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## **The measurement properties and acceptability of a new parent-infant bonding tool (‘Me and My Baby’) for use in UK universal healthcare settings: A psychometric, cross-sectional, study**

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18 **Keywords: Bonding<sub>1</sub>, Parent<sub>2</sub>, Baby<sub>3</sub>, Measure<sub>4</sub>, Psychometrics<sub>5</sub>.**

### **Abstract**

20 NICE guidelines acknowledge the importance of the parent-infant relationship for child  
21 development but highlight the need for further research to establish reliable tools for assessment,  
22 particularly for parents of children under one year.

23 This study explores the acceptability and psychometric properties of a co-developed tool, ‘Me  
24 and My Baby’ (MaMB).

### **Study design**

27 A cross-sectional design was applied. The MaMB was administered universally (in two sites)  
28 with mothers during routine 6–8-week Health Visitor contacts. The sample comprised 467  
29 mothers (434 MaMB completers and 33 ‘non-completers’).

30 Dimensionality of instrument responses were evaluated via exploratory and confirmatory ordinal  
31 factor analyses. Item response modelling was conducted via a Rasch calibration to evaluate how  
32 the tool conformed to principles of ‘fundamental measurement’. Tool acceptability was  
33 evaluated via completion rates and comparing ‘completers’ and ‘non-completers’ demographic  
34 differences on age, parity, ethnicity, and English as an additional language. Free-text comments  
35 were summarised. Data sharing agreements and data management were compliant with the  
36 General Data Protection Regulation, and University of York data management policies.

### **Results**

39 High completion rates suggested the MaMB was acceptable. Psychometric analyses showed the  
40 response data to be an excellent fit to a unidimensional confirmatory factor analytic model. All  
41 items loaded statistically significantly and substantially (>0.4) on a single underlying factor  
42 (latent variable). The item response modelling showed that most MaMB items fitted the Rasch

43 model. (Rasch) item reliability was high (0.94) yet the test yielded little information on each  
44 respondent, as highlighted by the relatively low ‘person separation index’ of 0.1.

45

### 46 **Conclusions and next steps**

47 MaMB reliably measures a single construct, likely to be infant bonding. However, further  
48 validation work is needed, preferably with ‘enriched population samples’ to include higher-  
49 need/risk families. The MaMB tool may benefit from reduced response categories (from four to  
50 three) and some modest item wording amendments. Following further validation and reliability  
51 appraisal the MaMB may ultimately be used with fathers/other primary caregivers and be  
52 potentially useful in research, universal health settings as part of a referral pathway, and clinical  
53 practice, to identify dyads in need of additional support/interventions.

## 54 **1 Introduction**

55 As mothers are typically primary caregivers, the current study evaluated the MaMB for use by  
56 mothers. Maternal bonding can be defined as a mother’s emotional connection and feeling  
57 towards her child (Condon, 1993). Bonding is often conflated with attachment. Whilst the  
58 constructs are related, they are distinct (Bowlby, 1982; Redshaw and Martin, 2013). Maternal  
59 bonding refers to a mother’s (typically self-reported) emotional connection and feelings towards  
60 their child. Attachment on the other hand, refers to an infant’s expectations of their caregiver’s  
61 responses and the pattern of their own behaviour, e.g., when activated in response to a perceived  
62 threat. Attachment typically develops from six months, whereas a mother’s bond to the infant  
63 begins to develop during pregnancy. Stronger bonding is theoretically linked to more frequent  
64 expression of behaviours such as maternal sensitivity and emotional availability (Feldman et al.,  
65 1999), which in turn foster positive interactions within the dyad and promote social and  
66 emotional development, including the development of secure attachment in the infant (Ainsworth  
67 et al., 1978; Le Bas et al., 2019).

68 Two systematic reviews (Branjerdporn et al., 2017; Le Bas et al., 2019) indicate that strong  
69 maternal bonding in pregnancy is associated with optimal child developmental outcomes. The Le  
70 Bas et al. (2019) review also suggested that higher affective postnatal parent-infant bond was  
71 predictive of positive child development outcomes. Both reviews suggested the findings should  
72 be interpreted with caution due to the relative paucity of studies in this area and highlighted the  
73 need for more robust self-report measures of bonding.

74 There are currently no agreed, standardised, methods for identifying mother/parent-infant dyads  
75 who may benefit from additional support around bonding and relationships in England. Although  
76 Health Visitors (HVs) work directly with parents some research suggests that they may struggle  
77 to consistently identify problems in the parent-infant relationship (Appleton et al., 2013; Elmer et  
78 al., 2019; Kristensen et al., 2017; Wilson et al., 2010). Relevant NICE guidelines acknowledge  
79 the importance of parent-infant relationship for child development and parent mental health but  
80 highlight the need for further research to establish reliable tools for assessment, particularly for  
81 parents of children under the age of 1 year (NICE, 2012, 2015).

82 There is a distinct need for validated, robust measures to be administered universally to identify  
83 and support families who may struggle with their parent-infant relationship. Parent-infant  
84 relationship is a key focus in the Early Years High Impact Area 2: supporting good parental  
85 mental health (PHE, 2020) due to the risks to subsequent child social and emotional development  
86 arising from poor parent-infant relationships (Cassidy et al., 2013; Fearon et al., 2010). A  
87 reliable, valid, identification tool could allow services to more confidently signpost parents who  
88 may benefit to one of the emerging evidence-based interventions (Barlow et al., 2010; Barlow et  
89 al., 2016; Facompre et al., 2018; Wright et al., 2015).

90 A very limited number of brief parent self-report tools exist that assess maternal-infant bonding,  
91 are freely available, and have some reliability and validity (Blower et al., 2019; Gridley et al.,  
92 2019; Kane, 2017; Wittowski et al., 2020), for example; Maternal Attachment Inventory (MAI;  
93 Müller, 1994); Maternal Postnatal Attachment Scale (MPAS) (Condon and Corkindale, 1998);  
94 Postpartum Bonding Questionnaire (PBQ) (Brockington et al., 2006); Mother Infant Bonding  
95 Scale (MIBS) (Taylor et al., 2005). However, most are not widely used, or have been validated  
96 with a small sample (for further discussion see Wittowski et al., 2020; Le Bas et al., 2019). A  
97 further two reviews, Blower et al., 2019 and Gridley et al., 2019 were undertaken to explore  
98 which measures would be acceptable, reliable, and valid for a large randomised controlled trial  
99 of a parenting intervention for parents of infants and toddlers and it was found that choice of  
100 measures was very limited (the trial was led by TB, the first author. For the protocol see Bywater  
101 et al., 2018).

102 The 19-item MPAS, which has preliminary evidence of reliability and validity (Kane, 2017;  
103 Wittowski et al., 2020) is the most used tool when linking maternal-infant bonding to later child  
104 development outcomes (Le Bas et al., 2019). The MPAS was piloted (with the involvement of  
105 the first and second authors) with 347 mothers in universal health visiting services (Dunn et al.,  
106 submitted; Bird et al., submitted) as part of Better Start Bradford - a 10-year National Lottery  
107 Community Fund project aimed at improving the socio-emotional development, nutrition and  
108 communication skills of children aged 0-3 living in deprived multi-ethnic communities  
109 (Dickerson et al., 2016). The pilot concluded that the MPAS could not be recommended for use  
110 in health visiting services in Bradford to assess parent-infant relationship due to; little variation  
111 in the responses of the 225 who completed the MPAS in English; an unexpected ceiling effect;  
112 issues with scoring, parental acceptability and understanding. The E-SEE trial found similar  
113 findings, with lack of variation in scores on a sample of 341 (Bywater et al., 2021 (submitted)).  
114 Using the learning from the MPAS pilot the study team co-developed a new tool, “Me and My  
115 Baby” (MaMB), in an iterative process via workshops and interviews with Health Visitors,  
116 Clinical Psychologists, service staff, Managers and parental input, to address the issues  
117 highlighted in the MPAS pilot. Prior to a measure being recommended for use in any context,  
118 evidence of the measurement properties should be established (Cooper, 2019). Psychometric  
119 properties comprise two overarching dimensions - validity and reliability. Validity is defined as  
120 the degree to which an instrument measures the construct(s) it purports to measure, and  
121 reliability is the degree to which a measure is free from measurement error (de Vet et al., 2015).  
122 Acceptable reliability is thus a necessary, though not sufficient, condition for achieving valid  
123 scores from an instrument. ‘Reliability’ also relates to the important concept of ‘test  
124 information’; that is, the trait level at which the instrument is most capable of discriminating  
125 between test takers/respondents. Thus, a test’s ‘information curve’ has important implications for  
126 how it is optimally used in practice; for example, when identifying a screening cut-off score.  
127 This study was therefore intended to evaluate the measurement model for the MaMB and  
128 acceptability when implemented in routine practice, as a prerequisite to further studies aiming to  
129 establish validity of the tool. The main aim was to address previous paucity and quality of  
130 available tools to assess parent (mother)-infant relationship, specifically bonding, by developing  
131 a measure for use in research as well as universal health settings as part of a referral pathway,  
132 and potentially clinical practice, to identify dyads in need of additional support or interventions.  
133 The research objectives for this study were:

