infants, a relationship said to be the principal explanation for the association between younger maternal age and lower child cognitive development. Fuligni and Brooks-Gunn (2013) found ethnic-group differences in the extent to which mothers were responsive and cognitively stimulating in interactions with their infants. Others did not observe differences in responsive-didactic behaviours as a function of maternal education or ethnic background, though being married and reporting fewer depressive symptoms were associated with more responsive and didactic behaviours (McFadden & Tamis-LeMonda, 2013).

Family context factors are also relevant mother-infant interactions and subsequent development. For example, a larger family size may reduce the quality and quantity of parent-infant interactions, which may impede intellectual development (Steelman, Powell, Werum & Carter, 2002). Furthermore, adverse living conditions such as housing inadequacy and over-crowding, are said to be linked with maternal caregiving and subsequent child development (for review see Evans, Wells & Moch, 2003). The third study aim was to explore the relationship between maternal and context characteristics in relation to didactic-responsive caregiving.

Evidence suggest that maternal responsive and didactic caregiving influences child cognition above and beyond maternal characteristics and context (Lugo-Gil & Tamis-LeMonda, 2008; McFadden & Tamis-LeMonda, 2013; Pearson et al., 2011; Page et al., 2010; Tamis-LeMonda et al., 2013), perhaps being the mediating mechanism by which maternal characteristics and contexts affect subsequent

development. Thus, in the final step of this investigation we tested whether maternal responsive-didactic behaviours predicted child cognitive abilities at 18 months, over and above infant play, maternal characteristics and home adversity. To provide ecological validity (Bornstein et al., 2007) both proximal and distal factors were included: proximal - maternal age, educational level, employment type and ethnic background; distal – adversity of living conditions.

To summarise, the aims of the present study were (1) to explore maternal individual variations in responsive-didactic caregiving; (2) establish whether infant level of play, mother and context characteristics are predictive of maternal behaviours; and (3) test the role of maternal responsive and didactic caregiving at 10 months in predicting child cognitive development at 18 months. Hypotheses were:

(1) The ratings of the quality and quantity of maternal behaviours can be summarised by three latent factors corresponding to contingent response, cognitively stimulating language and promotion of autonomy. These three factors will represent an underlying latent construct of responsive-didactic caregiving.

(2) Maternal responsive-didactic caregiving will occur in response to infant advanced object play; more advanced play yielding more responsive and didactic input. Significant findings would be statistically consistent with, but may not be indicative of, the hypothesised child effect.

(3) Maternal characteristics- age, education and ethnic background, and home characteristics- family size and adverse living conditions will predict maternal responsive-didactic caregiving.

(4) Higher levels of responsive-didactic behaviours at 10 months will predict subsequent infant cognitive abilities above and beyond child, mother and contextual factors.

## METHODS

### *Sample*

The study participants were from the Families Children and Child Care study (FCCC) a longitudinal investigation into the possible effects of childcare on child development. Recruitment was in hospitals in North London and Oxfordshire, catering for demographically diverse populations. The sample (N=1,201) closely reflected the socio-demographic distribution of the area populations (Malmberg et al., 2005). Eligibility criteria were: mother over 16 at time of birth and sufficiently fluent for interview in English, and child a singleton with no congenital abnormalities.

Due to limited resources, a random sub-sample of 400 was chosen from the larger sample for the current study. Criteria for selection were that mother and child have complete information at 3, 10 and 18 months. Random selection was undertaken in two waves by the second author, who was not involved in the coding process. A selection variable was created in SPSS 20, which specified that every third person out of the possible 900+ participants with available data was included in the study.

### *Procedure*

The study received ethical approval from the Royal Free and University College Medical School and from Oxford University. All participants provided written informed consent. Home interviews, questionnaires and observations were conducted with mothers when children were 3, 10, 18, 36 and 51 months, with assessments of child development at 18, 36 and 51 months. Data included in the present study were collected at 3, 10 and 18 months.

During the 10 months home visit, semi-structured play interactions between mother and infant were videotaped. Mothers were asked to 'play as they normally would', in 2.5 minute play segments, with a series of toys provided in a standardized sequential manner by the researcher. For the purpose of this study two play segments including toys that are likely to elicit maternal instruction behaviours were chosen: stacking rings and a shape-sorting box, totalling 5 minutes of videotaped interaction. These toys could be potentially challenging for 10-months-old infants in terms of fine motor skills and cognitive development, presenting a situation in which variations in mothers' propensity to scaffold their child play to achieve 'success' could be observed. These interactions were then coded for maternal responsiveness, cognitively stimulating language, autonomy promoting language and infant advanced object play.

