Imitation and the Active Child

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This thesis is based on the following submitted manuscripts:

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Summary of thesis

The central topic of this thesis is the role of individual differences in the development of imitation. The main claim of the thesis is that individual differences reflect infants' active involvement in their own developmental process. The thesis utilizes a combination of experimental and parent report data to demonstrate the manifold nature of the origins of imitation.

Chapter one introduces the topic of individual differences in imitation by reviewing, in the first part of the chapter, the literature on imitation during the first 18 months of life, and the literature on the role of temperament in social-cognitive development, in the second part of the chapter. Furthermore, the open questions concerning the role of individual differences and the infants' active involvement in the development of imitation are discussed.

Chapter two studies the relation between attentional preferences and individual differences in imitation of facial and vocal models in the first few months of life. Thus far studies of early imitation have dismissed individual differences as noise, therefore not much is known about the role of individual differences in imitation. The findings demonstrate that attentional preferences as measured with the Infant Behaviour Questionnaire-Revised (Gartstein & Rothbart, 2003) are related to specific differences in imitation. Furthermore the findings demonstrate that the major theoretical accounts of imitation are not sufficient to explain these results and a new theoretical model is proposed.

In chapter three the infant's active involvement in its own developmental process is studied by assessing the role of spontaneous imitation in the development of imitation of actions on objects during the first year of life. I demonstrate that infants' own initiative to imitate actions on objects is the most important predictor of the observed increase in imitation of actions on objects around 10- to12- months of age.

Chapter four assesses the role of infant sociability in imitation. In particular, it examines the hypothesis that sociability is related to faithful, but not selective, imitation. The findings demonstrate a positive link between sociability, as measured by the surgency scale of the Early Childhood Behaviour Questionnaire (Putnam, Gartstein & Rothbart, 2006), and faithful imitation. Finally, in the general conclusion I will argue that the two current dominant accounts of imitation, i.e. an innate account and a learning account, do not account for these results, and I will propose an alternative theoretical model that does account for these findings.

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Chapter 1. Introduction

1.1. Imitation

Imitation is an important mechanism for learning new skills and learning about social roles and rules. Imitation is utilized throughout development (see for examples of early imitation: Barr, Dowden & Hayne, 1996; Meltzoff & Moore, 1983; of imitation during pre-school years: Bekkering, Wohlschläger & Gattis, 2000; of imitation in adults: Garcia-Retamero, Takezawa & Gigerenzer, 2009; Van Baaren, Maddux, Chartrand, De Bouter & Van Knippenberg 2003), but is an especially important learning mechanism during infancy, before infants have acquired the use of language. In the first part of this chapter I will review some of the most important findings in research on imitation during the first 18 months of life. I will start with early imitation, which mainly consists of facial and vocal imitation, up to 6 months of age. I will then give an overview of the research on object imitation which starts around 6 months. Finally I will review research on selective imitation such as imitating goals and intentions, and faithful imitation, or overimitation. I will conclude the first part of the chapter with a summary of the types of questions that remain unanswered.

Some discussion exists concerning the definition of imitation. When imitation is studied during the first few months of life, imitation is usually defined as a close behavioural match between the observed act and the act produced by the infant. However, when studying imitation towards the end of the first year and beginning of the second year, differences exist between researchers concerning the appropriate definition of imitation. Even though in some studies imitation is defined as a close behavioural match with the target behaviour, many researchers suggest imitation needs to involve both copying the actions and some understanding of the goal or intentions of the model (see for example: Want & Harris, 2002). In this thesis imitation is studied from the first few months of life until the child is 15 months.

There are big differences between what an infant is capable of during the first few months of life and what it is capable of by the time it is 15 months. To be able to study imitation over such an extended period of time, imitation is broadly defined as a close behavioural match between the modelled behaviour and the produced behaviour.

1.1.1. Early imitation

The study of imitation during the first 6 months of life mainly concerns imitation of facial gestures and expressions, and imitation of vocalizations (see for example: Chen, Striano & Rakoczy, 2004; Field, Woodson, Greenberg & Cohen, 1982; Kugiumutzakis, 1999; Meltzoff & Moore, 1977). A few studies report imitation of finger and head movements (see for example Fontaine, 1984; Meltzoff & Moore, 1977, 1989). Research on imitation during the first six months of life plays an important role in one of the main debates in early imitation: Is imitation an inborn ability or is it acquired through learning? The seminal studies by Meltzoff and Moore (1977, 1983), demonstrating imitation of facial gestures in infants aged between several hours and 1 week, produced the first evidence that imitation might be an inborn ability. Up till then Piaget's (1962) view of imitation had been the dominant view: that imitation of facial gestures required a lot of experience because an infant cannot see itself perform the gestures, therefore facial imitation does not occur until towards the end of the first year. After the publication of the findings by Meltzoff and Moore many studies providing evidence for early imitation followed. Field and colleagues (Field et al., 1982) for example, demonstrated neonates did not only discriminate between emotional facial expressions but they were also able to imitate the happy, sad and surprised faces. Fontaine (1984) conducted a cross-sectional study to assess imitation of facial and manual gestures in the first six months of life. He found that by 2 months infants were able to imitate all of four facial gestures: tongue protrusion, mouth opening, cheek swelling and eye blinking. No imitation was found

for manual gestures. Kugiumutzakis (1999) conducted a longitudinal study following infants from less than 40 minutes old until 6 months. Infants showed imitation of facial gestures and the sound /a/ when less than 32 minutes old. They kept imitating facial gestures until 2.5 months. However, imitation of the sound /a/ disappeared until 2.5 months. From 2.5 months onwards infants were capable of imitating the sounds /a/, /m/ and /ang/. Imitation of facial gestures disappeared after 2.5 months. Kuhl and Meltzoff (1996) demonstrated vocal imitation in infants between 12- and 20-weeks of age for the vowel sounds /a/, /i/ and /u/. Furthermore, one of the most recent studies on neonatal vocal imitation by Chen, Striano and Rakoczy (2004) demonstrated that newborn infants can match mouth movements, mouth opening and mouth clutching, to the sounds /a/ and /m/.

The findings of early imitation have often been used as support for the idea that imitation might have an inborn nature. Several inborn mechanisms have been proposed. Jacobson (1979) for example, proposed an innate releasing mechanism. She demonstrated that infants responded with an increased frequency of tongue protrusion to tongue protrusion displays but also to a pen or a ball moving, in a similar way as a protruding tongue, towards the infant's face. Another more elaborate mechanism is that of an Active Intermodal Mapping system (AIM), proposed by Meltzoff and Moore (1989). AIM assumes an innate mechanism which allows the infant to detect the equivalent between the observed and produced act. A proprioceptive feedback loop allows the infant to evaluate its own body movements with what is observed.

However, several studies have failed to replicate findings of early imitation or demonstrated alternative explanations (see for example: Anisfeld, 1991, 1996; Jones, 1996, 2006; Kaitz, Meschulach-Sarfaty, Auerbach & Eidelman, 1988; Lewis & Sullivan, 1985), questioning the inborn nature of imitation. Lewis and Sullivan (1985), for example, assessed imitation of head turning, tongue protrusion, mouth opening, arm waving and sequential

finger movement at 2 weeks, 12 weeks and 24 weeks in a cross sectional study. They did not find any indication of selective imitation for any of the gestures at any age. Kaitz and colleagues (Kaitz et al., 1988) found imitation only for tongue protrusion and not for happy, sad or surprised expressions. In addition they found an increased tongue protrusion response during displays of happy expressions, which led them to question whether tongue protrusion reflected true imitation. Furthermore, reviews by Anisfeld (1991, 1996) revealed a consistent matching effect for tongue protrusion but the evidence for matching other gestures, such as mouth opening and a head turn was weak and inconsistent. Anisfeld therefore concluded there is no such thing as general facial imitation.

Jones (1996, 2006) provided an alternative explanation for the observed imitation of tongue protrusion. In one of her experiments (Jones, 2006) infants responded in a similar way to episodes of music alternated with episodes of silence as they did in Meltzoff and Moore's (1983) paradigm to episodes of tongue protrusion alternated with a neutral face. In addition, in another series of experiments Jones (1996) demonstrated that infants responded with an increased rate of tongue protrusions to an interesting display. Furthermore, she demonstrated that infants were more interested in tongue protrusion displays than mouth opening displays. Thus, according to Jones infants are demonstrating interest by protruding their tongue rather than imitation. Jones concluded that tongue protrusions responses are an increased arousal response to interesting stimuli. In addition, she suggested that imitation is a slow learned process, with imitation first occurring during the second year of life (Jones, 2007).

As can be concluded from the above discussed findings, research on neonatal imitation and imitation in the first six months of life has thus far been concerned with establishing what an infant can imitate and when. However, this has not provided us with a clear answer on how imitation starts and what the underlying mechanisms are. The debate whether imitation is innate or learned is still ongoing. What these studies seem to ignore however, is the large

observed variability in early imitative behaviours. Most studies dismiss this variability as noise, sometimes excluding over half of their sample (see for example: Meltzoff & Moore, 1983). More recently, however, researchers have started to recognize the importance of individual differences. Ferrari et al. (2009) for example demonstrated that individual differences in facial imitation in newborn rhesus macaques were related to later motor development. Infants classed as imitators were better at grasping and reaching tasks later on in life. These findings suggest that individual variability is an important feature of imitation to consider when studying imitation and its underlying mechanisms. However, thus far research on individual differences in imitation is lacking.