- 134 1. To explore MaMB pilot data to determine the item and test properties in relation to  
135 dimensionality and reliability, in terms of both internal consistency and test information; and
- 136 2. To identify any necessary revisions to MaMB following the results of our psychometric  
137 analysis.

138 These findings would have implications for which items would be retained in a final version of  
139 instrument, and how the scores might be best summarised and used in practice. The work also  
140 paves the way for validation studies.

## 141 **2 Materials and Methods**

### 142 **The tool under investigation**

143 The MaMB questionnaire (for further information see Appendix 2, and the protocol at  
144 <https://osf.io/q3hmf/>) has 11 items presented in a user-friendly format. Responses are indicated  
145 using a four-point Likert scale (‘never’, ‘sometimes’, ‘often’, or ‘always’, scored 0-3 with four  
146 reversed scored items). The language of items is simple to understand with a reading age of  
147 approximately 12, similar to that for popular magazines. A free text box is also included to give  
148 mothers the opportunity to record any comments or concerns they have about their relationship  
149 with their infant. Lower scores indicate a stronger affective bond.

150

### 151 **Research questions**

152 RQ1: Is the MaMB acceptable to mothers of infants (aged 6-8 weeks) and HVs when  
153 administered in a universal healthcare setting?

- 154 a) As a proportion of all eligible dyads, how many complete the MaMB?
- 155 b) What are the reasons given for non-completion?
- 156 c) Are the free text boxes completed by parents and what information is being  
157 recorded/reported in them?

158 RQ2: What are the measurement properties of the MaMB?

- 159 a) What is the most plausible dimensionality (factor structure) of the MaMB?
- 160 b) Does the scale (or subscales if applicable) of the MaMB demonstrate acceptable  
161 levels of internal consistency?
- 162 c) According to item response modelling, do the items demonstrate an acceptable fit to  
163 the Rasch model, implying that the summed scores from the instrument can be used  
164 as a ‘sufficient summary statistic’?
- 165 d) What is the relative level of information yielded for respondents by the test (or  
166 putative scales), and where might a potential cut-off score be best placed that most  
167 accurately differentiates between two groups of test-takers?

### 168 **Design**

169 A cross-sectional design was applied.

170 A briefing was prepared in partnership with Rotherham Doncaster and South Humber NHS  
171 Foundation Trust (RDaSH) to support the training of HVs in the use of the tool. The briefing  
172 covered the purpose of the tool, how to introduce it to families, how to score it and how to  
173 interpret the scores.

174 The MaMB was implemented universally (in two RDaSH localities) with eligible mothers during  
175 the 6–8 week routine HV contact following completion of the core mandated elements of the  
176 visit.

177 HVs asked mothers to complete a paper version of the tool, with support if needed or requested.  
178 During tool completion HVs were expected to use their professional skills to discuss with parents  
179 their relationship with their infant. If HVs were unable to complete the tool (e.g., due to time  
180 constraints) they would record the reason(s) for non-completion.

181 HVs inputted the responses electronically into the case management software (SystemOne) co-  
182 developed template to include; if tool administration was attempted, and if not why, and if tool  
183 administration had been abandoned prior to completion. The template also captured responses to  
184 all 11 items, and the free text responses to the open question on the back page of the paper tool,

185 and HVs comments on the interaction. Key demographic variables were also recorded to  
186 adequately describe the sample’s characteristics and to support subgroup analyses.  
187 The research team received anonymised (numerical and free text) data extracted from SystemOne,  
188 and a small number of key demographic characteristics such as age, ethnicity, and parity.

### 189 **Study setting**

190 Two RDaSH sites in Northern England implemented the MaMB at the 6-8 week universally  
191 mandated HV contact.

### 193 **Inclusion/exclusion criteria**

194 All mothers of a child aged 6-8 weeks living in the sites were eligible for the study.  
195 If a parent had opted out of NHS digital they may have completed the MaMB but were not  
196 included in the study (in England, NHS patients can choose to opt out of their confidential  
197 patient information being used for research and planning).

### 199 **Consent**

200 This study received ethical approval on 21st August 2020 by South Central - Berkshire B  
201 Research Ethics Committee, UK, Ref: 20/SC/0266, Integrated Research Application System  
202 (IRAS) 201, project ID: 273708.

203 Parents were given a MaMB Participant Information Sheet (V2.0 17<sup>th</sup> August 2020; See  
204 Appendix 1) at a visit prior to the 6-8-week check to give them time to read and understand why  
205 they will be asked to complete the MaMB.

206 Written consent from mothers completing the MaMB, and for the non-identifiable fully  
207 anonymized, data to be shared with the research team, was not required. This was because:

- 208 (1) The research team only accessed anonymised data. Data were restricted to the minimum  
209 needed to describe the sample and to conduct the proposed analyses of measurement  
210 properties and acceptability. Free text boxes, where completed, and were screened by an  
211 authorised RDaSH employee to remove any identifiable information prior to data sharing.
- 212 (2) There was no risk of harm to participants from completing the MaMB. The tool was one  
213 of several used by HVs to conduct a broad needs assessment, as is standard at the 6–8-  
214 week contact. The MaMB supplemented existing tools and was implemented in addition  
215 to standard care. HVs are trained and well equipped to support mothers who may be  
216 struggling to bond with their baby.
- 217 (3) It was deemed essential that the MaMB sample was representative of mothers of young  
218 infants in the research site so that the study findings are generalisable. Introducing an  
219 informed consent process would likely have led to selection bias, arising from parent and  
220 practitioner characteristics and attitudes.
- 221 (4) There is a clear value and benefit from doing the research, i.e., a need for a short, easy-to-  
222 administer, valid and reliable measure to support practitioners to identify families  
223 experiencing difficulties in their parent-infant relationship. The MaMB has been co-  
224 developed by academics, psychologists and HVs with parental input to address this gap,  
225 it is vital that this measure is tested before it can be recommended for use more widely.

### 226 **Sample size**

228 The average number of live births per year in the year prior to the study was 3460 in Site 1  
229 (Doncaster) and 3000 in Site 2 (North Lincolnshire), which would yield approximately 538  
230 births per month. Assuming a conservative 50% completion rate (allowing for potential  
231 implementation/uptake barriers such as time constraints, parent refusal or practitioner non-  
232 compliance, time lag in implementation and data entry) we anticipated 269 MaMBs would be

233 completed per month. To construct a sample large enough to support the analysis of  
234 psychometric properties we proposed a sample of 673 over a ten-week period. Based on a 50%  
235 completion rate, the overall sample would include a further 673 non-completers to explore  
236 acceptability (total n=1346). Please note this sample size was calculated pre-COVID-19.

237

## 238 **Psychometric analyses**

### 239 **RQ1**

240 To assess acceptability of the tool reported the proportion of participants who were recorded as  
241 being offered the tool but either refused, or failed to complete, it. Where data were available  
242 descriptive analysis of the reasons for refusal was to be produced.

243 Key demographic characteristics (age, parity, ethnicity, English as an additional language) of  
244 completers and non-completers were to be presented in contingency tables as either frequency  
245 counts or means for descriptive purposes.

246 A frequency count was intended to determine the proportion of completers who used the free-  
247 text box to expand on their answers. Free-text comments were to be summarised in a brief  
248 narrative.