For reliability purposes, a master's student was trained as the second coder. The training procedure included introduction to the concepts and behaviours covered in the coding scheme, this was followed by a period of coding maternal behaviours together and discussing any disagreements. Then each coder individually rated maternal behaviours in 10 cases that were not included in the study's sample. Face to face training was spread over 3 weeks totalling10 working hours, ICCs of collapsed behavioural categories were no lower than .71.

***Measures***

*Demographic characteristics*

At 3 months data were collected on child gender, maternal age, education, ethnic background, spoken language, family size and occupational status prior to birth of the child (as a socioeconomic indicator) defined using the Computer Assisted System for Occupational Coding (CASOC; Rose & O'Reilly, 1998). Additionally,

information about adverse living conditions was collected using the study-specific Environmental Adversity Index (EAI), composed of six adversity indicators: living in rented or insecure accommodation, no kitchen/no bath, 4+ stairs, no garden, no car and crowdedness. The EAI is an averaged composite measure of data collected at 3, 10 and 18 months; higher values reflecting more adversity (Malmberg et al., 2005).

*Maternal responsive-didactic caregiving*

The three proposed factors of maternal responsive-didactic behaviours (RDC), identified to be theoretically linked with scaffolding, were coded using both frequency counts and general impression codes. Based on their distribution, frequency counts were converted into codes ranging from 0-3 (0=behaviour not observed, 1=limited presentation of behaviour, 2=moderate presentation of behaviour and 3=behaviour presented substantially) to correspond with the general impression codes. The first author and the second coder double-rated 10% (N=40) of cases out of the 400 videotaped interactions. The first author coded a further 304 interactions (76%) and the second coder coded the remaining 56 cases. ICCs for collapsed codes were: contingent response (.86); cognitively stimulating language (.69); and autonomy promoting language (.92).

*Contingent response*

After each play segment, maternal contingent responses to infants' cues, body language and verbalisations were coded using general impression codes ranging from 0 to 3. The extent to which the mother looked at the infant's face in response to his/her utterances and actions, reciprocated infant's verbalisations and physical cues, and generally monitored child activity responding in a contingent manner was recorded. Following Fuligni and Brooks-Gunn's (2013) work with the three-bag assessment, behaviours considered non-contingent were: intrusiveness; failure to

reciprocate to infant's cues and address infant's mood; and generally having an adult-centred focus on the task. Contingent response codes ranged between 0-3 (0= maternal response non-contingent throughout; 1= maternal contingent response seen less frequently than non-contingent response; 2= maternal responses are mostly contingent; 3= mother consistently responds to infant in a contingent manner. Contingent response codes from both play segments were highly related (r=.67, $p<.001$) and were made into a composite measure ranging between 1- 6 (mean=4.69; SD=1.29).

*Cognitively stimulating language*

Following Ware, Brady, O'Brien, Berlin and Brooks-Gunn's (2000) coding scheme of the three-bag assessment with Early Head Start mothers and their 14 months old infants, mothers' use of language aimed at enhancing infants' cognitive and language development was recorded as frequency counts of: descriptions of objects or situations; asking questions; elaborating on the 'solution' to the toy; making connections to infant existing knowledge and using complex vocabulary. A new episode was coded after a 3 second gap or at the start of a new sentence. Frequency counts alongside the type of verbalisation were considered before being converted into codes ranging from 0-3 per play segment (0= none; 1= 1- 4 episodes; 2= 5-9 episodes and at least 3 different types of behaviours; 3= 10 ≤ episodes of cognitively stimulating language of at least four different types of behaviours). A mother was considered consistently stimulating if she presented a range of informative and lexically rich task-related statements. For example, whilst playing with the ring-stacking toy a mother named the ring colours and asked a couple of questions, the frequency of utterances may have been in the excess of 4 episodes yet this would warrant a code of 1 as mother presented two out of the possible five

language-based behaviours under investigation. Cognitively stimulating language coded for both play segments correlated (r=.53, $p$<.001). The codes were added into a composite measure, ranging between 0-6 (mean=2.65; SD=1.23).

*Autonomy promoting language*

Based on Bernier (2010) the use of language such as providing hints, designed to encourage the infant to complete the task without maternal intervention was recorded. Frequency counts (using the same definition of an episode as for cognitively stimulating language) were converted into codes, on the basis of distributions, and ranging from 0-3 per play segment (0= none; 1= 1episode; 2= 2-3 episodes; 3= 4 ≤ episodes of use of autonomy promoting language). Examples include "Now it's your turn"; "try to fit the shape/ring yourself"; "mummy will show you how to do it and then you have a go". Autonomy promoting language code for both play segments were associated (r=.43, $p$<.001). A composite measure was created ranging between 0-6 (mean=2.52; SD= 1.86).

