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The mindedness of maternal touch: An investigation of maternal mind-mindedness and mother-infant touch interactions

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ABSTRACT

Increasing evidence shows that maternal touch may promote emotion regulation in infants, however less is known about how parental higher-order social cognition abilities are translated into tactile, affect-regulatory behaviours towards their infants. During 10 min book-reading, mother-infant sessions when infants were 12 months old (N = 45), we investigated maternal mind-mindedness (MM), the social cognitive ability to understand an infant's mental state, by coding the contingency of maternal verbal statements towards the infants' needs and desires. We also rated spontaneous tactile interactions in terms of their emotional contingency. We found that frequent non-attuned mind-related comments were associated with touch behaviours that were not contingent with the infant's emotions; ultimately discouraging affective tactile responses from the infant. However, comments that were more appropriate to infant's mental states did not necessarily predict more emotionally-contingent tactile behaviours. These findings suggest that when parental high-order social cognitive abilities are compromised, they are also likely to translate into inappropriate, tactile attempts to regulate infant's emotions.

1. Introduction

Social touch is thought to play a vital role in early physiological, cognitive and social development (Field, 2010). The potential benefits of touch have been studied in many fields, ranging from animal studies to developmental psychology studies (e.g. Harlow and Zimmermann, 1958; Panksepp and Bishop, 1981; Sharp et al., 2012; Maitre et al., 2017). In particular, increasing clinical and experimental evidence points to the importance of maternal tactile interactions for the promotion of mental and physical health (e.g. Peláez-Nogueras et al., 1997; Field, 2010; Sharp et al., 2012). Human infants receive constant and sustained tactile stimulation whilst being cuddled and breastfed. Skin-to-skin contact at birth in premature infants ("kangaroo care"; Feldman and Eidelman, 2003) is standard practice in many countries, and it has been shown to promote successful breastfeeding and to help keep babies calm and warm (Bystrova et al., 2003; Moore et al., 2016). Caregiver touch is essential for growth and development; it actively reduces infant stress by increasing positive affect (Stack and Muir, 1992; Feldman et al., 2009) and calms infants in pain and discomfort (Bellieni et al., 2007; Maitre et al., 2017). In the context of attachment theory (Bowlby, 1969), studies support the facilitating role of touch in establishing the social bond between infant and caregivers (Ainsworth, 1979; Weiss et al., 2000; Beebe et al., 2010).

These studies on attachment, as well as other studies on parent-infant interactions, suggest that it is not merely the presence or absence of maternal touch that affects infant behaviour, but also the quality of the touch itself. For example, Stack et al. (1996) found that mothers employed different types of touch in order to elicit a specific behavioural response in the infant (e.g. high levels of tickling and lifting, and low levels of holding in order to elicit infants' smiling). These findings suggest that infants may become sensitive to precise characteristics of their mother's touch, particularly as regards the experience of certain emotions (Stack and Muir, 1992). Increasing evidence supports the idea that mothers might use touch in order to emotionally regulate the infant (e.g. Hertenstein and Campos, 2001). Hertenstein and Campos (2001) showed that specific qualities of tactile stimulation

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provided by the mother (in the sense of negative/tense and positive/relaxed fingers grip) in a given context were able to elicit an appropriate emotion or affect in the 12-month-old infants.

However, to our knowledge, little is known about whether the quantity and quality of maternal tactile behaviours towards their children depend on their higher-order social cognition abilities. Two factors that are deemed particularly important in terms of parental social cognition abilities are the parental capacity to infer the mental states of their infant and their capacity to recognise the infant as an individual with independent mental states. The former ability has been termed 'mentalization', or 'the capacity to envision mental states in self and others" (Fonagy et al., 2004, p. 23). The latter ability has been termed "mind-mindedness (MM) and is considered a related, but more specific concept employed particularly in parent-infant relationships to refer to the parent"s tendency to represent and respond to their infants as "individuals with a mind rather than merely as a creature with needs that must be satisfied" (Meins et al., 2001, p. 638). Importantly, according to some developmental theories (e.g. Fonagy et al., 2004; Meins et al., 2001) infants can progressively learn to independently recognise and regulate their own emotions because their caregivers have the ability to recognise their infants as having independent minds and feelings of their own (mind-mindedness), and respond to them with contingent affective displays (e.g. mirroring joy in response to a display of enthusiasm in the infant, Gergely and Watson, 1999). According to such theories, this parental ability to recognise and respond to an infant's mental needs accordingly, creates a situation of parent-infant synchrony (Feldman et al., 1999) and the contingent mirroring of the infant's emotions enables the infant to modulate her or his own affective states. Theories on caregiver-infant affective 'contingency' (Gergely and Watson, 1999), mirroring and mentalisation (Fonagy et al., 2004), mind-mindedness (Meins et al., 2001) or 'synchrony' (Feldman et al., 1999) are not identical but they share the idea of the importance of 'mind reading' and a co-ordination between infant and caregiver during interactions for the development of affect regulation. For example, Meins et al. (2002) suggest that when infants are exposed to caregiver comments that appropriately describe their mental states, they are offered a 'representational reference' for their current experience. A contingency between what the infant is experiencing and what the caregiver is verbally describing (i.e. mind-related comments) would allow the infant to see more clearly the connection between experience, behaviour and mental states and hence ultimately understand and regulate her and other people's mental states and actions.

Substantial evidence (i.e. Verhage et al., 2016 for a recent meta-analysis) links adults' mental representations of attachment and related concepts (e.g. mentalization, mind-mindedness) to the development of infant's attachment and mentalisation abilities (e.g. Meins et al., 2002, Meins et al., 2003; Verhage et al., 2016). Furthermore, parental attachment representations have also been associated with the sensitivity of parent-infant interaction, particularly in terms of parental responsiveness (e.g. Van IJzendoorn, 1995) and parental mind-mindedness (Arnott and Meins, 2007). However, the precise mechanisms by which higher-order social cognition abilities such as parental mind-mindedness are translated into specific affect regulation behaviours during infant-parent interactions remains unclear. In this study we are interested in the role of touch in parent-infant dyads and in particular we aim to investigate how concepts such as parental mind-mindedness that are measured typically based on verbal maternal comments are also expressed 'physically' in emotion-laden, tactile interactions.