### 249 **RQ2**

#### 250 Dimensionality and internal consistency reliability

251 The sample was originally intended to be randomised into exploratory and confirmatory  
252 (‘validation’) datasets, if the data obtained were sufficient to support this approach. Initially  
253 dimensionality was planned to be explored in the former data subset using parallel analysis (see  
254 below for details) (Horn, 1965). Once this had been established, it would be followed by an  
255 exploratory factor analysis (EFA) of exploratory portion of the response data. The potential  
256 factor structures elicited would then be tested using confirmatory factor analyses (CFA) on the  
257 confirmatory (validation) dataset. Internal reliability consistency of the postulated subscales  
258 would then be examined. The findings of these analyses were intended to indicate whether it is  
259 appropriate to summarise bonding via several subscales or simply by a single total overall score  
260 for the MaMB.

261 The parallel analysis would be performed using unweighted least squares (ULS) as the  
262 estimation method (Horn, 1965; Lorenzo-Seva and Ferrando, 2006). In a parallel analysis the  
263 maximum plausible number of factors to be retained is indicated at the point where the  
264 eigenvalues of the randomly generated data exceed those of the actual data. A series of EFAs  
265 was expected to be then performed to aid interpretation of any factors underlying the response  
266 patterns observed. Oblique (geomin) rotations were to be used in the factor analyses, assuming  
267 that, as in almost all psychological measures, underlying latent traits would be correlated with  
268 each other to some extent. The EFAs will be repeated, again using a geomin rotation, to derive  
269 standard errors (and thus standardised Z scores) for the factor loadings to evaluate their relative  
270 statistical significance (Asparouhov and Muthén, 2009). All EFAs and CFAs were to be  
271 conducted in Mplus version 6.1 employing robust weighted least squares (WLSMV) as the  
272 estimation method, or ‘full information maximum likelihood’, as appropriate.

273 Internal reliability consistency for the putative subscales based on the CFA structure was to be  
274 evaluated using Cronbach's alpha and McDonald's omega. Cronbach's alpha may be a poor index  
275 of internal reliability where tau-equivalence (equality of factor loadings across items in a scale)  
276 does not hold (Raykov, 1997). In this respect McDonald's omega is reported to represent a more  
277 accurate estimate of the extent to which items in a scale measure a unidimensional underlying  
278 construct.

#### 279 Item response modelling

280 Item response modelling and theory (IRT) is based on the modified factor analysis of binary and  
281 categorical data. Within the family of IRT models Rasch analysis was originally developed for  
282 the exploration of dichotomous responses to test items (Rasch, 1960), though was subsequently

283 extended to accommodate polytomous data. Rasch analysis can be used to create interval metrics  
284 of both item difficulty and respondent ability from ordinal (ordered categorical) or binary  
285 (dichotomous) response data. The Rasch model assumes that all items are identical in terms of  
286 their ability to discriminate between respondents according to ability/trait (i.e., equality of item  
287 factor loadings in classical factor analytic terms). For the present Rasch analysis the software  
288 package Winsteps version 4.01 was used (Linacre, 2017). A partial credit model was applied to  
289 the categorical MaMB item responses. In a Rasch analysis reliability can be appraised in several  
290 ways. Specifically, the person reliability coefficient relates to the replicability of the ranking of  
291 abilities while the person separation index represents the signal to noise ratio and estimates the  
292 ability of a test to reliably differentiate different levels of ability within a cohort (Wright and  
293 Masters, 1982).

294 Power issues in Rasch analysis are a matter for debate with some authors suggesting that around  
295 200 respondents are required to accurately estimate item difficulty whilst others suggest as few  
296 as 30 participants may be required in well-targeted tests (i.e. those where difficulty is well  
297 matched to ability) (Baur and Lukes, 2009; Goldman and Raju, 1986; Linacre, 1994). Thus, this  
298 study should be adequately powered to estimate item properties from both Rasch analysis as well  
299 as the factor analyses, the latter of which could be considered re-parameterized two parameter  
300 logistic regression IRT models. Thus, the fit of items to the Rasch model was to be assessed and  
301 any potential sources of misfit diagnosed. This will be important in deciding whether it is  
302 appropriate to summarise the scores on the scale/s as summed totals. Moreover, the Rasch  
303 calibration was intended to allow the evaluation of test information, which would indicate to  
304 what extent the test is able to differentiate test-takers across the putative trait levels under  
305 evaluation (assumed to be ‘perceived bonding with baby’).

### 306 **Data handling and sharing**

307 Fully anonymised data was exported from SystmOne and shared with the study team via the  
308 University of York secure drop off service, which securely encrypts data. Data management is  
309 compliant with the General Data Protection Regulation (GDPR) and University of York data  
310 management policies. The custodian of data, Professor Tracey Bywater (Chief Investigator), is  
311 the contact point for any data management queries.

### 313 **3. Results**

314 The pilot ran 10<sup>th</sup> September 2020 to 1<sup>st</sup> December 2020, and the MaMB was administered either  
315 face to face or over the telephone depending on COVID-19 restrictions at the time of  
316 administration.

317 See Figure 1 for a flow of participants through the study.

318

319

320

### **INSERT FIGURE 1 HERE**

321 The 434 response rate from the eligible 928 women equates to a 47% response rate, close to the  
322 predicted 50%.

323 The target sample size of 673 for MaMB completion was not achieved, and we only have data  
324 for 33/494 women who did not complete the MaMB rather than the proposed 673. The birth rate  
325 was lower than expected, and HVs changed to telephone rather than face to face visits during the  
326 study due to COVID.

327 Results will be presented in order of the research questions.

328 **RQ1:** Is the MaMB acceptable to mothers of infants (aged 6-8 weeks) and HVs when  
329 administered in a universal healthcare setting?



## ‘Me and My Baby’ (MaMB)

- 330 a) As a proportion of all eligible dyads, how many complete the MaMB?  
331 b) What are the reasons given for non-completion?  
332 c) Are the free text boxes completed by parents and what information is being  
333 recorded/reported in them?  
334

335 Table 1 shows the characteristics of the sample who completed the MaMB. The sample appears  
336 to represent the local population regarding ethnicity (83% white British, 10% White other, 7%  
337 Black, Asian, Multi-ethnic and other) and language (80% English as a first language, 6%  
338 missing). Although the numbers are small and we cannot draw conclusions from them, the 33  
339 non-completers appeared to differ on ethnicity and language, which may be a reason for not  
340 completing the MaMB, e.g., 24% were white ‘other’ in the non-completers, compared to 10% in  
341 the completers. Likewise, 38% of non-completers needed an interpreter compared to 14% from  
342 the completers. Although 461 cover sheets for non-completers were missing, there was minimal  
343 missing data at item-level for those that were returned.

### INSERT TABLE 1 HERE

344  
345  
346 From the 434 respondents who completed a MaMB 50 had one or more missing items. Scores  
347 from the 384 who fully completed the MaMB tool suggest that the sample had positive  
348 relationships with their baby, mean = 1.2 (SD 1.6), with a median summed score of 1 (inter-  
349 quartile range 0 to 2) from a possible 33 (the lower the score indicating the more positive the  
350 perception of the mother-baby relationship), and a range of 0-15.  
351 Twenty-nine respondents (parents and HVs) completed the free-text box with some mothers  
352 saying they felt guilty that they could not give more time to their baby or felt less than positively  
353 to toward their child at times, e.g;

354 *“I feel guilty for having less positive feelings especially when he is screaming”*

355 *“I feel I need time by myself sometimes, but feel guilty that I feel like that as a mum”*

356 Four mothers mentioned that they had not been separated from their baby yet, so items 8 and 10  
357 were not applicable.

### 358 **RQ2: What are the measurement properties of the MaMB?**

359 From 467 mothers 33 had no MaMB questionnaire data whatsoever, leaving 434 participants  
360 with some response data. The original plan was to divide up the data, randomly, into a training  
361 and validation set (see Methods). However, due to lack of variance in some of the item responses  
362 this was not possible. That is, dividing the dataset into two portions created items where little or  
363 no variation in responses were observed in some cases, rendering estimation of factor models  
364 impossible. Therefore, the entire dataset was explored in relation to its dimensionality.