*Infant advanced object play*

The extent to which the infant was engaged in advanced object play was coded in 15 x 10-second intervals for each play segment. Infant play was recorded separately from maternal behaviours using a coding system broadly based on Bigelow et al. (2004). Bigelow and colleagues measured 'functional play', which was translated into 'advanced object play'. Whether or not the infant was using the play pieces in the conventional manner, attempting or managing to complete the task (e.g. removing/ restacking hoops; putting the correct shape in its corresponding slot) was recorded in intervals of 10 seconds. Each 10-second interval, in which the infant showed advanced play was coded as 1; if infant was engaged in exploration, was directed by the mother or did not engage in play a code of 0 was given. A measure of

infant advanced object play was then created by calculating the proportion of 10-second intervals in which infants presented advanced object play out of the thirty 10-seconds segments observed with a possible range between 0-1. Infant advanced object play ranged between 0-.87 (mean= .15; SD= .13)

*Outcome - infant cognitive development*

At 18 months infant developmental assessments were conducted using the Bayley II Mental Development Index (MDI; BSID-II: Bayley, 1993). The MDI consists of two subscales, the motor scale and the mental scale. It aims to evaluate young children's sensory-perception problem solving, early language development, knowledge and memory (Lowe, Erickson, Schrader & Duncan, 2012). The third and most recent version of the MDI (MDI III) was not available at the time the study was conducted.

***Analytic Strategy***

The randomly selected sub-sample was compared to the rest of the FCCC sample, to ascertain whether it was representative. Next a Confirmatory Factor Analysis (CFA) of the observed maternal behaviour was carried out in Mplus 7.3 (Muthén & Muthén, 2012), specifying three first order latent factors: contingent response; cognitively stimulating language; and autonomy promoting language. Although associations were observed between individual behavioural codes, these were treated as separate parameters to adjust for any possible variability as the observed interactions included two different toys (see Malmberg et al., 2007). It was important therefore to confirm that the behaviours were consistent although the apparatus were different. The first order factors were predicted to load onto a second order latent factor of responsive-didactic caregiving (RDC). All parameters hypothesised to load onto the latent factors were freed and latent factors means and

variances were fixed at 0 and 1 respectively. This procedure was carried out so that analyses would yield an optimal value along with other model estimates, reducing differences between predicted and observed variance-covariance matrices (Brown & Moore, 2012). Once factor structure fit was confirmed, the first and second order factor scores were exported into IBM SPSS 20. Bivariate analyses were then carried out between latent factor scores, child, mother and contextual factors and the outcome, using Pearson correlation for continuous factors and t-test for categorical factors, to determine which covariates to include in the regression models.

In the next step, two multiple regression analyses were conducted, using the enter method, with entry in blocks. The first regression model tested whether infant advanced object play, maternal characteristics and contextual factors predicted maternal responsive didactic caregiving consisting of two steps, the first including infant play and the second comprising of maternal and contextual factors. The second regression model was conducted in three steps testing whether maternal responsive-didactic caregiving at 10 months predicted 18 month infant cognitive abilities, taking into account infant advanced play, maternal characteristics and context. The first and second steps of this model were identical to the first regression model. In the third step maternal responsive-didactic caregiving was added. A significant $R^2$ change would support the hypothesis that maternal behaviour is predictive of infant cognitive development above and beyond infant, mother and context characteristics.

## RESULTS

### *Sample characteristics*

The randomly selected sub-sample included 400 mother-infant dyads. Of the infants, 201 (50.3%) were girls, and 51.3% were firstborn. Over 80% (N=323) of mothers were of white British origin, aged between 16 and 46 (mean=30.9). Almost

all (91%) of the mothers resided with the child's father, and 44.5% were educated to degree level or above. At their most recent employment 41.5% of mothers (N=166) were in a professional or managerial role, 16.8% (N=67) were in intermediate level employment and the remaining 41.8% (N=167) of mothers had history or current employment categorised as working class. Over half of the sample's mothers were in some form of employment when child was 10-months-old (N=209; 52.8%).