1.1.2. Object imitation

Imitation of actions on objects has been studied from around the age of 6 months onwards. Most studies have been concerned with deferred imitation, i.e. imitation after a delay (Barr, Dowden & Hayne, 1996; Elsner, Hauf & Aschersleben, 2007; Herbert, Gross & Hayne, 2006; Meltzoff, 1988). Barr et al. (1996) found that infants as young as six months were able to immediately imitate the first step of a three-step action sequence. This sequence consisted of removing a felt mitten from a hand puppet's hand, shaking it and replacing it. Twelve-, 18- and 24- month-old infants were able to imitate even after a delay. In addition they demonstrated a developmental pattern regarding the number of steps copied after a delay: only a few 6 month olds copied the first step after a 24 hour delay and this was not significantly different from the control group who had not seen a demonstration. The majority of the 12-, 18- and 24- month olds copied the first step. The second step was hardly ever copied by the 6- and 12- month olds, but was readily copied by the 18- and 24- month olds. The third step was never copied by infants of 6 months old, rarely by 12 month olds but often by 18- and 24- month olds. Additionally, Meltzoff (1988) found that 9 month olds can imitate

simple 1-step actions on novel objects after a 24-hour delay. Combined with the findings of Barr et al. (1996) this suggests that the ability to imitate after a delay develops sometime between 6 and 9 months of age. Herbert et al. (2006) confirmed this by demonstrating that 6 month olds did not imitate a simple action on an object after a 24-hour delay but 9 month olds did.

Thus, from the second half of the first year onwards infants readily imitate actions on objects and from around 9 months of age infants are capable of deferred imitation of simple actions on objects. Not much is known however about imitation of action on objects before 6 months. It has proved difficult to test infants younger than 6 months on object imitation because of their limited motor abilities and limited attention span. However, that does not mean infants younger than 6 months are not capable of object imitation under the right conditions.

In addition, not much is known about spontaneous imitation of actions on objects because object imitation has thus far mostly been assessed in experimental settings and one cannot 'elicit' spontaneous imitation. One way of studying both object imitation under 6 months of age and the role of spontaneous imitation is to study them in a naturalistic setting as opposed to an experimental setting. Some observational studies have been conducted using mother-infant interactions in the home or in the lab to assess naturally occurring imitation (Flynn, Masur & Eichorst, 2004; Masur, 1987; Masur & Rodemaker, 1999; Pawlby, 1977). However, no clear distinctions are made in these studies between spontaneous imitation and imitation that has been encouraged or instructed by the mother. Furthermore, the vast majority of these studies assess imitation towards the end of the first year and during the second year of life, and involve very brief observations of a maximum of 15 minutes. Thus, it remains unclear whether object imitation occurs under 6 months of age and what role spontaneous

imitation plays in the development of imitation. Experimental methods or brief mother-infant interaction observations have not been sufficient to answer these questions.

1.1.3. Imitation of goals and intentions

Imitation of actions on objects has also been studied in relation to the development of understanding goals and intentions. The understanding of other's intentions is generally viewed as an important first step toward a theory of mind, which is the understanding that other people can have beliefs, desires and knowledge (Carpenter, Akhtar & Tomasello, 1998; Meltzoff, 1995). Assessing whether an infant imitates the intended act or not has become a readily used means of assessing an understanding that other people can have mental states.

Meltzoff (1995) used a failed-hand demonstration to assess whether 18-month olds would imitate the failed action or whether they would imitate the intended, but not observed, act. In the failed-hand demonstration infants were just as likely to produce the target acts as in the full demonstration condition, and more likely to produce the target acts than in the control conditions. Furthermore, Meltzoff demonstrated that infants were more likely to produce the target acts when the failed act was demonstrated by a human model, rather than when a mechanical device was used to demonstrate the failed action. Thus, infants' demonstration of understanding intentions or goals is specific for human-modelled acts.

There is some evidence indicating that this distinction between human action and action made by inanimate objects might already be present in infants around 6 months of age (Hamlin, Hallinan & Woodward 2008; Mahajan & Woodward, 2009; Woodward, 1998). Mahajan and Woodward (2009) demonstrated that 7-month-olds imitate reaching for an object significantly more when a human model acted as the demonstrator instead of an inanimate box. In another study 7-month-olds observed either a goal-directed action i.e. grasping or reaching toward an object, or a goal-ambiguous action i.e. touching the object

with the back of the hand or pointing. Infants were more likely to choose (touch, grasp) the same object as the model when the action had been goal-directed than when the action had been goal-ambiguous (Hamlin et al., 2008). This confirmed earlier habituation data (Woodward, 1998) in which infants from around 6 months onwards looked reliably longer in test trials where the goal object differed from the habituation trials while the movement path (grasping motion) remained the same, compared to test trials where the goal object remained the same while the movement path changed. In addition, 6-month olds did not demonstrate such differentiation when a mechanical claw was used instead of a hand. However, these studies with 6-and 7-month-olds assess a possible understanding of the goal, but not imitation of goals and intentions.

From around 12 months onwards infants become capable of selectively imitating goals and intentions. Carpenter, and colleagues (Carpenter, et al., 1998; Carpenter, Call & Tomasello, 2005), for example, were able to demonstrate that 12- to 18-month-olds vary their imitative behaviour according to the perceived goals and intentions. In one study (Carpenter et al., 1998) 14- to 18-month-old infants observed a sequence of two actions of which one was marked as accidental by saying ‘whoops!’ and one marked as intentional by saying ‘there!’, both with the corresponding intonation. Infants were twice as likely to reproduce the intentionally marked actions as they were the accidental actions. In another study Carpenter et al. (2005) demonstrated that 12- and 18-month olds vary their imitative behaviour according to the perceived goal. This study was adapted from a study with older children by Bekkering, Wohlschläger and Gattis (2000) demonstrating that children would imitate the object goal, i.e. covering the right dot on the table, and not the movement path of the hand, when the object was present. However, when no dots were present on the table children suddenly became more accurate in imitating the movement path of the hand, rather than the location on the table. In the adapted version of Carpenter et al. infants imitated putting a toy mouse in the

same location as modelled, i.e. one of two houses, but ignored the hopping motion that was modelled. However, when the houses were not present infants imitated the specific hopping motion with the mouse and were less accurate in putting the mouse at the same end location. These findings demonstrate that infants from around 12 months onwards are able to vary their imitative behaviour according to what they interpret the goal to be.

Contrary to selectively imitating aspects of an action sequence, more recently researchers have found that infants sometimes faithfully imitate actions of others in a persistent manner, even to the extent of imitating unnecessary actions. In a study by Nielsen (2006) for example infants observed a demonstration of opening a box using a tool, while it was easier to open the box without the tool, by using a hand. Twenty-four-month olds consistently used the tool to open the box. Eighteen-month olds would use the tool when the model acted in a social manner, but not when the model acted aloof, and twelve-month-olds only used the tool after viewing a failed-hand demonstration followed by a successful opening using the tool. Nielsen concluded that the older infants imitated for social reasons: they imitate exactly what the model demonstrated to initiate or maintain a social interaction. Brugger, Lariviere, Mumme and Bushnell (2007) observed a similar effect in their study: 14- to 16-month olds were more likely to imitate unnecessary actions when the model acted in a natural social manner than when the model acted in a non-social manner, demonstrating that infants rely on social cues. Lyons, Young and Keil (2007) proposed a different explanation for faithful imitation. Contrary to a social motivation they suggest children imitate faithfully, or over-imitate, because they automatically encode an adult's novel actions as causal. However, their experiments to support this claim only included 3- to 5- year olds and have not been replicated with infants. Thus, questions remain about the underlying mechanisms which determine whether an infant will imitate selectively or faithfully.

A vast amount of research has been conducted during the past decades on what specific behaviours an infant can imitate and when an infant can imitate these behaviours. Much has been learned from these studies. For example, we now know infants can imitate facial expressions from very early on in life, although some controversy remains about the precise meaning of these findings (Anisfeld, 1991, 1996; Jones, 1996, 2006; Meltzoff & Moore, 1977, 1983). Furthermore, research has revealed infants can imitate simple actions on objects from around 6 months onwards, become capable of deferred imitation around 9 months, and during the second year of life infants become capable of imitation of goals and intentions (Barr, et al., 1996; Carpenter, et al., 2005; Herbert, et al., 2006). However, there are still some unanswered questions. Not much is known yet about the role and origin of individual differences in imitation. In addition, not much is known about the role of spontaneous imitation because it is not possible to study this in an experimental setting. Furthermore, questions remain about the underlying motivations for faithfully or selectively imitating a sequence of actions on an object. In this thesis I will attempt to begin filling the gaps and answering these questions by assessing individual differences in imitation, spontaneous imitation and the possible motivations for selective and faithful imitation, based on data gathered in a longitudinal study on imitation from birth till 18 months.