### 365 *Dimensionality*

366 Firstly, a parallel analysis was conducted using the software FACTOR. This generates  
367 pseudorandom data, with the same dimensions as the real data. This process was adapted for use  
368 with the ordinal response data using polychoric matrices. Missing data values were handled  
369 using hot deck multiple imputation (Lorenzo-Seva and Van Ginkel, 2016). The results of the  
370 parallel analysis are shown in Table 2. These clearly indicate that there is a maximum of one  
371 factor (latent variable) underlying the response structure. This is evidenced clearly by the fact  
372 that the first latent variable explains around 60% of the variance in the indicators (item  
373 responses). However, a second postulated latent variable explains less variance than that found in  
374 a second latent variable for the pseudorandom data. The reliability, as indexed by Cronbach’s  
375 alpha was 0.64 (standardised Cronbach’s alpha 0.92) and McDonald’s Omega value of 0.92. The  
376 goodness of fit index for the one factor EFA was 0.985 (95% confidence intervals, derived via  
377 bootstrapping, 0.985 to 0.989). The psychometric properties of the items are shown in Table 3.  
378 For the standardised covariance matrix (polychoric correlations) as estimated from an ordinal

379 factor analysis of the items of the MaMB scale, using the FACTOR software package see *Table*  
380 *S1* in the supplementary material provided.

381  
382  
383  
384

**INSERT TABLE 2 HERE**

385 This unidimensional structure was confirmed by examining the fit to a single factor confirmatory  
386 factor analytic model within the Mplus v8.4 software environment. This confirmatory factor  
387 analysis (CFA) was adapted for the ordinal nature of the response data, using robust weighted  
388 least squares as the estimation method (WLSMV). There were technical difficulties estimating a  
389 one factor model due to the low variance in items 4 and 5 and their collinearity with responses to  
390 items 10 and 11 respectively (that is, responses to the latter items were almost wholly associated  
391 with response to the former). Specifically, the correlation between item 4 (‘difficult’) and item  
392 10 (‘apart’) was 0.987. That between item 5 (‘need’) and item 11 (‘play’) was also 0.987.  
393 Consequently, items 4 and 5 (which exhibited the lowest variance of the pairs were dropped from  
394 the CFA. When the CFA was repeated with the remaining nine items the one factor model  
395 showed a good fit to the data; the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) fit  
396 indices were 0.94 and 0.92 respectively ( $\geq 0.90$  usually is taken as acceptable fit, whilst values  
397 over 0.95 indicate good fit). Combining positive and negative worded items in a single scale can  
398 sometimes artificially lead to method effects. That is, these item types can sometimes show  
399 dependency on each other that manifest as correlated model residuals or ‘artefactors’ (Marsh,  
400 1996). For this reason the residuals from negatively worded items were permitted to correlate  
401 within the CFA model to evaluate if this resulted in improved fit. However, this was not the case,  
402 with fit, if anything, deteriorating slightly (the TLI reduced from 0.92 to .91). Moreover, the  
403 modification indices did not suggest that fit would be significantly improved by permitting  
404 correlated residuals between items. The issue of dependency between items was also evaluated  
405 as part of the Rasch calibration (see below).

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408

**INSERT TABLE 3 HERE**

409 The factor loadings demonstrate a substantial ( $>0.4$ ), positive and significant ( $p < 0.01$ ) magnitude  
410 of loadings for all nine MaMB items included. Negative items were reverse coded so that the  
411 latent variable and the item factor loadings were interpretable. Having established the  
412 unidimensional structure of the data it appeared appropriate to progress to a Rasch calibration of  
413 the MaMB items.

414  
415

*Rasch analysis*

416 The Rasch calibration results yielded much useful diagnostic information on the MaMB  
417 questionnaire. As highlighted earlier the scale reliability itself was moderate to high. Indeed, the  
418 item reliability estimated by the Rasch calibration was .94. However, the person separation index  
419 (which include ‘extreme’ and ‘non-extreme’ persons) was only .10. The person separation index  
420 reflects the number of groups that can be plausibly differentiated by the scale with acceptable  
421 precision. It represents a signal to noise ratio in the scale. Thus, the MaMB scale had virtually no  
422 ability to differentiate respondents. This was no doubt a reflection on the lack of observed  
423 variance in responses in the study sample. Nevertheless, in terms of scale development and  
424 future research it is useful to explore the item ‘difficulties’ (or ‘endorsibility’ in this case), as  
425 well as the fit statistics. These are shown below in Table 4. The z standardised fit, along with the  
426 difficulty/endorsibility and standard error (reflected in the diameter of each bubble) are also  
427 shown in the ‘bubble plots’ in Figures 2 and 3. In the Rasch context ‘fit’ in this sense refers to  
428 which the item responses follow a Guttman sequence (Rasch, 1960). That is, as the ability or trait

429 increases the respondent or test-taker tends to be observed to give a higher scoring category of  
430 response, allowing for the play of chance, e.g., 0010101112221221222223323333. Items where  
431 responses are too predictable ‘overfit’ the model. Those that are more erratic are described as  
432 ‘underfitting’. The former tends to indicate redundant items, that may be dependent on responses  
433 to other items. Underfitting items can distort or degrade the measurement properties of the scale.  
434 ‘Infit’ refers to fit where an item ‘difficulty’ is well matched to the level of trait or ability in a  
435 test taker. That is, for example, for a right/wrong maths question the person who is well matched  
436 would have a 50:50 chance of either a correct or incorrect answer. In this case ‘well targeted’  
437 items would tend to show a reasonable spread of responses for a set of test takers with trait levels  
438 that are matched to the item endorsibility. Conversely, ‘outfit’ refers to fit (conformity to the  
439 Rasch model) where item difficulty is not well matched to the test taker’s trait or ability level.  
440 These distinctions between infit and outfit tend to be more pertinent to knowledge tests, than trait  
441 assessments, however. As can be seen from Table 4 and Figures 2 and 3 overall, the MaMB  
442 items tend to conform reasonably well to the Rasch model. However, there are four key issues.

- 443 1. The items seem very easy (or in the case of negatively worded items- very hard) to  
444 endorse. This can be seen by the ‘measure’ estimates that tend to be around or above the  
445 zero point- a standardised trait (estimate) derived from the item responses.
- 446 2. A couple of items tend to overfit the model: ‘enjoy’ (item 1) and ‘irritated’ (item 2)).  
447 These tend to be somewhat overly predictable from the responses to the other items.  
448 However, this observation should be viewed cautiously as only the z standardised fit  
449 showed misfit, and this can be sensitive to relatively large numbers of observations (e.g.  
450 >300).
- 451 3. One items (‘I feel like I’m looking after my baby for someone else’ -item 9) tends to  
452 show poor outfit. This suggests some erratic ratings, by those respondents whose  
453 estimated trait level was some distance from the item ‘measure’ (endorsibility’).
- 454 4. One item showed poor infit and outfit, at least on the ‘z’ fit statistics (‘I can work out  
455 what my baby needs from me’). This suggests this item may have been relatively  
456 erratically answered. It may have been different respondents read or interpreted the item  
457 differently from each other. For example, some may have interpreted it in terms of basic  
458 needs, whilst others, more in terms of emotional needs. It may be useful to explore  
459 whether this item showed any item bias or differential item functioning in relation to  
460 demographic factors.

461 In terms of ‘person fit’; only 16 of the 438 (3.7%) participants showed marked underfit to the  
462 Rasch model, as indicated by a standardised infit or outfit of greater than 2.0. That is, their  
463 responses were more erratic than the Rasch model would have predicted. In contrast, only one  
464 respondent showed marked overfit, as defined as a standardised infit and/or outfit of less than -  
465 2.0.