What is special about tactile interactions, in comparison to other modalities of interaction such as gaze, is that they are necessarily mutual, proximal and frequently multisensory; we can look without been looked back, or, we can be looked at while we are not looking. However, in the absence of tools, we cannot touch someone without feeling the touch on our own body too, nor can anyone touch us without also feeling the touch on their body. Thus, social touch and the necessary physical contact it entails is a modality that is in this embodied sense, intrinsically shared and synchronous (Ciaunica and Fotopoulou, 2017). Also, touch requires physical proximity, which typically means touch is accompanied by a cascade of other sensations from other bodies, such as smell and vision, thus providing strong multisensory feedback from other bodies. In addition, social proximity itself has well known implications for cognition, for example influencing how space around the body is processed for both action and protection (Teneggi et al., 2013). Lastly, a recent proposal regarding the development of affect regulation suggests that touch is a fundamental component of the homeostatic regulation parents provide to their infants, which in turn is the basis of how infants progressively learn to regulate their own interoceptive states (the perception of the physiological state of the body) in relation to exteroceptive states (Fotopoulou and Tsakiris, 2017; see also Atzil and Barrett, 2017; Fonagy and Campbell, 2017; Bolis and Schilbach, 2017). Hence, examining the role of parental social cognitive abilities on parent-infant tactile interactions can shed light into some of the factors that may influence embodied, affect regulation in parent-infant interactions and its importance for emotional and physical development (Atzil and Barrett, 2017; Kleckner et al., 2017).

Specifically, this study focused on the relation between maternal mind-mindedness and the quantity and affect-regulatory quality of touch during mother-infant interactions. Mind-mindedness (MM) is typically operationalized in terms of mothers' tendency to comment appropriately on their infants' putative internal states during infant–-mother interactions, as defined and validated in previous studies (Meins and Fernyhough, 2015). However, not all such "mind-related comments" are indicative of MM; each of these comments is further coded dichotomously as *appropriate* (e.g. "*do you want this teddy?*" when the infant leans over towards the teddy) or *non-attuned* to the infant's current mental state (e.g. *"do you want to turn the page?"* when the infant has no interest in a book). MM has therefore been conceptualized as having two distinct dimensions: one indexing traditional notions of responsivity, and sensitivity (appropriate mind-related comments) and one that captures the caregiver's lack of attunement to the infant's point of view and imposition of the caregiver's own agenda (non-attuned mind-related comments). These two dimensions of MM are unrelated (Arnott and Meins, 2007; Meins et al., 2002) and have been found to independently contribute to different aspects of infant development (Meins et al., 2012). Here, our main aim was to examine whether there is a one-to-one, or a more complex relation between the maternal ability or inability to perceive the infants' mental states (as measured by means of appropriate and non-attuned mind-related comments, respectively), and her ability or inability to translate this perception into contingent touch reactions that 'mirrored' and hence regulated the infants emotional state (classified as contingent and non-contingent touch). Thus we developed a tactile coding scheme that distinguished between maternal touch that was appropriate (i.e. *contingent/excitatory,* in the sense of synchrony with what the infant was experiencing in that moment) or non-attuned (i.e. *non-contingent/down-regulatory* in the sense of lack of synchrony with the infant's emotional experience) to the infant's emotional needs or displays in order to explore to what extent the two independent dimensions of maternal MM were translated into contingent and non-contingent, tactile responses, respectively.

More specifically, we wanted to examine whether appropriate mind-related comments, and therefore understanding of the infant's mental state would result in a more affect-appropriate use of touch, i.e. tactile behaviours contingent to the infant's needs and desires. In contrast, we aimed to explore whether non-attuned mind-related comments would be associated with non-contingent tactile behaviours, e.g. restrictive or intrusive behaviours in response to enthusiasm or curiosity in the infant. To our knowledge the only relevant studied aspect of maternal mental characteristics in this context is post-partum depression (Tronick and Gianino, 1986; Herrera et al., 2004; Malphurs et al., 1996). Mothers with postnatal depressive symptoms have been shown

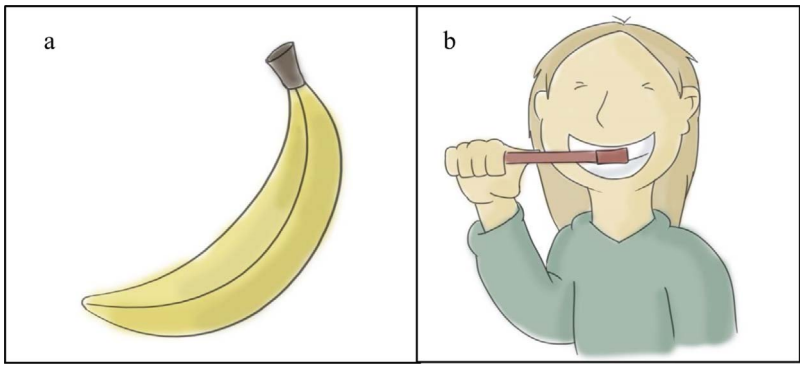

Fig. 1. Examples of the illustration of Book One (a) and Book Two (b). Adapted from Wheatley, L. (2017). *Mother-Infant Interaction During Book Sharing Across Socio-Economic Status Groups* (Doctoral thesis). Retrieved from University of Hertfordshire Research Archive (http://uhra.herts.ac.uk/handle/2299/17516).
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to use types of touch rated as 'negative' (e.g. rough tickling, poking, and pulling; Malphurs et al., 1996), and restrictive (e.g. lifting their infants in order to attract their attention or control their behaviour; Herrera et al., 2004) in greater extent than mothers without these symptoms. Notwithstanding the importance of these findings, it remains unclear which of all the mental and somatic symptoms (e.g. fatigue, pain) that are associated with postnatal depression may be the driver of these effects, and hence the precise role of maternal mental characteristics on mother-infant tactile interactions remains to be explored. Second, maternal MM might influence not only maternal touch towards the infant but also infant touch towards the mother in response to such emotional regulation, and of course their relation. To date infant touch has been examined only in few studies, and usually these have focused on infant self-touch and on its self-soothing effect when maternal emotional and tactile engagement is lacking (Weinberg and Tronick, 1996; Moszkowski et al., 2009) rather than on infant touch towards the mother. Thus, here we asked how infants use touch towards their mother rather than on themselves in response to more or less emotionally attuned mother's tactile behaviour.

We hypothesised that appropriate mind-related comments would be associated with a greater number of 'appropriate' tactile behaviours, i.e. touch that is contingent with the emotions or emotional arousal shown by infants (contingent/excitatory touch) and would thus also facilitate affectionate tactile responses from the infant. In contrast, we predicted that non-attuned mind-related comments would be associated with 'non-attuned' touch behaviours, i.e. touch that is not contingent with the infant's arousal (e.g. non-contingent/downregulating in the sense of restraining their excitement or trying to distract their attention by intrusive touch) and would thus also discourage an affectionate tactile response from the infant.