1.2. Temperament

One starting point for studying the origins and the role of individual differences in development is to look at temperament. According to Rothbart, Ahadi and Evans (2000) "temperament arises from our genetic endowment' and 'influences and is influenced by the experience of each individual, and one of its outcomes is the adult personality." (p.122). Temperament is studied in relation to a wide variety of research topics during infancy,

childhood and adolescence. The question that will be reviewed in this second part of the chapter is how aspects of temperament might influence social-cognitive development and imitation in particular.

While there is some debate about the correct definition for temperament most definitions include individual differences in emotional reactivity and/or self-regulation (Allport, 1961; Thomas & Chess, 1977) and agree on temperament emerging early, being relatively stable and biologically rooted. The most recent and, nowadays, most widely used definition in studies with infants and young children is that of Rothbart and colleagues (Gartstein & Rothbart, 2003; Rothbart & Derryberry, 1981). They define temperament as "constitutionally based individual differences in reactivity and self-regulation" (Gartstein & Rothbart, 2003, p. 66), i.e. the child's affective, motivational and attentional reactions to stimulus change and the regulation of these reactions.

Among the first to study child temperament were Thomas and Chess in their New York Longitudinal Study (Thomas & Chess, 1977). They described temperament as the *how* of behaviour, defining it as the behavioural style of the child. Their approach to temperament research and individual differences in development reflected a shift from a unidirectional view on child development in which the child is viewed as the 'receiver' of environmental inputs that influence development, to a view in which the child actively contributes to its own developmental process (Sanson, Hemphill & Smart, 2004). Based on the data collected through parent interviews, Thomas & Chess identified nine dimensions of temperament: Activity Level, Rhythmicity/Regularity, Approach or Withdrawal, Adaptability, Threshold of Responsiveness, Intensity of Reaction, Quality of Mood, Attention Span and Persistence, and Distractibility. In addition they distinguished three types of children: An *easy child* was characterized by regularity in behaviour, positive approach, high adaptability and mild or moderate intense mood which was mainly positive. A *difficult child* was characterized by

irregularity, negative withdrawal, non- or slow adaptability and intense mostly negative mood. A third type was named a s*low-to-warm-up child*. This group was characterized by negative responses of mild intensity and slow adaptability. They are distinguished from difficult children by the mild intensity of their reaction, both negative and positive.

Since the publication of the nine categories found by Thomas and Chess (1977), which was originally published in 1963, several attempts have been made to design a parental report measure based on their findings (see for example Carey, 1970). However, none of these questionnaires were able to rule out concerns about conceptual overlap between the various dimensions and concerns about internal reliability, which led Rothbart (1981) to design the Infant Behavior Questionnaire (IBQ). Rothbart's goal was to develop a parent report measure with high internal reliability, with no overlap between the dimensions of temperament, and which would include both temperament characteristics found by Thomas and Chess as well as additional aspects of reactivity and self-regulation. A final goal was to develop a measure that could assess both continuity and change in temperament over time, which had proven to be a problem for both Thomas and Chess' nine categories as well as for later parental report versions. Rothbart recognized parent report measures are influenced by the interactional history between caregiver and child in the home. She therefore suggested parent report measures of temperament might be best viewed as an assessment of temperament as demonstrated within infant-caregiver interactions. In addition she suggested that a parental report measure should avoid asking questions whereby parents are asked to make judgments about behaviours that occurred in the distant past and avoid questions that ask for a comparative judgment because it makes the answer dependent on the experience of the parent with other children. The IBQ therefore consisted of questions referring to specific behaviours that occurred during the past week and included six scales: activity level, smiling and laughter, fear, distress to limitations, soothability, and duration of orienting. Following the

development of the IBQ, Rothbart and colleagues developed measures of temperament for children of (pre-)school age, the Children's Behavior Questionnaire, and the toddler period, the Early Childhood Behavior Questionnaire (Putnam, Gartstein & Rothbart, 2006; Rothbart, Ahadi, Hershey & Fisher, 2001). In addition they published a revised version of the IBQ, the IBQ-R (Gartstein & Rothbart, 2003). Factor analyses carried out in several studies over the past years on these measures have consistently revealed three broad temperament factors: 1) *Extraversion/Surgency*: which includes scales like high intensity pleasure, activity level, impulsivity, approach and vocal reactivity 2) *Negative affect*: which consists of scales like: discomfort, fear, anger/frustration, sadness 3) *Effortful Control (or on the IBQ-R: Orienting/Regulation)*: includes scales like inhibitory control, attentional focussing, low intensity pleasure, cuddliness and duration of orienting (Gartstein & Rothbart, 2003; Putnam et al. 2006; Rothbart et al., 2001).

1.2.1. Temperament and development

Above described measures have been readily used to assess infant temperament in a wide variety of studies on social and cognitive development. The temperament questionnaires have been used to study links between temperament and language development, development of joint attention, development of theory of mind, and problem behaviour such as internalizing and externalizing problems (see for reviews: Eisenberg, Smith, Sadovsky & Spinrad, 2004; Rothbart , 2007; Rothbart, Ahadi & Evans, 2000; Sanson et al., 2004). Thomas & Chess (1977) proposed that the influence of temperament on development is determined by its interaction with the child's environment, which they called 'goodness of fit'. According to the 'goodness of fit' idea healthy development results from a good match between the child's temperament and the child's social environment. A mismatch between the child's temperament and the social environment negatively influences development. Thus the

'goodness of fit' approach assumes an interaction between child characteristics and the child's social environment that subsequently influences development. Other approaches that have been used to assess the influence of temperament on development are the unidirectional view that assumes a direct effect of temperament on development, and models assessing the mediating or moderating role of temperament (Sanson, et al., 2004).

To assess the possible role for aspects of temperament in the development of imitation in infants and young children I will now review the literature on temperament and imitation. In addition, I will review the literature on temperament and joint attention, including gaze following, because joint attention skills and imitation are found to be related (Carpenter & Tomasello, 1995; Charman, et al., 2000). Furthermore, more complex forms of imitation occurring towards the end of the first year and during the second year of life, such as imitation of actions on objects and selectively imitating goals and intentions, require the infant to have the ability to engage in joint attention and shared intentionality (Tomasello, Carpenter, Call, Behne & Moll, 2005).

1.2.2. Temperament and imitation

A small number of studies have suggested temperament might explain individual differences in imitation (Dixon, Salley & Clements, 2006; Fenstermacher & Saudino, 2006; Fouts & Click, 1979). These studies, however, did not have imitation as their main focus but used imitation as a means of measuring learning, or suggested temperament might play a role, but did not assess its role experimentally. For example, Fenstermacher and Saudino (2006) suggested in their review on individual differences in imitation, that attentional differences and traits such as introversion an extraversion might play a role in explaining individual differences in imitation. They concluded that because of the stability of some of these

differences in personality traits that genetic influences could be a source of individual variability in imitation

A few studies have provided experimental evidence for a role of temperament in explaining individual differences in imitation. Fouts and Click (1979) conducted a study on the differences in observational learning between introverted and extraverted children using televised and live models. More specifically, they assessed whether extraverts were better observational learners because they are more susceptible to social influences and/or whether they are better observational learners because of differences in attention to the modelling stimuli. Children saw five different sequences of simple actions, either performed live, by a televised human model, or a televised non-human model. Fouts and Click expected that extraverts would be better observational learners overall. Furthermore, they expected introverts to show the most observational learning with non-human televised models and the least observational learning with live human models. The opposite was expected for the extraverts. Results demonstrated that extroverted children showed more observational learning than introverted children overall and that this was not due to inattention to the model of the introverted children. Moreover, extraverts rather than introverts showed more inattention during the televised models, but still managed to reproduce more of the actions. No interaction effect was found between type of modelling and personality type. However, based on these findings, it is difficult to conclude that extraverts are generally better observational learners. Infants were specifically instructed to show as many ways to play with the toys as they had seen the model perform. This instruction was repeated until the child indicated it did not know any other way to play with the toys. It might be that extraverts were more likely to manipulate objects rather than imitating the specific actions on the objects. Fouts and Click only coded the target actions and did not report the number of responses concerning non-modelled actions. Furthermore extraverts might have been more persistent

than introverts. Thus, it remains unclear what the specific relation is between temperament and imitation.

Dixon et al. (2006) carried out an experiment assessing the role of attentional focus during word learning and nonword-learning (imitation) tasks in 21-month olds. In particular they assessed the role of attentional focus when they introduced distracters. Even though imitation was not their main focus, they do report some relevant results concerning the role of temperament in individual differences in imitation. Imitation, or the nonword-learning task, was measured by demonstrating two sequences accompanied by verbal instructions. One sequence consisted of placing a ball in a cup, placing a larger cup over the smaller cup and shaking it to make it rattle. The other sequence, again accompanied by verbal instructions, consisted of pretending to pour cereal into a bowl, pretending to pour milk into a bowl, stirring with a spoon, putting the spoon in the mouth and wiping the mouth with a napkin. Half of the infants received a distraction during the task while the other half did not receive a distraction. The distraction consisted of a Sesame Street video and was played either with both the sound and image track, or with just the image and no sound. Attentional focus was measured using the ECBQ (Putnam et al, 2006). The main findings concerning the imitation task demonstrated that infants high in attentional focus benefitted more from observing the model, i.e. imitated more target actions, than infants low in attentional focus. For the feeding task a three-way interaction was revealed. Infants with a low attentional focus benefitted the least from observing the model in the distraction condition.