Mothers in the current study did not differ significantly from the rest of the FCCC sample in terms of age, ethnic background, education or employment status, family size, adverse home environment or child cognitive development assessed at 18 months. A significant difference was observed between the samples in the number of mothers who speak English as a first language [$x^2$ (1) = 22.98; $p$< .001]. This was to be expected given that the coding scheme relied heavily on language, thus videotaped interactions in which the mother spoke in a different language to English were not included in the sample (see Table 1).

*Confirmatory factor analysis (CFA) – Responsive- didactic caregiving*

The CFA testing the factor structure of maternal responsive-didactic caregiving yielded an excellent model fit [$x^2$ (6) = 2.774, $p$= .837, RMSEA= .000, comparative fit index FI= 1.000, TLI= 1.007] supporting the hypothesis that the three latent factors, contingent response, cognitively stimulating language and autonomy promoting language would load onto a second order factor of maternal responsive-didactic caregiving. RDC explained 27% of the variance in contingent response, 73% of cognitively stimulating language, and 50% of the variance in autonomy promoting language. Contingent response was positively associated with cognitively stimulating language and autonomy promoting language ($r$=.56, $p$<.001; $r$=.50, $p$<.001) respectively. A correlation of ($r$=.79, $p$<.001) was observed between cognitively

stimulating language and autonomy promoting language. The factor scores were then exported for further analyses in SPSS 20 (see Table 2 for means and standard deviations of latent factor scores).

*Bivariate correlations and mean comparisons*

Prior to conducting the multiple regression analyses, bivariate correlations and independent sample t-tests for binary variables were carried out to determine which variables were associated with maternal RDC, infant advanced object play at 10 months and cognitive abilities at 18 months (see Table 3). Maternal RDC at 10 months was significantly associated with infant play at 10 months ($r$=.32, $p$<.001) and with child cognitive development at 18 months ($r$=.44, $p$<.001). A significant relationship was found between infant advanced object play at 10 months and cognitive abilities at 18 months ($r$=.19, $p$<.001). Significant associations were observed between maternal RDC and all maternal and family characteristics. Child development at 18 months was significantly associated with maternal age, education, employment level, ethnic background and adverse home environment, but not with family size (see Table 3) which was therefore not included in the second multiple regression model. Due to multicollinearity with maternal education, maternal employment was not included in further analyses. Girls were more likely to have higher scores on the MDI than boys, thus child gender was controlled for in the final analysis. The way in which RDC is measured in this study heavily relies on language, therefore, whether mothers spoke English as a first language was also entered as a control variable in both regression models.

*Maternal responsive-didactic caregiving (RDC), infant advanced play and cognitive development in context*

The next steps of the analyses included two multiple regression models. The first regression model tested whether infant advanced object play, mother and home characteristics predicted maternal RDC. Infant play was entered first followed by maternal characteristics and home adversity in the second step. As expected all variables significantly predicted maternal caregiving. Infant advanced play remained a significant predictor after taking maternal characteristic into account. Higher levels of maternal education and mother being older predicted higher levels of RDC, whereas being of a non-white ethnic background, speaking English as a second language, having more siblings and experiencing higher levels of home adverse environment predicted less RDC [$F$ (7, 387) = 139.45, p<.001]. Infant play accounted for 10% of the variance in maternal RDC, whilst mother and home characteristics explained a further 62% of the variance in maternal RDC (see Table 4).

The second model to predict cognitive development at 18 months was carried out in three steps. In the first step infant advanced object play was entered, followed by maternal and home characteristics, with maternal RDC added in the final step. Family size was removed from the second regression model, as it was not associated with 18-month cognitive development. It was hypothesised that maternal RDC would predict child cognitive development over and above infant play, maternal characteristics and contextual factors. Overall the model explained 22% of the variance 18 months cognitive ability. Infant advanced object play and gender predicted almost 5% of the variance, once mother and home characteristics were taken into account the model explained a further 9%, and when RDC was included in the model the remaining 8% were explained [$F$ (8, 377) = 14.39, p<.001]. More advanced infant play, higher levels of maternal education and less home adversity significantly predicted more advanced cognitive development at 18 months, but once

maternal RDC was taken into account these predictors were no longer significant. A standard deviation change in maternal RDC predicted over one-half a standard deviation increase in infant cognitive ability at 18 months. Child gender remained a significant predictor throughout, being female predicted better cognitive scores at 18 months. Interestingly, once RDC was included in the model, maternal English as a first language became a significant predictor, implying that maternal RDC, as recorded in this sample, heavily relies on language input (see Table 5). It is noteworthy that a parsimonious model including only significant predictors entered simultaneously explained almost 23% of the variance in infant cognitive ability at 18 months [$F$ (3, 383) = 38.67, p<.001]. All predictors remained significant: RDC (β=.54, p<.001); English as first language (β=.19, P=.001); gender-girl (β=.10, p=.03).