Finally, as we stated above, our main aim was to examine how parental mental abilities such as MM are translated into physical behaviours of affect regulation towards their infants. We chose tactile behaviours because of their unique role in social interactions and particularly homeostatic and thus affect regulation in development (Fotopoulou and Tsakiris, 2017). However, in order to examine whether this translation is the same across 'distal' modalities of physical interaction (e.g. gaze, gesturing), or whether it applies specifically to proximal and multisensory interactions as in the case of touch, we also measured two additional 'distal' maternal behaviours as controls (Reece et al., 2016) which are equally common at this stage of the development, namely maternal gestures and gaze at the infant. Maternal gesture and gaze stimulates joint attention between the mother and infant from an early age (e.g. Tomasello and Farrar, 1986), as well as predicting later literacy and language abilities in children (Brooks and Meltzoff, 2008; Rowe and Goldin-Meadow, 2009). While we cannot do justice to the literature of these modalities here and their relation with higher-order cognitive abilities, given the aforementioned characteristics of tactile interactions and in line with previous studies on touch (Reece et al., 2016), we expected a stronger relation between MM and affect-regulatory touch, than between MM and maternal gaze or gesturing.

In brief, in order to investigate all the aforementioned hypotheses we video-recorded 10-min mother-infant (when infants were 12 months old) book reading sessions, a naturalistic interaction of high ecological validity, and we rated spontaneous tactile interactions and the two dimensions of mind-mindedness during the same interaction.

2. Methods

2.1. Participants

Forty-five, British, mother-infant dyads (27 boys) were observed when infants were 12 months old (mean age 11.77, SD = 1.43). Mothers' ages were recorded as age ranges; 45% were over 36 years old, 40% between 26 and 35, and 15% below 25. Participants were recruited from local children's centres, National Childbirth Trust and social media adverts, and University emails. Inclusion criteria comprised English as the primary language used in the home. Exclusion criteria included any known developmental delays or difficulties in the infant, or having had more than three ear infections within a 6-months period. The study received institutional ethics approval, and was conducted according to the Declaration of Helsinki.

2.2. Materials and procedure

2.2.1. Book sharing

Dyads were filmed using a hand-held digital video recorder in their home whilst participating in a ten-minute book sharing activity (M video length = 10.31 min; SD = 1.54). The dyads were given two novel picture story books (produced by the research team) to ensure consistency between dyads, and remove any familiarity effects that could have occurred with pre-existing books. Book One comprised ten familiar objects typically found in infants' first words (e.g. banana). Book Two contained ten everyday routines to which infants would be accustomed (e.g. brush teeth). The books had no words to accompany the illustrations (Fig. 1).

2.3. Measures

2.3.1. Maternal mind-mindedness (MM)

Mind-mindedness (MM) was coded at 12 months according to an established coding scheme (Meins and Fernyhough, 2015), which involves coding maternal speech that refers to the infants' thoughts, feelings, knowledge and desires. MM was coded during the 10-min book sharing videos. The same videos were also used to code touch behaviour. Each MM comment was defined as either; (i) *Appropriate mind-related comment* (MM $_{(appropriate)}$, Meins et al., 1998, 2001), during which the mother describes her infant's thoughts, feelings, desires or knowledge accurately (i.e. they appear to be in-tune with the infant's internal states), or mothers link the book sharing to previous or future experiences or events relevant to the infant. E.g. "you like bananas",

"this is your favourite", "do you remember we saw a cat at the park" (k = 0.95; 95% CI 0.18–1.00). (ii) *Non-attuned mind-related comment* (MM $_{(non\text{-}attuned)}$, Meins et al., 1998, 2001), during which the mother incorrectly describes the infant's thoughts, feelings, desires and knowledge. E.g. "you want to turn the pages" when the infant expresses no interest in the book, (k = 1.00; 95% CI 0.47–1.00). Similarly, the mother makes reference to an event or experience in the infants past or future that does not relate to the book sharing topic. Mind-mindedness was coded as frequencies rather than durations to coincide with previous research involving these behaviours (e.g. Kirk et al., 2015). Specifically, we used the frequency scores for MM $_{(appropriate)}$ and MM $_{(non\text{-}attuned)}$ calculated using the total amount of comments produced by mothers during the interaction. In order to compute a fine-grain micro-analysis of both mother and infant behaviours, videos were analysed using the Observer XT (a computer aided coding system; Noldus, Wageningen, the Netherlands) by a trained experimenter (LW).

2.3.2. Socio economic status (SES)

Information about marital status, employment status, maternal education and occupational prestige were collected using the Hollingshead Index (Hollingshead, 1975). Hollingshead scores can range from 8 to 66.

2.3.3. Edinburgh postnatal depression scale (EPDS)

Post-natal depression was measured when the infants were 12 months old using the Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987); a 10-item self-report questionnaire developed to measure postpartum depression (e.g. *"I have been anxious or worried for no good reason")*. Responses are given on a four-point scale ranging from "no/not at all/never" to "yes/most of the time/always" and mothers are requested to refer to the way they have been feeling in the previous 7 days. The EPDS has been found to have good sensitivity and specificity (Cox et al., 1987; Boyce et al., 1993), with a cut-off score of 12/13 (max score = 30) indicating the likely presence of major depression, and 9/10 the likely presence of minor depression.

2.3.4. The mother-Infant touch scale (MITS)

Maternal and infant touch were coded according to a novel coding system developed on the basis of well-validated instruments used in previously studies (Polan and Ward, 1994; Ferber et al., 2008; Stack et al., 1996; Jean et al., 2009: Reece et al., 2016; see Table 1). This new scale was developed to allow coding of maternal and infant touch in parallel (which is not possible with existing systems) and contingent in valence, functionality and purpose. In contrast with existing scales, the MITS focuses on observational tactile behaviours which can be interpreted as contingent or non-contingent with the infant's emotional experience on the basis of any given context. The newly developed system makes an initial distinction between *incidental* and *intentional* maternal touch (see Reece et al., 2016). Intentional touch is then further characterised as *affectionate*, *instrumental* or *static*. In order to further categorize the valence of affectionate touch, we added the subcategories of *contingent/excitatory* (Touch $_{(maternalcontingent)}$) and *non-contingent/down-regulatory* (Touch $_{(maternalnon\text{-}contingent)}$). Touch $_{(maternalcontingent)}$/Excitatory was defined as a maternal touch emotionally contingent and congruent with what the infant was experiencing in that moment. In contrast, Touch $_{(maternalnon\text{-}contingent)}$/Down-regulatory was defined as a maternal touch non-attuned with the infant's emotional experience and needs, and therefore we included in this category all instances of maternal touch aimed at restraining rather than responding to the infants' willingness to act or express their emotions. In addition, we also measured *static* touch (see Table 1 for details).

Infant touch was similarly coded with an initial distinction between *intentional* and *incidental* touch, and further characterisation as *affectionate*, *instrumental* or *static*. In the case of infant touch, affectionate touch (Touch $_{(infantaffectionate)}$) was classified as a touch that gave a sense of affective closeness between infant and mother, and/or expression of emotional needs. Valence (i.e. excitatory vs. down-regulatory) was not coded since it was not possible to reliably infer the 'mind-reading' of the infant towards the mother.