These findings suggest there might be some role for attentional focus in individual differences in imitation. However, infants were very explicitly instructed on what to do, which makes it difficult to determine whether infants high in attentional focus are better at memorizing instructions than their low attentional counterparts, or whether they are better at imitating compared to their low attentional counterparts. In addition, the imitation tasks

differed in various aspects. The make-a-rattle task involved three steps, while the feeding task involved 5 steps. Moreover, in order to successfully copy all three steps in the make-rattle task infants needed to follow the exact same order whereas this was not necessary for the feeding task. Furthermore, the feeding task was familiar whereas the make-a-rattle task was a novel task. These differences make it difficult to draw a strong conclusion on the specific role of attentional focus.

Both the study by Fouts and Click (1979) and the study by Dixon et al. (2006) provide some indication for a role for attention and sociability in assessing individual differences in imitation. However, it remains unclear whether this influence really concerns imitation or whether other processes are at play.

1.2.3. Temperament and joint attention

Temperament is also related to the development of joint attention. Infants are motivated to share emotional states in dyadic interactions from very early on as evidenced by mutual gazing, touching and smiling. From around 9 months infants become motivated to share goals and intentions in a triadic manner such as giving and showing objects to others, or playing games such as building a block tower together. This triadic coordination of attention between the infant and a social partner towards a third object, is called joint attention (Mundy & Gomes, 1998; Tomasello, Carpenter, Call, Behne & Moll, 2005). The ability to engage in joint attention is considered to be important for social, cognitive and language development (Morales, et al., 2000; Rothbart, 2007; Vaughan Van Hecke et al. 2007). Joint attention and precursors of joint attention are also seen as important skills for various types of imitation. The ability to share and infer goals and intentions and the ability to coordinate attention between the model, the object and oneself is important for selective imitation of goals or

intentional actions and for imitation of actions on objects in general (Carpenter, Akhtar & Tomasello, 1998; Tomasello et al., 2005).

One of the reasons for studying temperament in relation to individual differences in joint attention is that aspects of joint attention such as attention, attention regulation and inhibitory control are important aspects of temperament. Additionally the motivation to share positive affect with others might also play a role in the development of joint attention (Vaughan et al., 2003). Thus temperament aspects such as sociability and positive affect might be related to differences in joint attention development.

Several studies have assessed the above mentioned associations. Morales et al. (2000) assessed the relation between the ability to follow gaze at 6 months, which is assumed to be an early aspect of joint attention, temperament at 6 months and language acquisition at 12 months. Gaze following was assessed by having the mothers turn their head to look at an object at either 90 degrees to their left or their right, several times during a face to face interaction with their infants. A positive relation was found between gaze following and the temperament scale duration of orienting. Furthermore the ability to follow direction of gaze together with duration of orienting positively predicted receptive language at 12 months.

Todd and Dixon (2010) demonstrated a moderating effect of temperament on responding to joint attention at 11 months. In their study half of the infants were exposed to gaze-following trials in the test phase with a background similar to the baseline trials, while the other half were exposed to gaze-following trials with a novel background. They found associations between gaze following and two sub dimensions of the factor surgency, namely approach and perceptual sensitivity. In the familiar background condition, low approach infants were less likely to engage in gaze-following than high approach infants. However, in the novel background condition the opposite was true: low approach infants engaged in more gaze-following than high approach infants. Todd and Dixon explain this finding by suggesting

that high approach infants were more interested and thus more distracted by the novel background. No effect of background was found for perceptual sensitivity. However, infants high in perceptual sensitivity were less likely to engage in gaze-following than infants low in perceptual sensitivity. Furthermore, associations were found between gaze following and negative affectivity, fear and distress. Infants who scored high on either of these scales showed a significant decline in gaze-following from baseline to test phase, indicating these infants are less willing to engage in social interaction. In addition, similar to Morales et al., associations were found between gaze-following and orienting. In the familiar background condition infants high in orienting were more likely to engage in gaze-following than infants low in orienting. The opposite effect was found with the novel background. Thus, several relations have been demonstrated between joint attention skills and temperament, demonstrating the role of temperament in evaluating individual differences in the development of joint attention (Todd & Dixon, 2010). Furthermore temperament also seems to play a role in the relation between joint attention skills and language development (Morales et al. 2000).

The above discussed studies on joint attention and imitation have demonstrated a possible role for temperament in explaining individual differences in social-cognitive development. In the present thesis I will address in more detail the possible role of temperament in individual differences in imitation during the first 15 months of life. More specifically I will assess possible attentional preferences and the role of arousal in individual differences in imitation. In addition, I will assess the role of sociability in selective and faithful imitation at the beginning of the first year.

1.3. The First Steps project

The research conducted for this thesis has been conducted as part of the First Steps project. Ample research is available on *when* different types of imitation develop but many questions remain about *how* imitation develops. Therefore the First Steps project was set up to assess imitation longitudinally across the first 18 months of life. First Steps follows 39 infants from birth till 18 months. Infants were healthy and carried to full gestation and were recruited through announcements in a local newspaper, the university website and at events for young parents and parents-to-be before the infant was born. Parents' level of education ranged from secondary school to postgraduate.The main question studied in this project is how imitation develops during this time. In addition, some aspects of motoric development and language development were also assessed.

First Steps consisted of monthly experimental assessments of different types of imitation, including facial imitation, vocal imitation, object imitation and gestural imitation. These four types of imitation were also assessed in the home environment through diary reports provided by the mothers. In addition to experimental testing and diary reports, mothers and their infants were observed monthly in ten-minute free-play interactions in the lab and mothers filled out several questionnaires throughout the study.

Each month mothers brought their infants to a 'baby breakfast'. During this breakfast meeting the various assessments would take place, mothers were able to have coffee and chat with other participants in the study, and discuss possible problems and questions about the study with the researchers of the First Steps project. A typical monthly visit to the lab consisted of 2 or 3 brief experimental testing sessions, a mother-infant interaction session and the downloading of the diary data onto the central First Steps diary database. A break was given in-between assessments where necessary.

In addition, every three months mothers received new information on what kind of behaviours they should record in their diaries, which were called the 'What-to-expect-sheets'. These behaviours were explained to the mothers during the breakfast and descriptions were also written down on the What-to-expect-sheets. Furthermore, mothers received phone calls in-between visits to discuss any questions and to remind them of their next breakfast meeting. Because of the close contact with the participants the attrition rate in the project was very low: only two mothers left the study before the final 18-month breakfast meeting, both because their work schedules had changed unexpectedly which made it difficult to combine work with their involvement in the project.

In the present thesis I have used the experimental data of facial, vocal and object imitation measured at 2-, 3-, 4-, 12- and 15- months. I was the primary experimenter in all of these experiments. In addition, I have used the diary reports of the infants during two three-month periods: from 4- to 6-months and from 10- to 12- months. Furthermore, I have used temperament data collected using the Infant Behavior Questionnaire-Revised (Gartstein & Rothbart, 2003) at 4 months and the Early Childhood Behavior Questionnaire (Putnam, Gartstein & Rothbart, 2006) at 15 months (see appendix 1 and 2 for a copy of the questionnaires).

1.4. Research aims

The research conducted for this thesis had two major aims, based on the unanswered questions mentioned in the previous section. The first aim was to establish the role of individual differences in the development of imitation during the first 15 months of life. Individual differences in imitation have, thus far, not received much attention because most studies have dismissed individual variability as noise. However, recent developments suggest that individual variability in imitation might be meaningful information and could therefore play an important role in the development of imitation. Previous research has primarily focused on group means when assessing imitation in the first few months of life. In the study in chapter two I have focussed on individual variability in imitation during the first few months of life, by including all infants in the analyses in order to capture all possible responses. Furthermore, as discussed in the previous sections there are indications for a possible role of temperament in imitation, although the precise nature of this role is still unclear. Therefore, in chapter two the possible origin of individual differences was assessed by measuring infants' attentional preferences. In chapter four infants' sociability was assessed in order to study the origins of differences in selective and faithful imitation.

The second aim of this thesis was to establish whether the observed individual differences in imitation might reflect infants' active role in their own developmental process. Assessing the role of temperament in individual differences in imitation was one way of studying the infants' active role in their own development. Another way of studying this is demonstrated in chapter three, where I assessed the role of spontaneous imitation, i.e. infants' own initiative to imitate, in the development of imitation during the first year of life. This was

accomplished by analysing the mothers' diary records of object-related imitation occurring in the home environment.