466 The potential for item responses to be dependent on each other was investigated by examining  
467 the matrix of correlated residuals from the Rasch model, between pairs of items. In general, the  
468 magnitude of these were very small (average 0.08). The only more substantial correlated residual  
469 ( $\geq 3.0$ ) was observed for that between item 5 (‘I can work out what my baby needs from me’) and  
470 item 6 (‘I feel like I can’t do things I enjoy because of my baby’). These two items had a  
471 correlated residual of -0.31. It is not clear why this dependency was observed, though given only  
472 one paired correlation out of 55 pairs exceeded 0.3 in magnitude this could be a chance finding

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**INSERT TABLE 4 HERE**

**INSERT FIGURE 2 HERE**

**INSERT FIGURE 3 HERE**

*Item category probabilities*

It was apparent that most of the items were not operating as four-point Likert scales. That is, in many items not all four categories of response were observed in this sample of respondents. Moreover, some intermediate categories of response were rarely observed. In effect this means that even if a respondent is higher on a trait level a lower category of response may still be observed. This is sometimes referred to as ‘Rasch-Andrich threshold suppression’. This effect is nicely illustrated below, by the item category probability curves for item 11. Although some respondents selected a response with a score of ‘2’ had higher trait levels than those who scored ‘1’ (‘0’ was not observed), in practice they were more likely to be seen to choose a ‘1’ category, as so few chose the ‘2’. These findings suggest, at least for the kind of general population sample used in this study, the use of four Likert scale points may be too many; that is, they may not lead to more information on a test-taker and introduce some risk of extreme responses style (ERS) bias. *Figure S1*, in the supplementary material, refers to probability of observing a respondent choosing a particular response category according to their overall trait level (‘baby bonding’). Note that curves do not always correspond to the ordered responses (0→1→2→3).

*Test information*

As would be expected for a test mainly composed of easily endorsed items, most of the area under the test information curve was for test takers whose traits were defined as slightly below the average. That is, those who were likely to give midrange responses to easily endorsed items. This can be seen by the fact the peak of the test information curve is just below the zero on the x-axis. This suggests the item calibration is not ideal to pick out mothers who may be struggling to bond with their babies (i.e., those who are likely to be observed with a lower total score on the MaMB scale). The test information curve is depicted in *Figure S2* in the provided supplementary material.

**Discussion**

There is a paucity of high-quality tools to assess parent-infant relationships. The MaMB was co-developed to address this gap and act as a tool to measure bonding for use in research and universal health settings.

The results suggest that it is feasible for HVs to administer the MaMB with mothers in universal services. HVs successfully completed the MaMB with approximately 50% of the universal population at the 6-8-week visit in the context of highly pressured services due to the Covid-19 global pandemic. Given low rates of missing data the MaMB appears to be acceptable to parents.

The psychometric analyses suggest the MaMB tool responses, in this sample of test takers, were unidimensional. The MaMB showed relatively high levels of internal reliability consistency and the items generally fitted the Rasch model. However, the high reliability may be partly an artefact of the lack of variation in responses observed – almost all respondents gave high-scoring categories on the items. The items did not generally behave as four-point response format questions, as it was common for some response categories to go unobserved. Consequently, test information was relatively low and was much less than may be required to identify at least two separate groups of respondents, e.g., if the MaMB were to be used as a screening tool.

522 For the 29 parents that completed the free text it appeared a useful part of the MaMB to expand  
523 on item completion with an opportunity to voice feelings or concerns. Responses suggest parents  
524 were engaging in a meaningful discussion about bonding with their health visitor. This suggests  
525 the MaMB could be considered a potential catalyst in opening discussions about sensitive  
526 aspects of parenting such as experiencing guilt for wanting some ‘alone’ time, or for feeling less  
527 positive when their baby is screaming. Such open conversations suggest that the tool could fit  
528 well within a pathway for accessing specialist services, such as infant mental health services.  
529

### 530 **Strengths**

531 The MaMB was co-developed over a series of workshops and interviews, using an iterative  
532 process with HVs, Clinical Psychologists, service staff and managers from different localities,  
533 and included parental input. It was piloted within routine HV contacts and, although the pilot  
534 was delivered during the COVID-19 pandemic with many visits taking place remotely, or with  
535 restrictions, completed MaMBs were obtained from 50% of the eligible population. The pilot  
536 study was classed as research as opposed to service design and had ethical approval as such.  
537 Previously psychometric analyses focused on exploratory and confirmatory factor analysis;  
538 however, this study also included IRT, which affords additional rigour and confidence in the  
539 results.  
540

### 541 **Limitations**

542 Some HV teams would have conducted some core 6-8-week contacts over the telephone rather  
543 than in the family home due to COVID-19. However, we do not have data to report how many.  
544 This may have led to lower completion rate of the MaMB.  
545

546 A much smaller than anticipated comparison group of non-completers was achieved. This was  
547 because HVs appeared not to complete, or partially complete, a cover sheet with demographic  
548 information if a mother did not wish to complete the MaMB. The pilot was conducted during the  
549 COVID-19 pandemic, during which time HVs were under enormous pressure to continue  
550 delivering statutory support to families despite adverse circumstances which likely contributed to  
551 the non-completion of cover sheets.  
552

### 553 **Deviations from the registered protocol**

554 Due to the limited information on non-completers we were unable to conduct planned statistical  
555 analyses of the characteristics of completers compared to non-completers. The amount of data  
556 contained within the free-text responses of completed MaMBs also prevented a planned thematic  
557 analysis of these data, though it was sufficient to provide useful information in a descriptive  
558 summary.  
559

### 560 **Future research**

561 The findings of this study suggest that the MaMB is a promising tool to assess parent-infant  
562 relationships. Future research directions fall across three domains (1) understanding practitioner  
563 experiences, (2) expanding sample of users, and (3) refining approach to measurement.

#### 564 *Understanding Practitioner Experiences*

565 Practitioners such as health visitors are a key component of using a measure of parent-infant  
566 relationships. A better understanding of their experience supporting mothers to complete the  
567 MaMB tool would help to further refine the tool. Obtaining ethical approval to ask HVs from the  
568 current study their views on completing the MaMB would be a priority for future research.

#### 569 *Expanding Sample of Users*

570 This study found that most participants responded similarly to items on the MaMB. Further  
571 piloting of the tool with an expanded sample of users would help to understand the reason for

572 this limited range of responses. For example, use with mothers experiencing mental health  
573 difficulties in the perinatal period would be particularly valuable. We might hypothesise that  
574 those within the clinical range of depression measures may respond differently when asked about  
575 their bond with their baby. This is highly likely to result in observing more variance in the items.  
576 It may also be able to show whether the tool is able to discriminate, with any precision, between  
577 at least two different groups of respondents. Note, in theory, a Rasch model is based on a sample  
578 free distribution (that is the estimates should be the same irrespective of the sample of test takers  
579 used for the calibration). However, in practice, precise estimates of item fit and difficulty may  
580 not be achieved, even with large samples, if some categories of response are rarely or never  
581 observed.

582 It was appropriate for this first pilot to target mothers, who are typically primary caregivers.  
583 However, we know that there is increasing variability in those who take on the primary caregiver  
584 role across society. Piloting the MaMB tool with a diverse range of caregivers would enable  
585 exploration of differences and similarities across responses for wider parent-infant relationships.  
586 It would also support use of the tool in practice, where fathers, same sex parents, or other kinship  
587 carers may be caring for a baby.

#### 588 *Refining Approach to Measurement*

589 To enable the tool to have a greater degree of variation across responses, future research could  
590 test the MaMB tool with amended items (as highlighted in the results) to make them more subtle.  
591 This could be helpful in picking up difficulties and bonding and attachment in parents or  
592 caregivers. Moreover, future research could evaluate the tool as a three-point Likert scale, as  
593 opposed to the four-point scale used in the current study. This could help to increase variation  
594 across items.

#### 595 **Conclusions**

596 HVs successfully administered the MaMB in universal services and the MaMB appears to be  
597 acceptable to parents. The MaMB demonstrated good internal consistency and may support HV  
598 signposting decisions for additional support, however, as the more robust analysis shows, if the  
599 MaMB was to be used as a screening tool, with a cut-off, or ranges of ‘concern’ then additional  
600 work is needed, which will need to include more families with risk factors such as depression in  
601 an enriched sample.

602 Regarding our objectives, we consider the MaMB to be feasible for use in routine practice with  
603 some amendments, and future piloting of such amendments.