This study aims to assess how maternal mind-mindedness may relate to maternal contingent/excitatory; maternal non-contingent/down-regulatory and infant affectionate touch. Hence, our inferential statistics focused on these, three general categories of touch, without examining other theoretically less relevant types of touch (e.g. instrumental), or by going into further details within these categories (e.g. whether stroking versus patting was used). Nevertheless, in order for us to identify such categories, we have developed a scheme that can distinguish them from other types of tactile interactions, as well as measure the total amount of tactile interactions. Accordingly, our coding scheme allowed us to distinguish the tactile interactions of interest from other type of interactions (e.g. instrumental touch during booking reading), as well as to generate a total amount of touch (Touch $_{(maternaltotal)}$) between each mother-infant pair, so we could take this variable into account in our analyses. Thus, please note that while the Mother-Infant Touch Scale can be used in future studies to address many different hypotheses about the nature of touch between mother and infants, only three main, theoretically-motivated categories were relevant to the current study, namely maternal contingent/excitatory; maternal non-contingent/down-regulatory and infant affectionate touch.

Coders were instructed to first identify the main category of touch (e.g. affectionate or instrumental) and their sub-category (e.g. contingent or non-contingent). To do so coders were instructed to observe the behaviour of the infants before and after the maternal touch and then to infer the mental state of the infant. The observations used to infer the infant mental state were, for example, facial expression (e.g. happy vs. sad), sounds/calls/utterances (e.g. laugh vs. cry) and body movement (e.g. rapid vs. slow, approaching, retreating). This retrospective coding technique always followed the same direction, that is from the child to the mother and back to the child again. Based on this constant reciprocity between mother and infant behaviour, it was possible to code whether maternal touch was attuned (contingent) or non-attuned (non-contingent) to the infant affect in that precise moment, instance by instance and indeed beyond simple positive-negative valence contingency. This means that there was no maternal touch which was regarded *as de facto* positive or negative towards the infant. Instead, this categorisation was always based on observing the infant before the maternal touch and their reaction after it. For example, if the infant was expressing distress by crying and moving his arms, a contingent maternal behaviour would be an affectionate one, such as stroking or hugging. In contrast, a down-regulatory, non-contingent behaviour would be holding the arms of the infant and pulling the child to pay attention to the book they were sharing, whilst the infant was clearly not interested. Another example could be a 'non-contingent' maternal hug; this was classified as non-contingent/down-regulatory if the infant was happily looking at the book and therefore he reacted to a sudden maternal pulling and hugging by 'complaining' because in that moment he/she wanted to turn the page and it was obstructed by the tactile behaviour of the mother.

Maternal and infant touch was analysed using the Eudico Linguistics Annotator (ELAN; Max Planck Institute for Psycholinguistics, The Language Archive, Nijmegen, The Netherlands; Lausberg and Sloetjes, 2009). Behaviours of interest were coded second-by-second by two researchers (LC & MLF), who were blind to any demographic information of the infant and mother. Each second that contained touch behaviours (termed a touch instance) was classified according to the coding system described in Table 1. This system allowed both the frequency and duration of behaviours to be analysed. The two coders first trained for reliability in using the ELAN system on six tapes randomly chosen from the study database. In this phase, agreements and disagreements were discussed in order to develop a consolidated coding

Table 1
Descriptions of maternal and infant touch categories developed based on previous studies.

Type of maternal touch	Description
Incidental	Touch that occurs by way of actions directed at an object instead of the child Reece et al. (2016)
Intentional	Touch directed at the child Reece et al. (2016)
Affectionate	Intentional touch that gives a sense of closeness between the child and the mother Reece et al. (2016)
a) Contingent-Excitatory	Touch that is contingent with the infant's experience and elicits positive affect in the infant, such as: • Light, gentle, active touch • Firm active (not restrictive) • Kissing or rubbing lips • Tickling • Vestibular stimulation (e.g. lifting) • Proprioceptive stimulation
b) Non-Contingent-Down-regulatory	Touch that is not contingent with the infant's experience. Intrusive, awkward, overwhelming, rough touch, such as: • Awkward light active affective touch • Restrictive firm active • Rough kissing or rubbing lips; biting • Rough tickling • Vestibular stimulation (e.g. rough or restrictive handling) • Proprioceptive stimulation (awkward holding)
Static touch	Passive contact such as resting the hand in contact with the infant Polan and Ward (1994)
Instrumental	Intentional touch that serves the child Reece et al. (2016), such as: • Proprioceptive stimulation (e.g. flexion-extension-flexion of the infant's limb by the mother for the purpose of dressing) • Vestibular stimulation (e.g. adjust the position with change in balance) • Matter-of-touch or functional (e.g. adjusting the clothes; cleaning the child, Polan and Ward (1994) • Instrumental touch towards the meaning of the story (not affective, e.g. touching the infant's foot when a picture of shoe appears)

Type of infant touch	Description
Incidental	Touch that occurs by way of actions directed at an object instead of the mother
Intentional	Touch directed at the mother
Affectionate	Intentional touch that gives a sense of closeness between the child and the mother (e.g. caress) (Reece et al. (2016)
Instrumental	Intentional touch that the infant use to complete an action (e.g. stand up; turn the page)
Static	Infant touch which is mostly static (e.g. infant hand resting on mother)

system before moving to the full coding procedure. The training was considered complete once the coders achieved a level of agreement equal to 80% of the total tactile behaviours. In the coding phase that followed, each of the two coders independently coded 19 and 20 videos, respectively, which were randomly split between them. Twenty percent of the videos (8 out of 39) were second-coded by the other coder and vice versa. Cohen's kappa was used to calculate the inter-observer agreement (Ferber et al., 2008; Mantis et al., 2014). Kappa coefficients and confidence intervals for the quantity of maternal touch behaviours were specifically computed (k = 0.56; 95% CI 0.30–.82) averaging together the categories: excitatory, down-regulatory, instrumental, incidental and static touch. Similarly, for infant touch behaviour we computed kappa coefficients for the touch (k = 0.44; 95% CI 0.20–.68) averaging across the categories: affectionate, instrumental, incidental and static. Disagreements on the quality of touch on the double coded videos were discussed; disagreement on the quantity were resolved by averaging the amount of touch across both coders. A moderate to substantial level of agreement was considered acceptable in this context, as it reflects the complexity of tactile interactions and methods reported in previous studies (see Reece et al., 2016; Brauer et al., 2016). The total touch instances for each touch category was weighted (divided) for the exact length of each video to account for differences in duration, so that frequencies of touch were balanced for the actual duration of the video and comparable among participants.