In chapter five both aims are discussed in relation to the two current dominant accounts of imitation, i.e. the nativist account and the learning account and in relation to a proposed alternative theoretical model of imitation based on the findings presented in this thesis. Furthermore, the limitations of the present studies and future directions for research are discussed.

Chapter 2. The third way for imitation: Innate differences influence learning.

2.1. Abstract

The nativist-empiricist debate is very prominent in developmental psychology research and has had a lasting effect on research into imitation. Many studies have found supportive evidence for one account or the other but in doing so researchers have been overlooking a third possibility of development being the result of both innate aspects and learning. In the current paper we propose an account that combines both innate aspects and learning through experience, in an attempt to explain the finding of large individual differences in early imitation. To assess this account and the nativist and empiricist accounts a longitudinal study was conducted testing infants on early imitation, temperament and arousal at 2-, 3- and 4-months of age. Results show that both the nativist and the empiricist accounts are not sufficient in explaining individual differences in early imitation. However, our proposal, based on work by Marler (1991) on bird song and work by Johnson (2005) on brain development, does account for the findings in the current study. We can therefore conclude the development of imitation might be better explained as the result of an interaction between attentional preferences and early experience.

2.2. Introduction

One of the main debates in child development research poses the question: Are children born with certain abilities or are these abilities acquired through experience? The debate around this question dates as far back as Ancient Greece: Plato believed infants were born with innate knowledge, while Aristotle believed all knowledge was acquired through experience. Throughout history researchers such as Locke, Watson and Skinner have been claiming infants acquire knowledge solely through experience, while others, for example Chomsky, claimed an innate basis for language.

One of the clearest examples of the nativist-empiricist divide in recent time can be found in the area of social learning, and early imitation in particular (see for example: Meltzoff & Moore, 1989; Jones, 1996, 2006, 2007). Imitation is an important mechanism for acquiring new skills and because it does not require the ability of language, imitation is especially important in infancy. Nativists argue infants are born with an innate system that enables them to imitate. One example of such a system is the Active Intermodal Mapping system (Meltzoff & Moore, 1989). This innate system allows infants to map what they see onto their own body by means of a proprioceptive feedback loop. However, learning theorists claim imitation is learned through experience. For example some researchers dismiss early imitative behaviours as arousal or an exploration response and claim real imitation does not occur until the second year of life (Jacobson, 1979; Jones, 1996; Meltzoff, & Moore, 1983; 1989; Reissland, 1988). This divide is being maintained by studies reporting supportive evidence for one account or the other (e.g. Chen, Striano & Rakoczy, 2004; Meltzoff & Moore, 1977; 1983; Anisfeld, 1996; Jones, 1996; 2006), even though several researchers acknowledge development is best studied as an interaction between innate aspects and learning through experience (see for example: Johnston, 1987; Turkewitz, 1995; Spencer et

al., 2009). In the current paper we applied the view that development is the result of both innate aspects and experience, to study the development of early imitation and individual differences in imitative behaviour in particular.

In social learning in animals and more specifically in birds, it has been more common to look at the possibility of development being the result of both intrinsic and extrinsic aspects. Several researchers studying bird song have proposed a model of learning incorporating both innate preferences and environmental input (e.g., Marler 1991; Gallistel, Brown, Carey, Gelman & Keil, 1991). Gallistel and colleagues (1991) suggested *domain specific learning mechanisms* which pre-determine the bird to attend to specific elements in the environment. Similarly, Marler (1991) called the innate component *innate learning preferences* or *innate responsiveness* and suggested that the input the bird could potentially receive varies based on factors in the environment. In the case of a bird acquiring bird song this could be the strength of the bird song stimulation. Thus what they suggest is a model where innate preferences influence what the animal attends to in the environment and influences what will be learned and how well it will be learned.

However, the research on birds learning bird song relies on cross-species comparisons and has been conducted to explain differences between species rather than differences in learning within the same species. In the present study we are interested in differences between infants; therefore no cross-species comparisons are made. The ideas of Marler (1991) and Gallistel and colleagues (1991) are, however, interesting as an analogue for building our ideas and alternative models when studying individual differences in the development of early imitation.

Johnson and colleagues (Johnson, 2005; Johnson et al. 2005; Johnson, Grossmann & Cohen Kadosh, 2009) proposed a similar idea as Marler (1991) and Gallistel et al. (1991), in human infants concerning the development of the social brain. He proposed that initial biases

in attention orient infants to relevant social stimuli such as faces. Johnson labelled the process of interaction between innate aspects and experience *interactive specialization*. His example of face processing illustrates this process of interactive specialization: Early on in infancy perceiving faces results in large brain areas being activated and, in addition during this period areas that respond to faces are not specific and also respond to, for example, objects. Throughout development, as a result of interactions between brain regions and between the brain and the environment, the processing of faces becomes more and more specific, e.g. the region that is activated when perceiving faces gets narrower (localization) and becomes more specific for faces alone (specialization). Thus, in Johnson's proposal both innate biases and experience with the relevant social stimuli influence the development of the social brain.

The ideas proposed by Marler (1991), Gallistel et al. (1991) and Johnson and colleagues (Johnson, 2005; Johnson et al. 2005; Johnson et al. 2009) are examples of how innate components can interact with the environment to influence development. However, as mentioned already these ideas are not exactly the same as the subject of study in the present chapter. In the present study we are interested in individual differences in the imitative responses on imitation eliciting paradigms between infants. Furthermore we aim to assess whether these differences might be related to differences in characteristics of the child. The above discussed models of *domain specific learning mechanisms, innate learning preferences* and *interactive specialization* can serve however, as a model from which we derive our of proposal of what might be going on in the development of early imitation.

We propose in the present paper a third way for imitation in which child characteristics interact with the child's social environment which influences the subsequent learning process. More specifically we propose an interplay between *innate attentional preferences* that orient the learner's attention to specific stimuli, the learner's *environment* and the subsequent *learning processes*. This idea allows for both innate aspects and learning

through experience to be considered as part of the development process. More specifically we propose that early differences observed in imitation are related to early differences in innate attentional preferences, the early environment and the subsequent learning process. In order to study this proposal we conducted a longitudinal study assessing early imitation, learning and infant characteristics.

One way of assessing our proposal of a third way for imitation is to compare the predictions of this alternative model with the predictions of the two current dominant models, i.e. nativist theories and learning theories of imitation. To do so we set out to study both individual variability in early imitation and early imitation at the group level. Thus far research of early imitation has focused on measuring group means and establishing whether infants as a group imitate or not at a certain age (see for example, Chen, Striano & Rakoczy, 2004; Meltzoff and Moore, 1983), while ignoring the large individual differences that are often observed in early imitative behaviours. More general, experimental research in psychology is concerned with the variance between conditions or treatments, for example comparing responses when exposed to tongue protrusion displays with responses when exposed to mouth opening displays. Therefore individual variability is usually dismissed as noise by experimentalists (Cronbach, 1957). This is in sharp contrast with the focus of another group of researchers, who Cronbach calls correlational psychologists, who are studying the variance between individuals. They are interested in precisely that what experimentalists try to minimize in their samples. This divide between experimentalists and correlational psychologists is prominent in developmental psychology and is reflected in divisions such as experimental versus observational research and group means versus individual differences approaches (McCall, 1981). Cronbach (1957) and McCall (1981) both called for combining the experimental and the individual differences approach rather than focussing on just one of them, in order to depict a complete picture of development. Both suggest models of

development that involve both variance between treatments and variance between individuals, but importantly also involves the interaction between the two. In the present study we attempted to combine experimental methods with an individual differences approach.

In order to study both between treatment variance (i.e. imitation at the group level) and individual variability in the present study to assess the three accounts of imitation, the following questions were assessed: Can we observe early imitation at the group level? Can we observe individual differences in early imitation? And are these individual differences related to infants' attentional preferences? In order to answer these questions a longitudinal study was conducted using two experimental paradigms known to have demonstrated early imitation: the mouth modelling paradigm designed by Meltzoff and Moore (1983) and the sound modelling paradigm developed by Chen et al. (2004). In addition we measured infants' behavioural arousal (Thelen and Fisher, 1982) to assess the claim made by learning theorists that early imitative behaviours are the result of an increased arousal response. A measure of early temperament was included to assess possible attentional preferences.

2.2.1. Measuring meaningful individual variability

Recently some researchers in the area of imitation have started to recognize the importance of individual variability. For example, Ferrari et al. (2009) assessed facial imitation in rhesus macaques with a similar paradigm to Meltzoff and Moore (1983). The macaques were tested on facial imitation at 1-, 3-, 5- and 7- days old. In addition, their reaching and grasping abilities were assessed at 7-, 14-, 21- and 30- days old. They then defined imitators and non-imitators based on infants' performance across the testing sessions. By repeatedly testing the infants and using the information of all sessions combined in their definition they assured all subjects were included in the analyses. Results demonstrated that differences in early facial imitation in infant rhesus macaques were related to differences in

later motor development. The macaques who were capable of facial imitation early in life performed better at the reaching and grasping task later on in development than infants who did not show facial imitation early in life. These results demonstrate that early observed individual variability can be meaningful variability and should not be treated as noise. To ensure the full range of possible responses was captured in the current study none of the infants were excluded from the analyses.