In light of the regression results a final analysis was carried out to test whether the effect of RDC on infant 18-months cognitive ability differ as a function of child gender and/or whether mother spoke English as a primary language. Interaction terms between maternal RDC and child gender, and RDC and maternal English as first language status were introduced to the parsimonious regression. The three remaining significant predictors were mean centred and multiplied to create the interaction items (Howell, 2012). The interaction between maternal RDC and child gender was not significant and no differences were observed in the parameter estimates of the predictor variables. Similarly no interaction was observed between RDC and English as first language, however, once the interaction term was included in the model, the effect of not having English as a first language became non-significant (β=.90, $p$=.370). The effect of RDC remained significant (β=.50, $p$<.001).

## DISCUSSION

The present study aimed to elucidate the transactional nature of mother-infant interactions and their relationship with subsequent cognitive development. The longitudinal design enabled a test of whether infants' contributions to interactions elicited specific maternal responsive-didactic behaviours that link with cognitive development. In addition, the possible correlates of maternal caregiving were explored to further understand the mechanisms by which mother characteristics and contexts influence intellectual abilities.

In the initial step it was found that maternal behaviours related to the three chief aspects of scaffolding, namely contingent response, cognitive stimulation and promotion of autonomy were observed in interactions between mothers and their 10-month-olds. The interactions were not 'end-producing' or the analysis sequential, thus the observed behaviours cannot be defined as scaffolding in the traditional sense. However, observational data are expected to be indicative of an underlying style of interaction or a general level of particular behaviours (Aspland & Gardner, 2003), and it has been shown that maternal behaviours remain stable over time (Bornstein & Tamis-LeMonda, 1990; Fuligni et al., 2013; Fuligni & Brooks-Gunn, 2013). Therefore, it is likely that such responsive-didactic behaviours may represent the antecedents of future contingent scaffolding.

It could be argued that the behaviours observed in the present study can be considered different aspects of general maternal responsiveness (see Tamis-LeMonda et al., 2014 for review). This may be the case; however the aim was to look at the combined effect of maternal contingent response and didactics in relation to infant abilities, previously shown to be two separate constructs (Page et al., 2010). These findings, based on a population of relatively advantaged UK mothers, are consistent

with McFadden and Tamis-LeMonda (2013). They found in their study of predominantly low-income USA mothers that a combined measure of responsive and didactic behaviours strongly predicted subsequent cognitive abilities over and above other maternal caregiving behaviours and characteristics. It is of note, however, that maternal language input explained a much larger proportion of the variance in RDC (about 74%), whereas contingent response accounted for a much lower proportion (14%). It is clear that in this investigation RDC is largely driven by individual differences in maternal language input, though it is also important to recognise that maternal language input is associated with mothers' response to child behaviour. In relation to didactic input, a significant overlap was observed between cognitively stimulating language and autonomy promoting language. However, these constructs were differentiated with the assumption that cognitively stimulating language represents referential language, whereas autonomy promoting language reflects more regulatory speech (see Tamis-Lemonda et al., 2013).

Infant advanced object play was found to predict maternal responsive and didactic caregiving confirming the expectation that infants who managed to 'find the solution' for the challenging toys would elicit more responsive and lexically varied input from their mothers and this in turn will enhance subsequent cognitive development. Previous studies by Bornstein and colleagues (2007) and Lugo-Gil and Tamis-LeMonda (2008) support these findings that infants who are more advanced in their abilities attract more responsive and didactic feedback from their caregiver. This in turn provides the infant with a richer experience of the world and more opportunities for learning. This relationship must, however, be interpreted with caution. Some argue that parents and children influence one another in equal measures (McFadden & Tamis-LeMonda, 2013) and it is clear that there is a

bidirectional relationship between maternal input and infant play (Bigelow et al., 2004). What is more, shared biological factors are likely to be implicated in reciprocity between mother and infant as well as infant cognitive development and maternal propensity to interact in a particular way (Song et al., 2014), meaning that making assumptions about the direction of influence between mother and infant may be somewhat problematic.

Maternal characteristics and context predicted mothers' tendency to be more or less responsive and didactic in her behaviour. Older maternal age predicted greater presentation of maternal RDC, as was shown by Keowen, et al. (2001). It was also found that having a higher level of education predicted more responsive-didactic caregiving. This is in keeping with previous findings, suggesting that higher levels of maternal education were associated with greater maternal sensitivity, more verbal input (Page et al., 2010) and more complex scaffolding strategies (Lowe et al., 2013) during mother-infant interactions.