2.3.5. Maternal gesture

The non-verbal elements of the book sharing coding scheme were developed prospectively following a thorough review of the current literature, which examined maternal behaviours impacting infant and child development. The frequency of maternal gestures was coded at using the Observer system (see Section 2.3.1.) by a trained experimenter (LW) as follows: (a) *declarative*, to share attention with the infant, e.g. pointing to the pictures in the book (k = 0.97; 95% CI 0.58–1.00), (b) *symbolic*, a gesture with a specific meaning, e.g. a hand gesture for duck by touching the thumb to fingers and then apart (k = 0.96; 95% CI 0.88–1.00), (c) *imperative*, to indicate a want, e.g. pointing to the other book for the infant to get it (k = 1.00; 95% CI 0.72–1.00). We computed the frequency of each of the three different kinds of gestures separately, and then the sum total of all three gestures combined.

2.3.6. Maternal gaze

Duration of mother gaze was coded using the Observer system (see Section 2.3.1.) by a trained experimenter (LW) to obtain an overall measure of what the mother was looking at during the interaction. Also, the frequency of mother gaze was recorded to obtain an indication of the regularity of the mothers' change in gaze, which would give an idea of the responsiveness to her infant, as well as the relationship between the mother and infant, and the book, during the interaction. Eye gaze was measured when it changed from and to the following: (a) *gazing at the book*, (b) *gazing at the infant*, (c) *other gaze*, for example looking at something else in the room. For the purpose of this study, only the total amount of gazing at the infant was taken into account since it was included to act as a control variable for the specificity of the relation between MM and maternal touch, which was always directed to the infant (k = 0.89; 95% CI −0.26 to 0.99).

2.4. Procedure

Testing took place in participants' homes. Once the mother and infant were comfortable and familiar with the researcher (LW) the mother was video-recorded engaging in book sharing (see Section 2.2.1.) with her infant for 10 min, in a setting of their choice (e.g. kitchen, living room, or infant's bedroom). Mothers were free to decide on the setting for this activity to make it as natural as possible and to ensure the mother and infant felt comfortable during the activity. The only instructions given to the mothers were to look at the picture books with their infant as they felt comfortable or how they would normally,

and that they would be filmed during this time. All book sharing sessions were completed with the mother and the infant only, with the researcher unobtrusively recording. The camera was discreet, approximately measuring 10 centimetres in length by 5 centimetres in width, and was held by the researcher throughout the filming. Dyads often moved around the room and therefore the camera was moved and positioned accordingly to capture the mother and infant at all times. Mothers then completed the questionnaire (i.e. demographics, SES and EPDS) with the researcher.

2.5. Design and statistical analysis

The data analysis was conducted taking into account both the quantity (total touch occurrence) and quality (type or category) of touch. With regard to the quantity of touch, all the instances of touch were grouped together regardless of touch categories in order to obtain one value for maternal touch and one for infant touch (i.e. total amount of touch within the length of the video). The total quantity of maternal touch was included in all the analyses as a covariate in order to account for the overall tactile interactions in each dyad.

2.5.1. Preliminary analyses

All data were analysed by means of hierarchical (or block wise) regressions, and all the variables were inserted by means of forced entry. The reason why we decided to use the block wise method is because this statistical method allowed to investigate the effect of MM after accounting for all the other variables that could play a role (i.e. Touch $_{(maternaltotal)}$; postnatal depression and socio-economic status, etc if appropriate). In the first block (Step 1) we have included the variables known to have an effect on our outcome measures based on previous studies and variables we wanted to control for (e.g. socio-economic status, Touch $_{(maternaltotal)}$ and total maternal speech). In the second block (Step 2) we have entered the more explorative variables, namely MM $_{(appropriate)}$ and MM $_{(non\text{-}attuned)}$ as they were our main predictors of interest.

Firstly, in preliminary analyses, postnatal depression, socio-economic status, infant age, maternal age, infant gender, Touch $_{(maternaltotal)}$, total maternal speech, maternal gestures, maternal gaze, MM $_{(appropriate)}$ and MM $_{(non\text{-}attuned)}$ were tested by means of correlational analyses in order to investigate whether they co-varied with the main variables of interest, namely Touch $_{(maternalcontingent)}$, Touch $_{(maternalnon\text{-}contingent)}$ and Touch $_{(infantaffectionate)}$. The multivariable analyses were performed using a purposeful selection of covariates (Hosmer et al., 2008). In case of a $p-$value $< .20$, we included these variables as covariates in the analyses. After these first two hierarchical regressions, we have followed up these with other two hierarchical regressions which included only the variables which significantly contributed to the model at a p-value $< .05$ in order to specify the contribution of these variables only to the *final model* (Hosmer et al., 2008). In addition, we examined the relation between the two dimensions of MM, indexed as MM $_{(appropriate)}$ and MM $_{(non\text{-}attuned)}$ by correlational analyses. Since we used the frequencies of MM $_{(appropriate)}$ and MM $_{(non\text{-}attuned)}$, maternal total speech was included in all the analyses together with Touch $_{(maternaltotal)}$ as control variables and irrespective of the results of the correlational analyses (which therefore have not been reported)

2.5.2. Mind-mindedness and maternal touch

Following the above, preliminary analyses we assessed our main hypotheses concerning how MM related to maternal tactile affect-regulatory touch by running two separate, hierarchical multiple regressions (Field, 2009). In the first we examined Touch $_{(maternalcontingent)}$ as the outcome (dependent) variable, entering postnatal depression, socioeconomic status, infant age, maternal age, infant gender, Touch $_{(maternaltotal)}$, total maternal speech, maternal gestures, maternal gaze, if appropriate – as covariates in Step 1 and MM $_{(appropriate)}$ and MM $_{(non\text{-}attuned)}$ as the primary predictors (independent) variable of interest (Step 2). In the second hierarchical multiple regression, we examined Touch $_{(maternalnon\text{-}contingent)}$ as the outcome variable, entering postnatal depression, socioeconomic status, infant age, maternal age, infant gender, Touch $_{(maternaltotal)}$, total maternal speech, maternal gestures, maternal gaze, if appropriate – as covariates in Step 1 and MM $_{(appropriate)}$ and MM $_{(non\text{-}attuned)}$ as the primary predictors (independent) variable of interest (Step 2). Due to sample size restrictions, infant touch had to be addressed in separate analyses, described below.