Including all infants in the analyses is an important difference between the current study and previous studies on early imitation. As previously discussed, numerous studies have found evidence of early imitation. However, many researchers seem to ignore the large numbers of infants being excluded from the analyses in these studies. For example in one of the most influential papers by Meltzoff and Moore 65% of the infants were excluded from analyses based on a variety of reasons (Meltzoff & Moore, 1983). Subsequently, only a small sample from the originally recruited sample made it into the final analyses. Eliminating more than half of the sample might have resulted in selecting the infants who were most likely to demonstrate imitation. Thus, even though Meltzoff and Moore found evidence for early imitation it is not possible to conclude that all infants can imitate. This phenomenon is not limited to Meltzoff and Moore's study. Others such as Fontaine (1984) and Chen, et al. (2004) have also excluded large portions of their sample (39 % and 19 % respectively). As mentioned earlier, studies thus far have justified excluding 'non-cooperative' infants from their sample by dismissing individual variability as noise. However, by doing so researchers might have eliminated meaningful information.

Another way to ensure capturing all possible responses is to use a repeated measures design. Therefore the current study assessed early imitation longitudinally at 2-, 3- and 4-months. In addition to capturing early individual differences in imitation this design also allowed us to capture the possible role of learning in early imitation. Learning theorists

suggest imitation is a slow learned process. Jones (2007) for example concluded that imitation only emerges during the second year of life based on a cross-sectional study assessing imitation of a variety of actions between 6- and 20- months of age. Even though Jones' goal was to study the emergence of imitation she did not study imitative behaviours before 6 months. She based this decision on a study by Kokkinaki and Kugiumutzakis (2000) who did not report much imitative behaviour in the first few months of life; however several studies have found early imitative behaviours (Chen et al. 2004; Field et al 1982; Meltzoff & Moore, 1977; 1983). Moreover, because of the increasing evidence demonstrating that individual variability in imitative behaviour might be meaningful, we argue one should start measuring imitation as early as possible.

2.2.2. Measuring attentional preferences

Another important part of our third way for imitation is that child characteristics, such as an attentional preference for particular stimuli, may play a role in the development of imitation. One line of research concerned with child characteristics and which studies early individual variability between infants is the research on early temperament. Gartstein and Rothbart (2003) defined temperament as 'constitutionally based individual differences in reactivity and self-regulation' (p66). Reactivity is defined as the child's affective, motivational and attentional reactions to stimulus change. Self-regulation refers to the processes that modulate these reactions. According to Rothbart (2007) temperament together with experience develops a child's personality. While there is some debate about the correct definition of temperament most definitions do include individual differences in emotional reactivity and/or self regulation (Allport, 1961; Thomas & Chess, 1977) and most agree on temperament emerging early, being relatively stable and biologically rooted, making it a good candidate for explaining early individual variability. To measure infant temperament Gartstein

and Rothbart (2003) developed the Infant Behaviour Questionnaire-Revised (IBQ-R), a parental report measure. The IBQ-R consists of 14 scales to assess a range of temperament dimensions. To assess possible attentional preferences that might set up the infant to attend to and acquire experience with particular stimuli we included several scales of the IBQ-R. Rothbart described the IBQ-R measure as an assessment of infant temperament as demonstrated within infant-caregiver interactions (Rothbart, 1981), thus it is not possible to completely separate infant characteristics from early experience. Therefore in the present study attentional preferences are measured as a combination of infant characteristics and early experience. In addition, a measure of behavioural arousal during testing at 4 months was included to assess the alternative explanation often used by learning theorists that the observed early imitative behaviours are an increased arousal response (e.g. Jones, 1996; 2006).

Each of the three theories, i.e. nativist theories, learning theories and the third way for imitation, predicts different outcomes for the above described questions and measures. Learning theories predict that no early imitation at the group level will be found. Early imitative behaviours that do emerge at the individual level are explained by an increased arousal response.

Nativist theories, on the other hand, predict that early imitation at the group level will be found. However, because of an innate capacity to imitate few individual differences are predicted. In addition a strong relation between the two early imitation tasks is expected.

The third way for imitation predicts, however, that infants show early individual differences in imitative behaviour and that this is related to temperamental differences. We expect that differences in infants' specific attentional preferences towards specific stimuli will influence what they attend to in their environment and their subsequent learning process. To this end we chose to look at the *vocal reactivity* scale of the Infant Behavior Questionnaire-

Revised (Gartstein & Rothbart, 2003) and the *high intensity pleasure* scale. The *vocal reactivity* scale measures infants' exposure to and experience with vocalisations during daily life. The third way of imitation would predict that imitators on the sound modelling task, but not the imitators on the mouth modelling task, score higher on vocal reactivity. Similar predictions are made for the *high intensity pleasure* scale, because this measures with how much pleasure the infants respond to novel and high intensity stimuli. The sound modelling task is of a higher intensity compared to the mouth modelling task. The *activity level* scale was included as a general measure of the infant's activity level and as an additional measure of general arousal.

2.3. Method

2.3.1. Participants

Thirty-nine Infants were recruited as part of the First Steps longitudinal study (see section 1.3 for more information). Due to a technical problem the sound modelling data at month 3 of one infant could not be used. The current paper reports on data gathered at 2 (M = 60 days, range = 46 to 66 days), 3 (M = 92 days, range = 75 to 101 days) and 4 (M = 121 days, range = 111 to 128 days) months.

2.3.2. Procedure and design

Mothers brought their infants to a 'baby breakfast' in the lab. Infants were tested in a separate room and when in a calm and alert state. Infants were seated in an infant seat in a semi upright position. A female experimenter sat in front of the infant with the infant's face approximately 25 cm away from the experimenter's face. Two digital cameras, Sony Mini DV DCR-PC110E, were used. One camera captured the infant's face and the other camera the experimenter. Both cameras were connected to a quad that fed into a Sony DV recorder in

order to record a split screen image. Sound was recorded with an AKA C 1000S microphone placed next to the infant approximately 25 cm away from the infant's mouth. The experimenter monitored the infant's state throughout testing and testing was paused when the infant got upset or fell asleep.

Imitation measure. To assess early imitation infants were tested on two imitation paradigms. We chose to use two imitation measures to assess the relationship between the performance on both measures as well as the differences in performance on these measures. At 2 months infants were tested on the mouth modelling paradigm designed by Meltzoff and Moore (1983). This paradigm has been demonstrated to be successful at measuring early imitation. In order to capture the full range of possible responses it was vital in the current study to include all infants. Pilot testing on this task had revealed testing before or after 2 months increased the risk of infants needing to be excluded from analyses. In addition Kugiumutzakis' (1999) study demonstrated infants copied mouth opening and tongue protrusion from birth till about 2.5 months. Furthermore Fontaine (1984) demonstrated in his study on facial imitation from birth till six months that two months was the only age at which infants copied all four assessed gestures (tongue protrusion, mouth opening, cheek swelling and closing eyes). Hence the mouth modelling paradigm was assessed at two months.

The procedure in the current study was taken from the procedures used by Meltzoff and Moore. Each infant was presented with two gestures: a mouth opening and a tongue protrusion. Each gesture was modelled four times for 4 seconds with a 1 second pause, which made up one trial. A trial was followed by a 20 second pause before the next trial started. This procedure was repeated until the infant had received three trials of each gesture. Trials were blocked, so each infant received three trials of one gesture before switching to three trials of the other gesture. The order of the gestures was counterbalanced across infants. When infants

became upset they were given a break. Some infants received additional trials to ensure each infant had received six complete trials during which they were in a calm and alert state.

In addition to the mouth modelling paradigm infants were tested on a sound modelling paradigm designed by Chen, Striano and Rakoczy (2004) at 2-, 3- and 4- months of age. Similar to the mouth modelling paradigm this task has been proven to successfully measure early imitation. The repeated measures design was chosen to capture both early learning and individual variability in early imitation. The ages of testing were determined based on earlier research by Kugiumutzakis (1999) where it was found infants as young as 32 minutes are capable of matching the sound /a/ and from 2.5 months onwards they become capable of matching the sounds /m/ and /ang.

The procedure was highly similar to Meltzoff and Moore's mouth modelling paradigm (Meltzoff & Moore, 1983) in order to maximize the chances for the infant to produce a match. Each infant was presented with two sounds: a vowel sound /a/ and a consonant sound /m/. Each sound was modelled four times for 4 seconds with a 1 second pause, which made up one trial. A trial was followed by a 25 second pause before the next trial started. This procedure was repeated until the infant had received four trials of each sound. Trials were in blocks, so each baby would get four trials of one sound before switching to four trials of the other sound. The order was counterbalanced across infants. When infants became upset or sleepy they were given a break. To make sure that all infants had received 8 complete trials during which they were in a calm and alert state some infants received additional trials.