604

605 **ASSOCIATED PROTOCOL:**

606 Version 2, 7<sup>th</sup> December 2020 – to access the protocol for further information please visit:

607 <https://osf.io/q3hmf/>

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612

613 **STUDY SPONSOR**

614 The University of York. Data sharing agreements and data management were compliant with the

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616

617 **RESEARCH REFERENCE NUMBERS**

- 618
- 619 • IRAS Number: 273708
  - 620 • This study received ethical approval on 21st August 2020 by South Central - Berkshire B  
621 Research Ethics Committee, UK, Ref: 20/SC/0266, Integrated Research Application  
622 System (IRAS) 201, project ID: 273708.
  - 623 • Funder References: HEIF - H0026802, ARC-YH: NIHR200166, The National Lottery  
624 Community Fund (previously the Big Lottery Fund) - 0094849, National Institute for  
625 Health Research (NIHR) Public Health Research (PHR) (ref 13/93/10).
  - OFS Study Registration Number: [osf.io/6br2e](https://osf.io/6br2e)

626 **CONFLICTS OF INTEREST**

627 TB and SB are supported by the NIHR Yorkshire and Humber Applied Research Collaboration  
628 (ARC - YH). KS is an employee of RDaSH. All other authors do not declare any potential  
629 conflicts of interest

630

631 **AUTHOR CONTRIBUTIONS**

632 TB secured funding, TB and AD conceived the study, TB, AD, CE, KS, PAT, SB designed  
633 various aspects of the study. TB and SB provided supervision of the study from the academic  
634 perspective (UoY) and KS from the practitioner perspective (RDaSH). PAT conducted the  
635 statistical analysis and provided psychometric expertise, and KS and MP participated in co-  
636 developing the tool and provided clinical and practitioner expertise. AD and CE were research  
637 fellows on this study and coordinated and conducted various activities.

638 TB wrote the initial draft, and all authors have contributed and commented on subsequent drafts  
639 of this paper. TB, corresponding author, will act as guarantor and affirms that the manuscript is  
640 an honest, accurate, transparent, and full account. All listed authors meet authorship criteria and  
641 no others meeting the criteria have been omitted.

642

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665 in the design or writing of the paper.  
666

## 667 **SUPPLEMENTARY MATERIAL**

668 Supplementary material is provided for this study.

669

## 670 **DISCLAIMER**

671 The views expressed in this publication are those of the authors and not necessarily those of the  
672 NHS, the NIHR or the Department of Health and Social Care. This study also received funding  
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675 in the design or writing of the paper.  
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823 **Appendix 1: The MaMB Participant Information Sheet**  
824 **(To include logos)**

825 **Information on the ‘Me and My Baby’ questionnaire**

826 **What will happen at your next Health Visitor visit?**

827 When your baby is between 6 and 8 weeks old your Health Visitor will talk to you about how you  
828 and your baby are getting along. At this visit your Health Visitor will ask if you have any questions  
829 about the information in this leaflet, and if you’re willing to complete some questions about your  
830 relationship with your baby.

831 **Why are you asking about my relationship with my baby?**

832 The Me and My Baby questionnaire is short and has been developed by Health Visitors and  
833 researchers, with other NHS staff, and with input from parents.

834 Not everyone finds it easy to get on with their new baby. Some mums, even if they have other  
835 children, sometimes feel they don’t understand their new baby, or that their baby is being difficult  
836 on purpose.

837 Also, when things are going well, many mums find it useful to reflect on their feelings about their  
838 baby. If you feel like things aren’t going how you want them to your Health Visitor can help you. We  
839 are asking all mums in your area to complete the questionnaire. For now, we are only asking  
840 biological mums who are the main carers of their new baby.

841 **Why are you asking these questions?**

842 In partnership with the Department of Health Sciences at the University of York, we are exploring  
843 how useful these questions are in showing when relationships between mum and baby are going  
844 well and not so well. You don’t have to answer these questions if you don’t want to, and you can  
845 stop completing the questionnaire at any time – your decision will not affect your relationship with  
846 your Health Visitor or the support they offer you.

847 **What will happen to my answers?**

848 Your Health Visitor will look at your answers and talk to you about your relationship with your baby.  
849 Health Visitors are highly trained and understand that being a mum is different for everyone.  
850 If the questionnaire is useful, it may help Health Visitors in offering future support and training to  
851 parents around forming a good relationship with their baby. Your answers will be shared with  
852 colleagues in the Department of Health Sciences at The University of York (the university are  
853 partnering with Rotherham Doncaster and South Humber NHS Foundation Trust to explore the  
854 usefulness of the questionnaire).

855 **1.1.1 How will we use information about you?**

856 1.1.2 Your NHS Trust will not share any identifiable information about you (e.g. your name or address) with  
857 the University of York. The University will examine all anonymous answers on the Me and My Baby  
858 questionnaire to see if the questions are helpful in identifying where the relationship between mums  
859 and their new baby may be difficult or where some support may be helpful. These findings could help  
860 to improve the care new mums across your area receive in the future. The findings will be shared in  
861 reports, copies of which will be available on the following websites:

- 862
- 863 • If you live in xxxxx see xxxxx
  - 863 • If you live in xxxxx see xxxxx
  - 864 • Research team website: <https://www.arc-yh.nihr.ac.uk/home>

865 The research team at the University of York will only have access to fully anonymised data, they will  
866 not receive any data or codes that can be used to identify you and they will not be able to see your  
867 name or contact details.

868 The research team will keep all data safe and secure on University of York servers. Once we have  
869 finished the study, the University of York will keep the fully anonymised data for 10 years at which  
870 point it will be securely destroyed.

### 871 **1.1.3 What are your choices about how your information is used?**

- 872 ● You can stop being part of the study at any time, without giving a reason, but we will keep
- 873 information about you that we already have.
- 874 ● We need to manage your records in specific ways for the research to be reliable. This means
- 875 that we won't be able to let you see or change the data we hold about you.

### 876 **1.1.4 Where can you find out more about how your information is used?**

877 *You can find out more about how we use your information*

- 879 ● at [www.hra.nhs.uk/information-about-patients/](http://www.hra.nhs.uk/information-about-patients/)
- 880 ● by asking a member of the research team **sarah.blower@york.ac.uk**
- 881 ● The sponsor for this study is the University of York
- 882 [https://www.york.ac.uk/staff/research/governance/research-policies/policy-for-clinical-](https://www.york.ac.uk/staff/research/governance/research-policies/policy-for-clinical-research)
- 883 [research](https://www.york.ac.uk/staff/research/governance/research-policies/policy-for-clinical-research)
- 884 ● at the University of York data protection officer's website: [https://www.york.ac.uk/records-](https://www.york.ac.uk/records-management/dp/)
- 885 [management/dp/](https://www.york.ac.uk/records-management/dp/)
- 886 ● *by ringing your Health visiting service on the numbers below*

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888 **If you would like more information, please contact your Health Visiting service in XXXXX on**  
889 **XXXXX, or XXXXX on XXXXX**

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892 **Appendix 2 – The MaMB. NOTE: this measure is under further development. Please contact**  
 893 **the corresponding author if you wish to use it in the format below.**

894 **Me and My Baby**

895 Having a new baby can bring up lots of different feelings and emotions. This questionnaire is  
 896 designed to explore how you are feeling about being a parent to your baby.

897 Answering these questions will help us to understand how things are going for you. There is space on  
 898 the back of this page for you and your Health Visitor to explore why you have answered the way you  
 899 have if you wish. **Thinking about your feelings about your baby, choose the response for each**  
 900 **statement that feels right to you...**

	Never	Sometimes	Often	Always
1. I enjoy looking after my baby				
2. I feel irritated with my baby when we are together				
3. I feel affectionate towards my baby				
4. I feel that my baby is being difficult or trying to upset me on purpose				
5. I can work out what my baby needs from me				
6. I feel like I can't do things I enjoy because of my baby				
7. I feel the changes in my life are worth it to look after my baby				
8. I miss my baby when we are not together				
9. I feel like I'm looking after my baby for someone else				
10. When we've been apart I look forward to seeing my baby again				
11. I enjoy playing with my baby				

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Is there anything else you'd like to add about how you feel about your baby?