2.5.3. Mind-mindedness and infant touch

We then focused on Touch $_{(infantaffectionate)}$. In this study, it was not possible to have specific hypotheses about the valence of infant affectionate touch because we did not distinguish between a contingent/positive and non-contingent/negative valence when coding the infant touch. However, we aimed to explore whether MM and/or maternal touch had an effect on infant touch, by means of a hierarchical multiple regression (Field, 2009). We examined Touch $_{(infantaffectionate)}$ as the outcome variable, entering Touch $_{(maternalcontingent)}$ and Touch $_{(maternalnon\text{-}contingent)}$ as covariates (Step 1) and MM $_{(appropriate)}$ and MM $_{(non\text{-}attuned)}$ as primary predictors of interest (Step 2).

3. Results

3.1. Descriptive statistics

Means and standard deviations for all the touch subcategories are reported in Table 2. We checked the normality assumptions of the

Table 2
Means and standard deviations of tactile categories. The total touch instances (measured as frequencies) for each touch category has been weighted (divided) for the exact length of each video.

Type of maternal touch	Sub-categories	M (*SD*)
Contingent affectionate touch	Excitatory	8.61 (8.83)
Non-contingent affectionate touch	Down-regulatory	4.20 (4.47)
Non-affectionate touch	Instrumental	2.46 (1.88)
	Incidental	1.78 (1.57)
	Static	0.81 (2.54)
Total		17.86 (9.49)
Type of infant touch	**Sub-categories**	**M (*SD*)**
Affectionate touch	Affectionate	4.38 (4.43)
Non-affectionate touch	Instrumental	2.81 (3.34)
	Incidental	3.13 (2.32)
	Static	5.11 (5.68)
Total		15.42 (9.09)

Table 3
Correlational matrix for Independent and Dependent variables. The reported values are Pearson's *r*.

		1	2	3	4	5	6	7	8	9	10	11
1	SES											
2	EPDS	−0.48										
3	Maternal gaze	0.23*	−0.09									
4	Maternal gesture	0.39***	−0.5	0.06								
5	Infant age	0.29	−0.03	−0.14	−0.22*							
6	Gender	−0.04	−0.22	−0.16	0.15	0.11						
7	Maternal age	0.56***	0.22	−0.15	0.33**	−0.05	−0.15					
8	AMR comments	0.46***	−0.14	0.30**	0.29*	0.19	0.02	0.26				
9	NAMR comments	−0.47***	0.26	−0.15	−0.30**	−0.10	−0.12	−0.29	−0.26			
10	Contingent touch	0.16	.21*	−0.18	0.27*	−0.13	−0.12	−0.05	0.07	−0.04		
11	Non-contingent touch	−0.33**	0.23*	−0.12	0.01	0.16	−0.36**	−0.24*	−0.26*	0.53***	0.07	
12	Infant affectionate touch	0.23*	−0.07	0.07	0.04	−0.10	−0.10	0.14	0.11	−0.11	−0.02	−0.29**

SES = socioeconomic status; EPDS = Edinburgh Postnatal Depression Scale; AMR = appropriate mind-related; NAMR = non-appropriate mind-related.
* $p < .20$.
** $p < .05$.
*** $p < .01$.

residuals by looking at a Q-Q-Plot and by means of Shapiro-Wilk test conducted on the residuals themselves. Both the standardised and unstandardized residuals for all regressions were found to be normally distributed; therefore, parametric analyses were used. The mean score for postnatal depression (EPDS) was 2.2 (SD = 2.02, range 0–8). The SES had a mean score of 46.51 (SD = 15.32; range 8–66). The mean of frequency for MM $_{(appropriate)}$ was 9.20 (SD = 7.15; range 0–33); the mean of MM $_{(non\text{-}attuned)}$ was 0.48 (SD = 1.39; range 0–7).

3.2. Preliminary analyses

Preliminary analyses were conducted to check whether postnatal depression (EPDS), socio-economic status (Hollingshead score), infant age, maternal age, infant gender, Touch $_{(maternaltotal)}$, total maternal speech, maternal gestures, maternal gaze were related to our variables of interest, namely Touch $_{(maternalcontingent)}$ and Touch $_{(maternalnon\text{-}contingent)}$, and Touch $_{(infantaffectionate)}$ (Table 3). Touch $_{(maternalcontingent)}$ was related at a *p*-value < 0.20 with postnatal depression and maternal gesture. Touch $_{(maternalnon\text{-}contingent)}$ was related at a *p*-value < .20 with postnatal depression, socio-economic status, maternal age and infant gender. Touch $_{(infantaffectionate)}$ was related at a *p*-value < .20 with socio-economic status (see Table 3). Total maternal speech and Touch $_{(maternaltotal)}$ were included in all the analyses to account for maternal verbosity and the total amount of tactile interactions. MM $_{(appropriate)}$ and MM $_{(non\text{-}attuned)}$ were included in all analyses in Step 2 as they were our main variables of interest.

3.2.1. Mind-mindedness and contingent maternal touch

The first hierarchical regression focused on the role of MM on Touch $_{(maternalcontingent)}$ (see Section 2.5.2.). Tests for multicollinearity indicated that a very low level of multicollinearity was present (VIF = 1.20 for EPDS; 1.27 for Touch $_{(maternaltotal)}$; 1.84 for total maternal speech; 1.50 for maternal gestures; 1.28 for MM $_{(appropriate)}$, 1.46 for MM $_{(non\text{-}attuned)}$). Results of the hierarchical regression analysis showed that the only significant predictor of Touch $_{(maternalcontingent)}$ was Touch $_{(maternaltotal)}$ which explained 62.1% of the variance ($R = 0.821$, $R^2 = 0.674$, $F\ (6,\ 37) = 12.73$, $p < .001$; please see Table 4 for the beta coefficients of all the variables). The hierarchical regression including only the significant covariate of the previous regression (see Section 2.5.1.) showed that the best fitting model for predicting contingent maternal touch is the one taking into account Touch $_{(maternaltotal)}$ and MM $_{(non\text{-}attuned)}$ which explains 64.7% of the variance ($R = 0.820$, $R^2 = 0.672$, $F\ (3.40) = 27.28$, $p < .001$; Table 4). The results showed that the main predictor of Touch $_{(maternalcontingent)}$ is Touch $_{(maternaltotal)}$.