Ethnicity was another factor in this study explaining variance in maternal responsive-didactic caregiving; mothers from white British ethnic background were likely to show more responsive-didactic behaviours. Previous research with ethnically diverse samples in the United States showed mixed findings. No significant differences were found in didactic/responsive behaviours in mothers from Dominican, African-American and Mexican backgrounds (Tamis-LaMonda et al., 2013). Similarly Fuligni et al. (2013) found that European-American, African-American and Latin-American mothers showed similar patterns of supportive behaviours, however they identified differing mean levels of supportiveness as a function of ethnic group, suggesting that although mothers from different ethnic backgrounds may present the same behaviours, the degree to which such behaviour occurs may differ. To ascertain

whether the differences in presentation of RDC as a function of ethnicity were related to mothers' first language, whether mother spoke English as a first language was included as a covariate. The effect of ethnicity on RDC remained even after taking mother first language into consideration.

The context of the home environment was also predictive of maternal responsive and didactic behaviours. Family size, having more than one child, predicted less RDC, suggesting that as family size increase, mothers' tend to invest less in interactions with their infants. However, it is of note that although family size was associated with maternal behaviours, a relationship with subsequent infant outcomes was not observed. Nevertheless, this was not the case for adverse living environment. Living in low-quality, over-crowded and insecure housing predicted both maternal RDC and child cognitive abilities. The Environmental Adversity Index used in this investigation to measure household adversity may reflect aspects of socioeconomic disparities and household disorder both associated with less responsive and didactic caregiving. Socioeconomic status has been found to affect both didactic input (Hart & Risely, 1995; Lowe et al., 2013) and sensitive responding (Prime et al., 2015). A less-ordered, more chaotic home environment has been associated with both negative and positive parent-child relationship (Coldwell, Pike & Dunn, 2006) and higher levels of intrusive, non-contingent and less didactic style of interaction (Matheny, Wachs, Ludwig & Phillips, 1995).

The findings suggest that maternal RDC is one mechanism by which context and maternal characteristics may influence cognitive development. The final regression model showed that, before taking maternal RDC into consideration, more infant advanced object play and mothers being educated to a degree level or above predicted better cognitive functioning at age 18 months, whereas having a more

adverse home environment had the opposite effect. Infant advanced object play at 10 months was the strongest predictor of cognitive abilities 8 months later, but once maternal RDC was taken into consideration it was no longer predictive. A likely process is that infants who were more able at 10 months elicited their mothers' responsiveness; mothers then responded in a more didactic manner, enhancing infants' learning and cognitive abilities in turn. This emphasises infants' impact on their own environment, which can promote or delay development (Song et al., 2014). Furthermore, maternal RDC predicted infant cognitive development above and beyond maternal education and adverse living conditions; this suggests that the associations between these factors and infant cognitive abilities are at least in part accounted for by variations in maternal RDC. This corresponds to recent findings showing that maternal responsive and didactic behaviours mediate the effects of socioeconomic indicators on children's development of EF (Cuevas et al., 2014; Hackman et al., 2015), and receptive vocabulary (Prime et al., 2015).

Unlike other coding schemes such as Biringen's (2008) EAS, aimed at evaluating the general affective quality of parent-child interactions, the coding scheme employed in this study largely focused on maternal language input in the context of cognitive development. As the coding was largely dependent on language it is perhaps not surprising that once maternal RDC was taken into consideration in the final model, maternal spoken language became a significant predictor of infant cognitive development at 18 months. The subsequent moderation analysis did not reveal a significant interaction between the two factors.

*Strengths and limitations*

The representativeness and size of the sample is one of the study's strengths. This sub-sample was chosen at random from the FCCC sample and no differences

were observed with the remainder of the FCCC participants on any demographic information increasing the generalisability of the findings. This representativeness is a strength providing evidence from UK mothers corresponding with findings from USA studies. It is also a limitation in that the FCCC sample did not include a large proportion of ethnic minority families or mothers with no educational qualifications.

A second strength is that specific behaviours recorded during a very brief interaction are associated with both context recorded by home visitors and maternal reports and with child outcomes 8 months later. A recent study by Prime et al. (2015) showed that a new, quick to administer instrument measuring maternal cognitive sensitivity at age three, had substantial overlaps with the gold standard measure of sensitivity. In addition to that it was found to predict child receptive vocabulary a year later.