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903 **Scoring Sheet:** The score for each response is in the equivalent box below – find the option selected by the parent for  
904 each question and add up the scores. Higher scores on this tool suggest that a parent is finding it difficult to develop an

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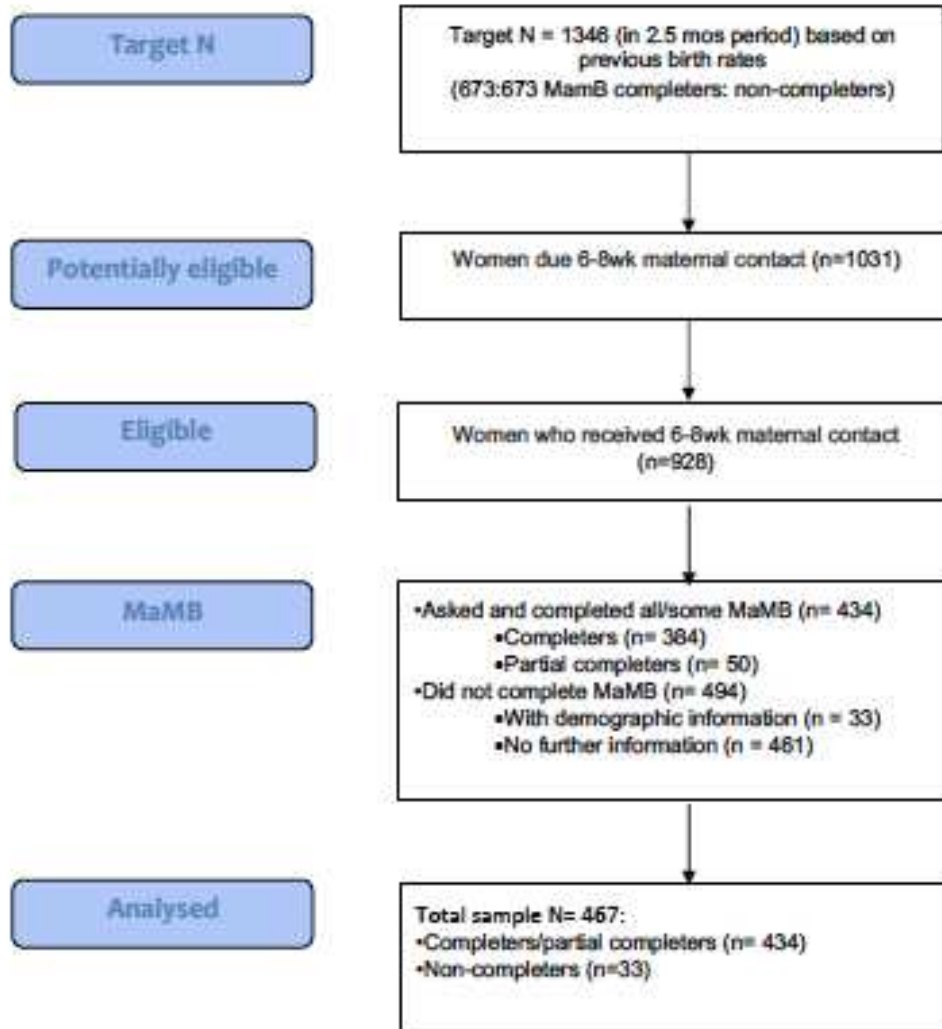
appropriate bond with their infant. **It is important to note that there are no validated cut offs for clinical concern on this tool – so combine scores with your professional judgement when deciding what to do next for a parent.**

	Never	Sometimes	Often	Always
1. I enjoy looking after my baby	3	2	1	0
2. I feel irritated with my baby when we are together	0	1	2	3
3. I feel affectionate towards my baby	3	2	1	0
4. I feel that my baby is being difficult or trying to upset me on purpose	0	1	2	3
5. I can work out what my baby needs from me	3	2	1	0
6. I feel like I can't do things I enjoy because of my baby	0	1	2	3
7. I feel the changes in my life are worth it to look after my baby	3	2	1	0
8. I miss my baby when we are not together	3	2	1	0
9. I feel like I'm looking after my baby for someone else	0	1	2	3
10. When we've been apart I look forward to seeing my baby again	3	2	1	0
11. I enjoy playing with my baby	3	2	1	0
<b>Total:</b>	+	+	+	
	= Total Score: _____			

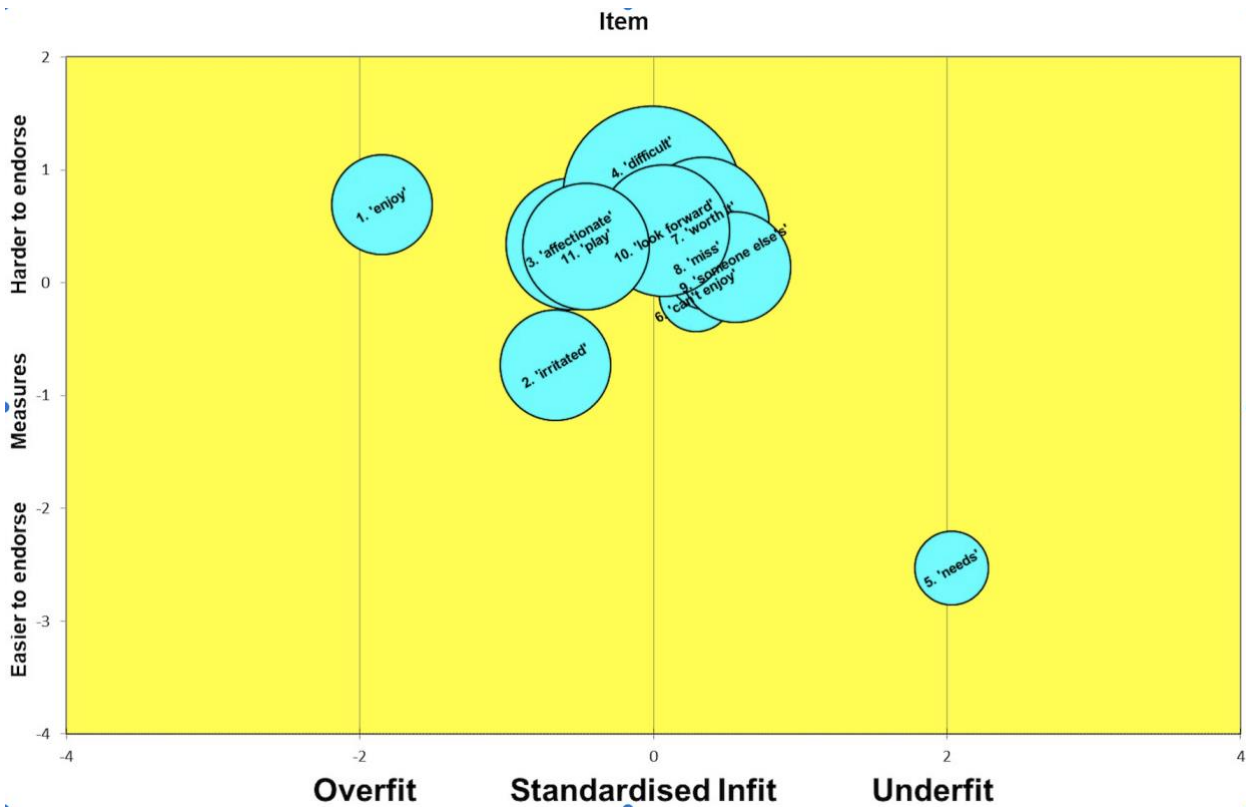
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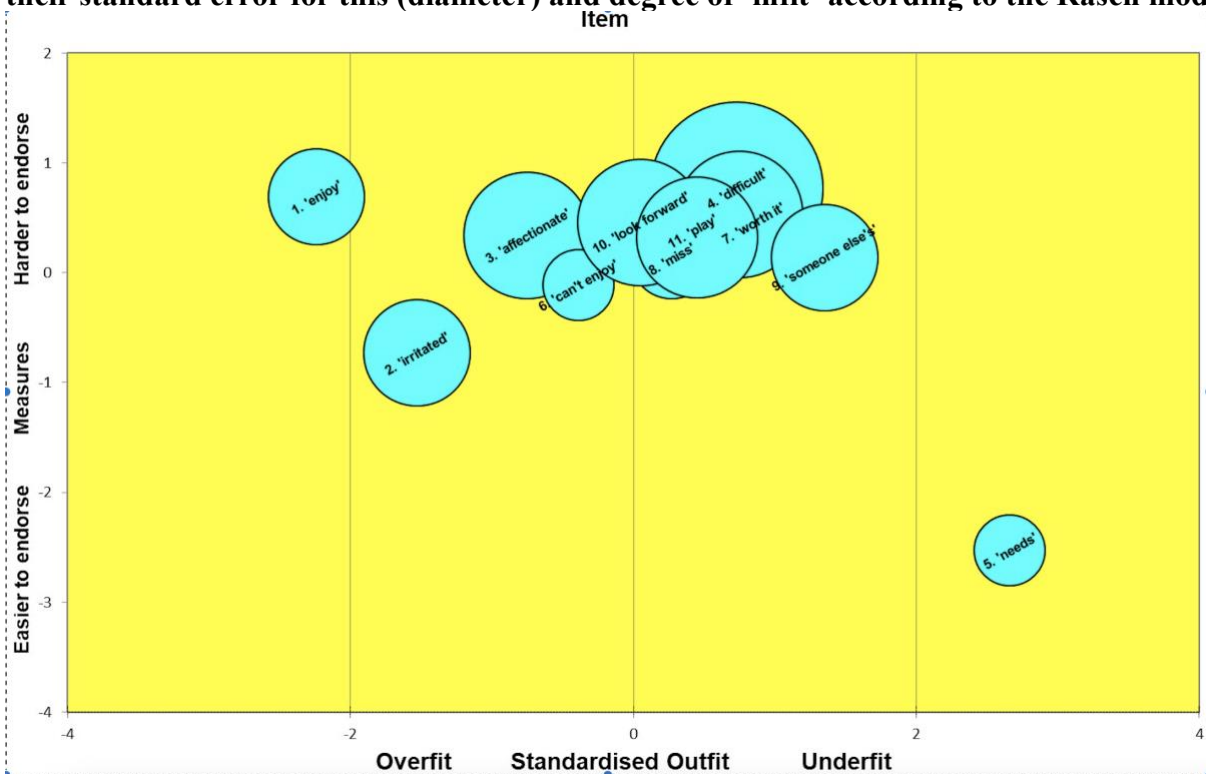
Figure 1. Flow chart of participants