3.2.2. Mind-mindedness and non-contingent maternal touch

The second main hierarchical regression focused on the role of MM $_{(non\text{-}attuned)}$ on Touch $_{(maternalnon\text{-}contingent)}$ (see Section 2.5.2.). Tests for multicollinearity indicated that a very low level of multicollinearity was present (VIF = 2.16 for SES; 1.05 for EPDS; 1.77 for Touch $_{(maternaltotal)}$; 2.22 for total maternal speech; 2.03 for maternal age, 1.37 for infant gender; 1.37 for MM $_{(appropriate)}$, 1.59 for MM $_{(non\text{-}attuned)}$). Results of the hierarchical regression analysis showed that the best fitting model for predicting Touch $_{(maternalnon\text{-}contingent)}$ is a linear combination of the Touch $_{(maternaltotal)}$ and MM $_{(non\text{-}attuned)}$ which explains 40.9% of the variance ($R = 0.720$, $R^2 = 0.519$, $F\ (8.43) = 4.71$, $p < .001$; please see Table 4 for the beta coefficients of all the variables and Fig. 2). The hierarchical regression including only the significant covariate of the previous regression (see Section 2.5.1.) showed the best fitting model for predicting Touch $_{(maternalnon\text{-}contingent)}$ is the one taking into account Touch $_{(maternaltotal)}$ and MM $_{(non\text{-}attuned)}$ only which explains 44.6% of the variance ($R = 0.696$, $R^2 = 0.485$, $F\ (3,40) = 12.56$, $p < .001$; Table 4).

3.2.3. The effect of mind-mindedness and maternal touch on infant touch

The final main hierarchical regression focused on the role maternal touch and/or MM on Touch $_{(infantaffectionate)}$ (see Section 2.5.3). Tests for multicollinearity indicated that a very low level of multicollinearity was present (VIF = 1.02 for Touch $_{(maternalcontingent)}$; 1.47 for Touch $_{(maternalnon\text{-}contingent)}$; 1.11 MM $_{(appropriate)}$; 1.43 for MM $_{(non\text{-}attuned)}$). Results showed that the best fitting model for predicting Touch $_{(infantaffectionate)}$ is the one taking into account Touch $_{(maternalnon\text{-}contingent)}$ which explains 6.3% of the variance ($R = 0.326$, $R^2 = 0.106$, $F\ (2.41) = 2.44$, $p = .100$; Table 4). The hierarchical regression including only significant covariate of the previous regression showed that the best fitting model for Touch $_{(infantaffectionate)}$ is the one taking into account Touch $_{(maternalnon\text{-}contingent)}$ which explains 8% of the variance ($R = 0.324$, $R^2 = 0.110$, $F\ (1,42) = 4.92$, $p = .032$; Table 4).

4. Discussion

This study aimed to investigate for the first time the role played by maternal mind-mindedness in the extent to which, and how, mothers and infants engage in reciprocal, affective-regulating tactile interactions. We found that verbal statements portraying that mothers were not attuned to the infant's needs and desires were predictive of emotionally non-contingent/down-regulating maternal touch and of contingent/excitatory touch. However, appropriate mind-related comments (i.e. appropriate verbal statements towards the infants' mental states) were not predictive of more emotionally contingent maternal touch with their infants. In terms of infant touch, our results showed

Table 4
Results of hierarchical multiple regressions on maternal and infant touch. Unstandardized coefficient B, standard error of B and standardised coefficient β are reported.

	Contingent Maternal Touch		
Independent variables	B	SE B	*β*
Postnatal depression	−0.037	0.317	−0.012
Maternal gesture	0.011	0.033	0.039
Total maternal touch	0.584	0.073	0.842**
Total maternal speech	−0.003	0.007	−0.050
Appropriate mind-related comments	0.093	0.091	0.106
Non-attuned mind-related comments	−0.939	0.508	−0.210
Final model			
Total maternal touch	0.584	0.065	0.842**
Non-attuned mind-related comments	−0.904	0.427	−0.202*

	Non Contingent Maternal Touch		
Independent variables	B	SE B	*β*
SES	−0.043	0.052	−0.148
Postnatal depression	−0.123	0.310	−0.056
Infant gender	−1.44	1.14	−0.162
Maternal age	−0.034	0.674	−0.008
Total maternal touch	0.196	0.072	0.395**
Total maternal speech	0.004	0.007	0.090
Appropriate mind-related comments	−0.061	0.083	−0.097
Non-attuned mind-related comments	1.23	0.464	0.386**
Final model			
Total maternal touch	0.215	0.058	0.435**
Non-attuned mind-related comments	1.29	0.382	0.406**

	Affectionate Infant Touch		
Independent variables	B	SE B	*β*
Contingent maternal touch	0.032	0.111	0.045
Non-contingent maternal touch	−381	0.186	−0.375*
Appropriate mind-related comments	−0.003	0.101	−0.005
Non-attuned mind-related comments	0.279	0.586	0.086
Final model			
Non-contingent maternal touch	−0.374	0.182	−0.368

* p < .05.
** p < .001.

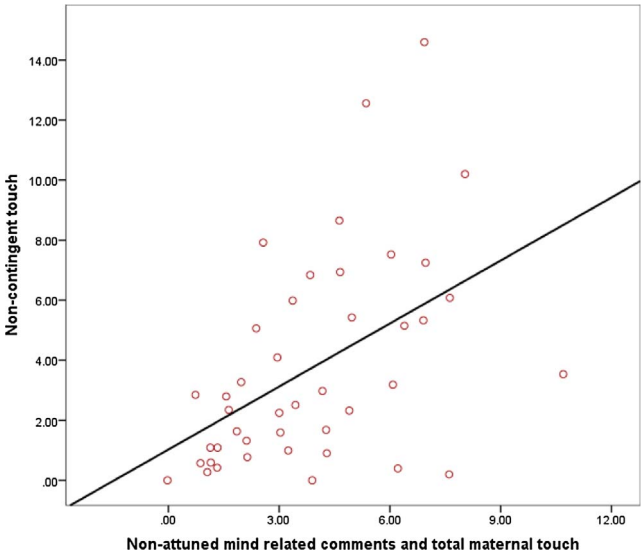

Fig. 2. Scatter plot representing the significant multiple regression model taking into account the predicted values of non-attuned mind related comments and total quantity of maternal touch on non-contingent maternal touch at 12 months.

that non-contingent maternal touch was associated with a reduced use of affectionate touch towards the mother.

This study showed that not only mothers might use touch in order to emotionally regulate the infant (e.g. Hertenstein and Campos, 2001), but that this ability might depend on the extent to which mothers understand and explicitly recognise infant's mental states. Our data support the hypothesis that non-attuned mind-related comments tend to be accompanied by tactile responses that are not contingent with the infant's emotion (e.g. downregulating/restraining their excitement or trying to distract their attention by intrusive touch) and thus also discourage an affectionate tactile response from the infant.

However, as tested in this study, there does not seem to be a one-to-one relation between mind-mindedness and maternal touch, and ultimately infant touch. Specifically, our findings show that appropriate mind-related comments did not necessarily predict more emotionally-contingent tactile behaviours, which did not predict more frequent affectionate infant touch. These two dimensions of MM have been shown not to be related in the past and to influence infant development differently (Meins et al., 2003, 2012). However, to our knowledge this is the first study to show that they also influence the affective quality of tactile interactions differently. The fact that only non-attuned mind-related comments are predictive of non-contingent maternal touch might suggest that the inability to understand the infant's needs and emotions is more strongly expressed via non-contingent embodied interactions as compared to the ability to successfully do so. In other

words, we can speculate that the less able mothers are to understand their infant's mental states, the more likely they are to express their own mental states in their tactile responses towards their infants, i.e. attempt to regulate their baby in more concrete, proximal, embodied ways. The lack of understanding of the infants' desires and needs might lead to a stronger need of physically control and restraint the infant, who in return, responds with a lack of affectionate behaviours towards the 'non-understanding' mother.