Attentional preference measure. To assess whether possible individual differences in imitation were related to temperament mothers filled in several scales of the Infant Behaviour Questionnaire-Revised (Gartstein & Rothbart, 2003) at 4 months. The scales used in the current study were *high intensity pleasure* and *vocal reactivity* to assess specific preferences for vocal stimuli and stimuli of a high intensity.

Arousal measure. A measure of behavioural arousal during the sound modelling task at 4 months was included to assess the alternative explanation that early imitative behaviours are caused by an increased arousal response. Arousal was operationalized as the amount of motor movement (see Thelen & Fisher, 1982) during the testing session. The session at 4 months was chosen based on the finding that at 4 months the highest number of infants imitated at least one sound. The *activity level* scale of the IBQ-R was included as an additional measure of general arousal in daily life.

2.3.3. Coding

For the mouth modelling paradigm videos were coded for tongue protrusion and mouth opening, with only the infants' faces visible. The definitions for tongue protrusion and mouth opening are taken from Meltzoff and Moore (1983). A mouth opening was coded when the infant showed an abrupt jaw drop opening the mouth across the entire extent of the lips and then returning to the resting position. The resting position was usually closed lips but occasionally a very small opening remained. A tongue protrusion was defined as a clear forward movement of the tongue such that it crossed the back edge of the lower lip (see Meltzoff & Moore, 1983 for a detailed description). A second coder re-coded a random sample of 20% of the videos to calculate the interrater reliability. The intraclass correlation coefficient (ICC) for mouth opening during mouth opening trials was r= 0.96, for mouth opening during tongue protrusion trials: r= 0.85, for tongue protrusion during tongue protrusion trials: r= 0.80, and for tongue protrusion during mouth opening trials: r= 0.88.

For the sound modelling paradigm videos were coded with the sound off and only the infants' faces were visible. Infants' mouth movements were coded for mouth opening and mouth clutching. Similar to the Chen et al. (2004) study a mouth opening was interpreted as matching the /a/ sound and a mouth clutching as matching the /m/ sound. A mouth opening

was coded when the lips would open from their resting position and would then return back to their resting position. Yawns were included as often a yawn would start as a normal mouth opening and then progress into a yawn. Wide-open smiles were also included. Mouth movements due to sneezing, coughing and crying were not included. A mouth clutching was coded when the infant would press the lips together and then released it to a less tight resting position or when the infant would move the lips back and forth once. Sucking on lips was not included. A second coder recoded a random sample of 20 % of the videos for reliability. The mean ICC for the interrater reliability was: 0.83 at month two, 0.84 at month three, and 0.84 at month four.

To establish the level of arousal, videos at 4 months were coded for behavioural arousal by another coder unaware of the hypotheses. Coding was based on a behavioural arousal coding scheme used by Thelen and Fisher (1982). Infants' arousal was coded continuously as one of four states: 1) *Asleep*, 2) *drowsy*, 3) *alert no gross motor movement*, 4) *alert gross motor movement.* Because testing was paused when the infant got upset or sleepy only *alert no gross motor movement* and *alert gross motor movement* are reported here. *Alert no gross motor movement* was defined as infants being in a quiet alert state and not moving or showing little movement (e.g. minor head turn). *Alert gross motor movement* was defined as infants making large movements for example rapidly moving their arms, moving their feet, continuous head movements, and movements of the upper body such as arching of the back. The behaviour needed to last at least 2 seconds in order to be classed as one of the above states. In order to assess interrater reliability a second coder recoded 5 randomly chosen videos. The videos were split into 5-second intervals and for each interval it was assessed whether both experimenters agreed on the arousal state observed during those 5-second intervals. This resulted in a Kappa of 0.91.

2.4. Results

2.4.1. Preliminary analyses

No infants were excluded from analyses. Data did not meet the criteria for parametric tests; therefore a log transformation was carried out after a constant of 1 was added to all variables, which resulted in a normal distribution of the data. All results presented here are based on the transformed data unless stated otherwise.

Independent-samples *t*-tests were carried out to test for gender and order effects for both matching tasks. Several gender effects were found for sound modelling. Boys (*M*=.66) demonstrated higher rates of mouth opening during /a/ modelling than girls (*M*=.48) at month 3, $t(36)= 2.18$ $p <.05$. Boys (*M*=.072) also demonstrated higher rates of mouth opening during /m/ modelling at month 3 (girls *M*= .51), $t(36)= 2.12$, $p<.05$, and higher rates of mouth opening during /a/ modelling at month 4 (boys *M*= .50, girls *M*= .32), $t(37)= 2.19$, $p< .05$. Separate analyses for boys and girls are reported were necessary. No gender effects were found for the mouth modelling task (*p*s > .28).

No order effects were found (*p*s > .08 for sound modelling, *p*s > .06 for the mouth modelling task) except for the rate of mouth opening during mouth opening modelling in the mouth modelling task, $t(37)= -2.92$, $p < .05$. The rate of mouth opening during mouth opening modelling was higher (*M*=.62) when the modelling started with mouth opening as compared to when the modelling started with tongue protrusion (*M*=.39). This could mean that when starting with mouth opening infants were more likely to match mouth opening. Hence, separate analyses are reported where necessary. Effect sizes will be reported using *r*.

2.4.2. Early imitation

To assess early imitation we compared infants' tongue protrusion responses with their mouth opening responses during the mouth modelling task. The mean rates in Table 1 suggest that infants respond with more tongue protrusion than mouth opening overall. However, a paired-samples *t*-test comparing the mean rate of tongue protrusion (*M*= .57) with the mean rate of mouth opening (*M*=.53) collapsed across condition revealed no significant differences, $t(38) = .87$, $p > .05$, $r = .14$.

Table 1. *Mean rates per minute and standard deviations of mouth movements during TP and MO of the untransformed data*

	Month 2	
	Mean	SD
During TP		
Mouth opening	2.94	2.44
Tongue protrusion	3.46	3.37
During MO		
Mouth opening	2.66	2.17
Tongue protrusion	4.09	3.79

To test for imitation at the group level two paired-samples *t*-tests were carried out comparing tongue protrusion and mouth opening gestures. The first test compared the rate of tongue protrusion with the rate of mouth opening during tongue protrusion trials. The second compared the rate of mouth opening with the rate of tongue protrusion during mouth opening trials. The first paired-samples *t*-test revealed no significant differences in rates during the tongue protrusion trials, $t(38) = .43$, $p > .05$, $r = .07$. Infants tended to respond with similar levels of mouth opening (*M*=.50) and tongue protrusion (*M*=.49) gestures. The second test

revealed no significant difference between tongue protrusion (*M*=.50) and mouth opening (*M*=.47) during mouth opening trials, $t(38)= -1.48$, $p > .05$, $r= .23$. Because preliminary analyses revealed a significant effect for order, separate analyses were conducted for the two orders. This did not reveal a significant difference in rates of mouth opening and tongue protrusion during mouth opening trials or tongue protrusion trials for either order.

2.4.3. Repeated measures of early imitation

To assess early imitation over time, matching on the sound modelling paradigm was measured at 2, 3 and 4 months. Means and standard deviations for the sound modelling task are shown in Table 2.

Table 2. *Mean rates per minute and standard deviations of mouth movements during /a/ and /m/ of the untransformed data*

	Month 2		Month 3		Month 4	
	Mean	SD	Mean	SD	Mean	SD
During /a/						
Mouth opening	2.13	2.13	3.44	2.43	2.08	1.71
Mouth Clutching	1.98	1.75	2.42	1.71	1.37	1.38
During /m/						
Mouth opening	2.45	1.76	4.31	3.87	1.92	1.42
Mouth clutching	1.89	1.64	2.19	1.38	1.75	1.36

The mean rates in Table 2 suggest infants respond overall with more mouth opening than mouth clutching. A *t*-test comparing mouth opening with mouth clutching collapsed across month 2, 3 and 4 revealed that infants responded with significantly more mouth opening than mouth clutching, $t(37) = 3.14$, $p < .05$, r=.46.

In order to test for imitation at the group level two paired-samples *t*-tests were carried out at all three ages. The first compared the rate of mouth opening during /a/ trials with the rate of mouth clutching during /a/ trials. No significant differences were found at month 2, $t(38) = -.21$, $p > .05$, $r = .03$. At month 3 a significant difference was found, $t(37) = 2.13$, $p < .05$, $r = .33$. Infants responded with higher rates of mouth opening than mouth clutching during /a/ trials. Preliminary analyses demonstrated a gender effect for mouth opening during /a/ trials so follow up *t*-test for boys and girls separately were conducted. These analyses revealed a significant difference for boys $t(19) = 2.30$, $p < .05$, $r = .46$, but not for girls $t(17) = .44$, $p > .05$, $r = .11$. Boys tended to respond with more mouth opening ($M = .66$) than mouth clutching ($M = .49$) during /a/ trials. At month 4 a trend for matching the sound /a/ was found, $t(38) = 1.98$, $p = .06$, $r = .31$. Follow up analyses for boys and girls separately revealed that boys responded with higher rates of mouth opening ($M = .50$) than mouth clutching ($M = .31$), $t(20) = 2.60$, $p < .05$, $r = .50$. No significant differences were found for girls $t(17) = .25$, $p > .05$, $r = .06$.