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931 **Figure 2. Bubble plot of the MaMB items, according to estimated endorsability ('measure'),**  
932 **their standard error for this (diameter) and degree of 'infit' according to the Rasch model.**



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934 **Figure 3. Bubble plot of the MaMB items, according to estimated endorsability ('measure'),**  
935 **their standard error for this (diameter) and degree of 'outfit' according to the Rasch model.**

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938 **Table 1.** Characteristics of completers (N=434) and non-completers (N=33)

	Completers (N=434)		Non-Completers (N=33)	
	Count	Percent	Count	Percent
<b>Site</b>				
Doncaster (Site 1)	256	59%	21	64%
North Lincolnshire (Site 2)	178	41%	12	36%
<b>Mother age (in years)</b>				
Mean (SD)	28.45 (5.76)	/	29.25 (5.17)	/
Min	16	/	21	/
Max	43	/	43	/
<b>Child age (in weeks)</b>				
Mean (SD)	6.69 (1.69)	/	8	/
Min	4	/	6	/
Max	25	/	31	/
<b>Ethnicity</b>				
White British	359	83%	16	49%
White Other	43	10%	8	24%
Asian/Asian British	13	3%	0	0
Black African	5	1%	3	9%
/Caribbean/Black British				
Mixed/Multi-ethnic	2	0.5%	1	3%
Other	9	2%	1	3%
Missing	3	0.5%	4	12%
<b>Mother's first language is English</b>				
Yes	348	80%	15	46%
No	59	14%	13	39%
Missing	27	6%	5	15%
<b>Interpreter needed (for non-first lang English)</b>				
Yes	8	14%	5	38%
No	50	85%	7	54%
Missing	1	1%	1	8%
<b>First child</b>				
Yes	195	45%	9	27%
No	235	54%	20	61%
Missing	4	1%	4	12%

939 N.B. Table 1 includes a descriptive summary of available data from the 33 women who did not complete a MaMB but  
 940 their health visitor completed a cover sheet

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 946 **Table 2.** Results from a parallel analysis, adapted for ordinal data. \*Note only the percentage of  
 947 variance explained by the first factor exceeds that observed for the random data.

<b>Factor</b>	<b>Variable Real- data % of variance</b>	<b>Mean of random % of variance</b>	<b>95<sup>th</sup> percentile of random % of variance</b>
1 <sup>st</sup>	61.4*	18.4	21.9
2 <sup>nd</sup>	10.1	16.2	18.6
3 <sup>rd</sup>	6.7	14.3	16.1
4 <sup>th</sup>	5.8	12.6	14.2
5 <sup>th</sup>	5.0	10.7	12.3
6 <sup>th</sup>	3.1	9.0	10.5
7 <sup>th</sup>	2.6	7.3	9.0
8 <sup>th</sup>	2.3	5.5	7.4
9 <sup>th</sup>	1.9	3.9	5.8
10 <sup>th</sup>	1.2	2.1	4.0
11 <sup>th</sup>	0.0	0.0	0.0

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**Table 3.** Psychometric properties of the MAMB items, including exploratory factor analysis results, assuming one underlying factor (dimension).

<b>MaMB item (abbreviated wording)</b>	<b>Item mean (SD)</b>	<b>Item-total correlation</b>	<b>Cronbach's alpha with item removed*</b>	<b>Factor loading</b>	<b>Communality</b>
1. Enjoy looking after baby	0.08 (.29)	0.64	0.58	0.849	0.721
2. Feel irritated with baby	0.08 (.27)	0.52	0.60	0.709	0.502
3. Affectionate towards baby	0.04 (0.2)	0.51	0.60	0.835	0.698
4. Feel baby is being difficult	0.02 (.15)	0.33	0.63	0.675	0.456
5. Can work out baby's needs	0.54 (.58)	0.57	0.66	0.489	0.239
6. Can't do enjoyable things because of baby	0.21 (.43)	0.55	0.61	0.635	0.403
7. Life changes worth it	0.04 (.22)	0.35	0.63	0.645	0.415
8. I miss my baby when not together	0.10 (.36)	0.52	0.61	0.705	0.497
9. Feels like someone else's baby	0.04 (.27)	0.35	0.63	0.637	0.406
10. Look forward to seeing baby again	0.03 (.23)	0.43	0.62	0.722	0.521
11. Enjoy playing with	0.04 (0.23)	0.49	0.61	0.797	0.636

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\* Cronbach's alpha for test with all 11 item responses included was 0.64

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**Table 4.** Item ‘endorsibility’ (‘measure’) of the MaMB scale, along with the Rasch fit statistics. These include both ‘infit’ and ‘outfit’ statistics as both the mean squared error and standardised (z) fit.

<b>Item</b>	<b>Item difficulty/ ‘Endorsibility’</b>	<b>Infit (mean- squared)</b>	<b>Infit (standardised)</b>	<b>Outfit (mean- squared)</b>	<b>Outfit (standardised)</b>
1. Enjoy looking after baby	0.69	0.76	-1.85	0.53	-2.24
2. Feel irritated with baby	-0.73	0.91	-0.67	0.65	-1.53
3. Affectionate towards baby	0.34	0.82	-0.56	0.53	-0.75
4. Feel baby is being difficult	0.77	0.97	-0.01	1.33	0.73
5. Can work out baby’s needs	-2.53	1.20	2.03	1.31	2.66
6. Can’t do enjoyable things because of baby	-0.11	1.03	0.29	0.95	-0.39
7. Life changes worth it	0.53	1.07	0.34	1.31	0.75
8. I miss my baby when not together	0.13	1.06	0.37	1.05	0.27
9. Feels like someone else’s baby	0.14	1.17	0.56	2.09	1.35
10. Look forward to seeing baby again	0.46	0.98	0.07	0.91	0.05
11. Enjoy playing with	0.32	0.86	-0.46	1.15	0.45

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