This finding is in line with previous conceptualization, according to which if the caregiver response is incongruent with the infant's affective states, the baby will identify with that incorrect mirrored affect (Fonagy et al., 2004). For example, if the infant wants to reach a specific toy but the mother restrains this behaviour and holds the infant, he/she might think that there is something wrong with his/her having curiosity for that toy and might, for example, incorrectly interpret the environment as dangerous. By contrast, caregivers who respond to their babies' affective needs with contingent affective displays (e.g. mirroring joy in response to a display of enthusiasm in the infant) create a situation of contingent mirroring of the infant's emotions, thus enabling the infant to modulate her or his own affective states (Fonagy et al., 2004). Our data provide further support to this idea by suggesting that when mothers can recognise the mental states of their infants appropriately and can verbalise them, may have at their disposal a greater variety of means to affective regulate their baby, including verbal and more distal embodied aspects of communication (e.g. gaze, gesture, tone of voice) and hence their tactile behaviours, as well as all of their responses, do not have such specificity.

Indeed, while Meins et al.'s (2001) original operationalization of MM in the first year of life included five different indicators, including behaviour responses such as gaze following and imitation, only the more abstract of these categories (appropriate verbal statements) was found to have predictive value of infant's attachment security at 12 months. Similarly, it is increasingly understood that MM may predict maternal sensitivity (how promptly mothers respond to their infant's needs) in the prediction of attachment security, rather than the other way round (Laranjo et al., 2008).

Taken together these findings suggest that the lack of appropriate parental mind-mindedness as measured by means of non-attuned mind-related comments may have more specific effects on tactile affect regulation as compared to appropriate MM at verbal levels. More generally, the dissociation between non-attuned and appropriate mind-related comments in our findings is in line with the idea that mind-mindedness is a multidimensional construct, and that these two aspects can make independent contributions to the mother-infant relationship and infant development (Meins et al., 2012). For example, indices of appropriate mind-related comments and non-attuned mind-related comments have been found to be unrelated (Arnott and Meins, 2007; Meins et al., 2002). Importantly, whereas appropriate mind-related comments are positively correlated with maternal sensitivity (Arnott and Meins, 2007; Meins et al., 2001), non-attuned mind-related comments appear to be unrelated to such sensitivity (Arnott and Meins, 2007; Meins et al., 2002). Thus, our findings may be explained by the fact that non-attuned comments tap into aspects of caregiving that are not captured by traditional definitions of sensitive responsivity; this could be a reason why the present study only captures the relation between non-attuned mind-related and non-contingent touch. However, an alternative explanation could be that the difference we found between non-attuned and appropriate mind-related comments may reflect methodological reasons. For instance, appropriate mind-related comments and non-attuned mind-related comments occur at very different frequencies in maternal discourse, with appropriate mind-related comments being around four or five times more frequent (Meins et al., 2011; Meins et al., 2003). It is thus possible that the frequencies of two types of comments in a relatively brief book reading session do not have the same sensitivity in predicting other maternal behaviours. Future studies could thus explore the reliability of our results in different settings and durations of mother-child interactions. However, given the small sample size and limited statistical power observed in this study, the results and their interpretation should be taken with caution and further investigated in future research. Additionally, to maximize statistical power, we have just investigated our strongest hypothesis and a limited amount of variable could be entered as co-variate in the regression models. Furthermore, our study did focus exclusively on mothers, therefore it does not make justice to the fact that certain aspects of infants' social development might be similarly influenced by male parents. However, we hope that our findings might pave the way for further investigation on the relation between parental characteristics and tactile interactions.

Contingent affectionate touch included touch that was coded as being in line with the infant's needs and emotions (e.g. light active touch, or firm gentle touch as a soothing, supportive response) or that elicited a positive excitatory response in the infant, such as playful tickling as an excitatory interaction. Light touch, as well as tickling, seems to be mediated by a specialised nerve pathway – the CT afferents system – which responds optimally to dynamic, slow velocity and low pressure touch (Löken et al., 2009). Recent studies showed that sensitivity to slow, CT-optimal touch (as compared to static and faster emotionally neutral velocities) emerges very early on in infancy, suggesting a potential role of this modality in social affiliations (Bystrova, 2009; Fairhurst et al., 2014; Gentsch et al., 2015; Croy et al., 2016). The current study showed that mothers engaged with contingent, excitatory affectionate touch, such as slow active touch, tickling and kissing, to a greater extent compared to down-regulatory affectionate touch. However, we found that high-order socio-cognitive maternal characteristics such as MM do not seem to affect the extent to which mothers engage in this type of touch. Thus we believe that future studies could investigate specifically which other top-down factors, maternal traits or mental states could influence the extent to which mothers engage in CT-optimal/affective touch with their infants. Additionally, it should be acknowledged that the current study measured postnatal depressive symptoms when the infant was 12 months old; therefore the possibility that a recall bias might have influenced the postnatal depression scores cannot be excluded and this data should be considered with caution.

This study supports the unique role of touch in the development of emotion regulation in the infant and brings the ideas of mentalization and emotional regulation a step further by showing that infants seem to physically react to the maternal inadequate emotional and tactile response by reducing the proximity and affective tactile contact with the mother. We stated in the introduction that what is special about social touch, in contrast to gaze and gestures, is its mutuality, proximity and centrality in homeostatic regulation. Touch is a fundamental component of the homeostatic regulation parents provide to their infants, which in turn is the basis of how infants progressively learn to regulate their own interoceptive states (the perception of the physiological state of the body) in relation to exteroceptive states (Fotopoulou and Tsakiris, 2017; see also Atzil and Barrett, 2017; Fonagy and Campbell, 2017; Bolis and Schilbach, 2017). Our data showed that maternal MM as measured by non-attuned and appropriate mind-related comments, was not related to maternal gestures and gaze at the infants, suggesting that non-attuned mind-related comments might uniquely affect embodied mother-infant interactions at 12 months. Our control analyses provide additional support to the need to study the specific links between abstract maternal abilities to read infant mental states and their subsequent, proximal as opposed to distal embodied and homeostatically-relevant responses.

In conclusion, our findings showed for the first time a direct relationship between the maternal inability to understand the infant's mind and non-contingent emotionally-regulatory touch.

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