There are a number of limitations to the study. The affective aspect of mother-infant interaction was not taken into account in this investigation, although it is often treated as an integral part of scaffolding interactions (Neitzel & Stright, 2003). Although it was hypothesised that infant advanced object play will be the determinant of maternal responsive-didactic caregiving, one cannot ignore the possibility that maternal behaviour determines the maturity of child play. This study is a secondary data analysis of existing data and no information was collected about child abilities prior to 18 months, meaning that earlier abilities cannot be used as covariates. To assist in elucidating the direction of influence, factors that could be taken into consideration in future research are maternal experiences of care in her family of origin, said to influence the way in which mothers interact with their children (Belsky et al., 2005), and child temperament, said to increase/reduce susceptibility to specific rearing experiences (Belsky, Bakermans-Kranenburg & van IJzendoorn, 2007).

## CONCLUSIONS

The findings of this study provide some evidence that that maternal responsive-didactic caregiving when infants are aged 10 months is a coherent concept and is predictive of infant cognitive development 8 months later, taking into account infant advanced object play and family context. Both contingent response and didactic input appear to matter in interactions as early as the first year. It remains to be seen whether the behaviours observed during these brief interactions remain predictive of child cognitive abilities at later stages of development.

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CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest.

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Table 1: Characteristics of child, mother and contextual factors of the study sub-sample and the remainder of the FCCC sample (mean and standard deviation in brackets for continuous factors, N and percentage in brackets for categorical factors)

| | Included in study | Remainder of FCCC sample | Difference |
|---|---|---|---|
| | N=400 | N=801 | $P$ / $\chi^2$ |
| *Infant* | | | |
| Bayley MDI 18 months | 91.89 (13.33) | 92.77 (13.36) | *n.s.* |
| *Mother Characteristics* | | | |
| Maternal age | 30.93 (5.26) | 31.04 (5.27) | *n.s.* |
| *Maternal education* | | | |
| No Degree (%) | 221 (55.53) | 407 (51.06) | *n.s.* |
| University degree or above (%) | 177 (44.47) | 390 (48.94) | *n.s.* |
| *Maternal ethnicity* | | | |
| White British (%) | 323 (80.75) | 626 (78.15) | *n.s.* |
| Minority (%) | 77 (19.25) | 175 (21.85) | *n.s.* |
| *Maternal first language* | | | |
| English (%) | 368 (92.90) | 668 (83.00) | *.001* |
| Not English (%) | 28 (7.10) | 137 (17.00) | *.001* |
| *Maternal employment status* | | | |
| Working class (%) | 167 (41.75) | 314 (39.20) | *n.s.* |
| Intermediate level (%) | 67 (16.75) | 154 (19.23) | *n.s.* |
| Professional/Managerial (%) | 166 (41.50) | 333 (41.57) | *n.s.* |
| Mother in employment[a] (%) | 209 (52.80) | 361 (53.00) | *n.s.* |
| Mother not in employment (%) | 187 (47.20) | 319 (46.80) | *n.s.* |
| *Contextual Factors* | | | |
| Adverse home environment[b] | -0.03 (0.98) | 0.02 (1.01) | *n.s* |
| First-born (%) | 205 (51.25) | 411 (51.31) | *n.s.* |
| Siblings (%) | 195 (48.75) | 390 (48.69) | *n.s.* |

[a] Mother is employed at 10 months
[b] Standardised score of the environmental adversity index (EAI) collected at 3 months.
n.s. not significant

Table 2: Descriptive statistics (mean and standard deviation) for maternal responsive-didactic caregiving latent factor scores

| Item | Mean | SD | Range |
|---|---|---|---|
| Contingent response | .21 | 1.05 | -3.23 - 1.96 |
| Cognitive stimulation | .06 | 1.19 | -3.11- 3.18 |
| Transfer of responsibility | .01 | .98 | -2.34 - 2.25 |
| Responsive-didactic caregiving | .15 | 1.08 | -3.33 - 2.82 |

Table 3: Significant mean comparisons and bivariate correlation coefficients between observed maternal, infant behaviour and child cognitive outcome with demographic characteristics and contextual factors (for binary variables means are provided with standard deviations in brackets)

| | Maternal Responsive-didactic caregiving | Infant advanced object play -10 months | Bayley MDI - 18 Months |
|---|---|---|---|
| *Mean Comparisons* | | | |
| Child Gender [a] | | | |
| Male | .11(1.05) | .14 (.13) | 90.08 (13.2) |
| Female | .19 (1.12) | .15 (.13) | 93.63 (12.28) |
| *t-value* | -.76 | -.96 | -2.66** |
| Maternal Education [b] | | | |
| No Degree | -.24 (1.05) | .15 (.14) | 89.31(12.82 |
| University degree or above | .62 (.93) | .15 (.12) | 95.06 (13.34) |
| *t-value* | -8.50** | .33 | -4.31** |
| Maternal Ethnicity [c] | | | |
| White British | .41 (.91) | .15 (.13) | 92.96 (12.8) |
| Minority | -.95 (1.08) | .13 (.10) | 87.36 (14.61) |
| *t-value* | 10.20** | 1.32 | 3.33** |
| Maternal first language [d] | | | |
| English | .31 (.92) | .15 (.14) | 92.23 (13.3) |
| Other | -1.94 (.88) | .11 (.11) | 87.14 (13.23) |
| *t-value* | 12.47** | 1.44 | 1.95† |
| *Bivariate correlations* | | | |
| Maternal Age | .26** | .01 | .18** |
| Maternal employment type [e] | .42** | .05 | .25** |
| Number of Siblings | -.15** | -.12* | -.07 |
| Home Adverse Environment [f] | -.53** | -.07 | -.26** |

[a] Coded 0 = male, 1 = female.
[b] Coded 0 = no degree, 1 = university degree or above.
[c] Coded 0 = white British, 1 = minority
[d] Coded 0 = English first language, 1 = English not first language
[e] Coded 1 = working class, 2 = intermediate, 3 = professional/managerial
[f] Standardised score of the environmental adversity index (EA
†p <.10; * $p$<.05; **$p$<.001

Table 4: Multiple regression analysis predicting maternal responsive-didactic caregiving from infant advanced object play, maternal and home characteristics

| | **B** | **β** | $\Delta_{R^2}$ |
|---|---|---|---|
| **Step 1** | | | .10** |
| Infant advanced object play | 2.66 | .32** | |
| **Step 2** | | | .62** |
| Infant advanced object play | 2.08 | .25** | |
| Maternal Age | .02 | .09* | |
| Maternal Education [a] | .62 | .28** | |
| Maternal Ethnicity [b] | -.73 | -.27** | |
| Maternal English first Language [c] | -1.68 | -.40** | |
| Siblings [d] | -.16 | -.08* | |
| Home Adverse Environment [e] | -.31 | -.29** | |

Total variance explained by the model 71%
B = Unstandardised coefficient; β = standardised coefficient; $\Delta_{R^2}$= $R^2$ change
[a] Coded 0 = no degree, 1 = university degree or above.
[b] Coded 0 = white British, 1 = minority.
[c] Coded 0 = English first language, 1 = English not first language
[d] Coded 0 = only child, 1 = has siblings
[e] Standardised score of the environmental adversity index (EAI)
*$p$ <.05; **$p$<.001

Table 5: Multiple regression analysis predicting child cognitive abilities at 18 months (Bayley MDI BSID-II) from child, mother and home characteristics and maternal responsive didactic caregiving

| | **B** | **β** | $\Delta_{R^2}$ |
|---|---|---|---|
| **Step 1** | | | .05** |
| Gender | 3.25 | .12* | |
| Infant advanced object play | 18.89 | .18** | |
| **Step 2** | | | .10** |
| Gender | 3.02 | .11* | |
| Infant advanced object play | 17.35 | .17** | |
| Maternal Age | .18 | .07 | |
| Maternal Education [a] | 3.92 | .15* | |
| Maternal Ethnicity [b] | -2.98 | -.09 | |
| Maternal English first Language [c] | -2.19 | -.04 | |
| Home Adverse Environment [d] | -2.20 | -.16* | |
| **Step 3** | | | .08** |
| Gender | 2.54 | .10* | |
| Infant advanced object play | 3.27 | .03 | |
| Maternal Age | .09 | .04 | |
| Maternal Education | -.27 | -.01 | |
| Maternal Ethnicity | 1.68 | .05 | |
| Maternal English first Language | 8.77 | .17* | |
| Home Adverse Environment | -.14 | -.01 | |
| Maternal Responsive Didactic Caregiving | 6.50 | .53** | |

Total variance explained by the model 22%

B = Unstandardised coefficient; β = standardised coefficient; $\Delta_{R^2}$= $R^2$ change

[a] Coded 0 = no degree, 1 = university degree or above.

[b] Coded 0 = white British, 1 = minority.

[c] Coded 0 = English first language, 1 = English not first language

[d] Standardised score of the environmental adversity index (EAI)

*$p$ <.05; **$p$<.001