The second paired-samples *t*-test compared the rate of mouth opening with the rate of mouth clutching during /m/ trials. Results showed no significant difference between the rate of mouth opening and mouth clutching at month 2, $t(38) = -1.73$, $p > .05$, $r = .27$. A significant difference was found at month 3 between the rate of mouth opening ($M = .62$) and the rate of mouth clutching ($M = .46$) during the sound /m/, $t(37) = -3.18$, $p < .05$, $r = .46$. However the observed relation was the opposite of the predicted relation: Infants responded with higher rates of mouth opening than mouth clutching during the /m/ trials. Follow up analyses separately for boys and girls revealed a significant difference for boys, $t(19) = -3.54$, $p < .05$, $r = .63$. Boys tended to respond with higher rates of mouth opening ($M = .72$) than mouth clutching ($M = .46$). No significant difference was found for girls $t(17) = -.86$, $p > .05$, $r = .20$. No significant differences in mouth movements were found for the sound /m/ at month 4, $t(38) = -1.53$, $p > .05$, $r = .24$. Even though infants seemed to be matching the /a/ sound at three months

they also responded with more mouth opening than mouth clutching during /m/ modelling and this effect seemed to be driven by the way boys responded. Similarly the matching findings of the sound /a/ at month 4 seem to be due to the boys responding with significantly more mouth opening than mouth clutching during /a/, while girls do not respond significantly different.

2.4.4. Individual variability

One of the main goals of the current study was to test for individual variability in matching behaviour. For this reason we ensured all infants were included in the analyses and in addition we used a repeated measures design. To assess individual variability in imitation infants were divided into imitators and non-imitators. The definition of imitators and non-imitators was based on the definition used by Ferrari et al. (2009). In their definition the infant macaques did not need to match both mouth movements to be classed as an imitator but they did need to show consistent imitation over time. In the current study infants were classed as imitators (N= 24) on the sound modelling task if they increased in matching over time, for example from matching one sound to matching both, or remained stable matchers over time (based on the untransformed data). This group included both infants who matched both sounds as well as infants who matched one sound as long as they demonstrated consistent matching. See Figure 1 for the individual patterns of imitation at month 2, 3 and 4. Non-imitators (N= 14) were the infants who decreased in matching over time, did not match at all or were unstable matchers. For the mouth modelling task, which was only measured at two months, infants were classed as imitators (N=29) when matching at least one of the two gestures. A Chi-Square was used to assess whether infants who were imitators on the sound modelling task were also imitators on the mouth modelling task. No relation was found between imitators on the two tasks, $\chi 2$ (1) = 1.01, p >.05, and the phi statistic of .16 indicated a weak relation.

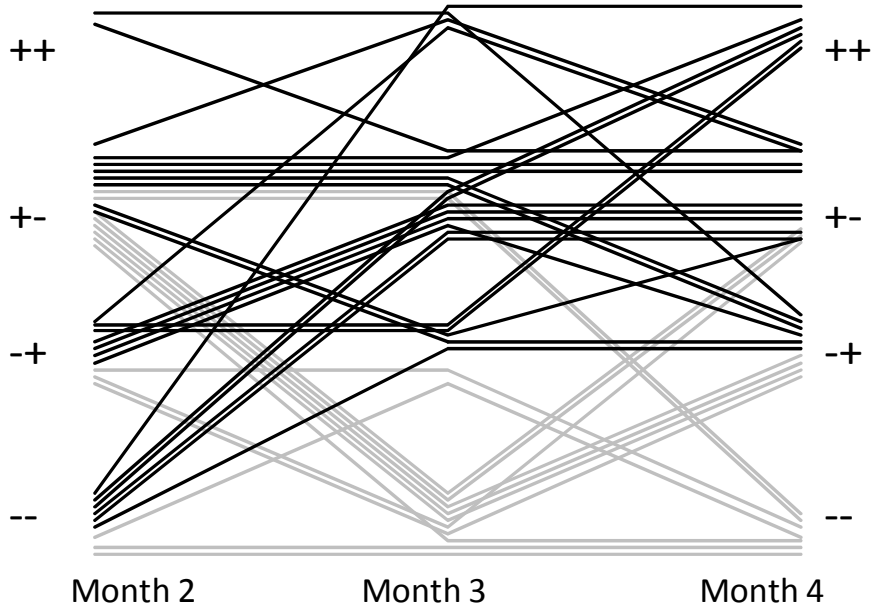

Figure 1. Individual trajectories of imitation on the sound modelling task, divided by imitators (dark lines) and non-imitators (grey lines). -- = no imitation, -+ = imitation of /m/ sound, +- = imitation of /a/ sound, ++ = imitation both sounds.

To assess whether the imitative responses could be explained by arousal we compared the imitators with the non-imitators during the sound modelling task on their amount of time spent in the *alert gross motor movement* or *alert no gross motor movement* state during the sound modelling testing session at 4 months. Because time spent in one state was the opposite of time spent in the other state transforming the data did not result in a normal distribution of the variables. Time spent in no gross motor movement was close to a normal distribution after transformation, therefore both the non-parametric analyses on the untransformed data and a t-test on the transformed data are reported here. An independent-samples *t*-test on the transformed data revealed no significant differences between imitators (M=1.31) and non imitators (M= 1.41) on their time spent in each arousal state, $t(36)= 1.09$, $p > .05$, $r= .16$. A Mann-Whitney test comparing imitators and non-imitators on the untransformed data revealed a similar result, $z = -0.79$, $p > .05$ (see Table 3). Thus no significant difference was observed between imitators and non-imitators on arousal.

Table 3. *Means and standard deviations for percentage of time spent in each arousal state for imitators and non-imitators of the untransformed data*

	Imitators		Non-imitators	
	Mean	SD	Mean	SD
Gross motor movement	73.25	12.85	70.97	15.32
No gross motor movement	26.75	12.85	29.03	15.32

Infants' temperament was assessed to examine whether individual variability was related to infants' attentional preferences. Therefore we compared the scores on the *activity level* scale, the *vocal reactivity* scale and the *high intensity pleasure* scale of the IBQ-R of the imitators on the sound modelling task with the scores of the non-imitators on these scales. Infants' scores on the temperament scales met the criteria for parametric tests, so no transformation of the data was needed. Independent t-tests revealed no significant differences between imitators and non-imitators on the *activity level* scale, $t(36) = -0.99$, $p > .05$, $r = .16$ (Figure 2). However imitators did have significant higher scores on the *vocal reactivity* scale and the *high intensity pleasure* scale, $t(36) = -2.32$ $p < .05$, $r = .36$; $t(36) = -2.73$, $p < .01$, $r = .41$. See also table 4 for the correlations between imitators/non-imitators on each task and the temperament scales.

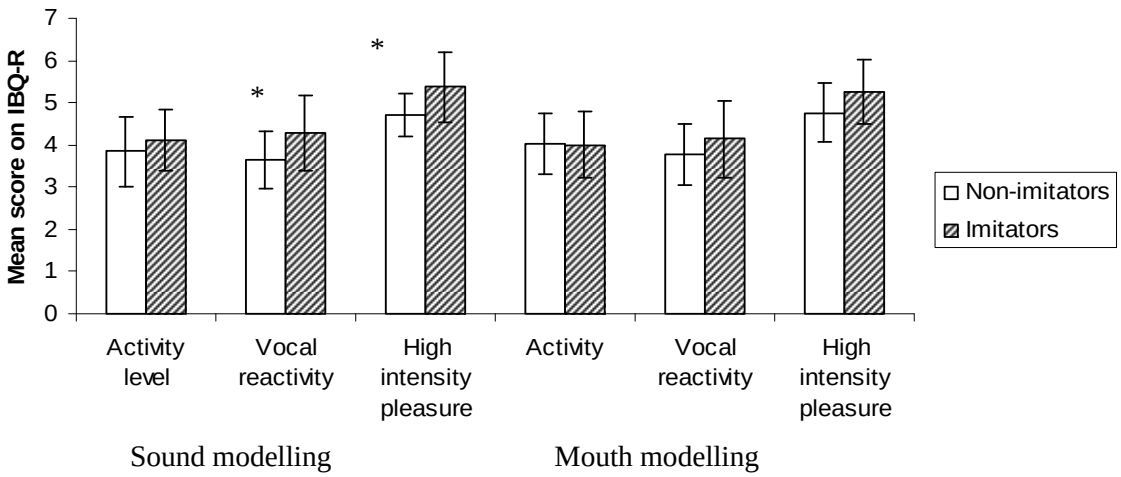

Figure 2. Mean scores and standard deviations for imitators and non-imitators in the sound modelling and mouth modelling task on the IBQ-R scales.

Figure 2 also shows the same analyses for the imitators and non-imitators on the mouth modelling task. Imitators and non-imitators did not differ on any of the three IBQ-R scales included, $t(36) = 0.12$, $p > .05$, $r = .02$ for activity level; $t(36) = -1.18$, $p > .05$, $r = .19$ for vocal reactivity; $t(36) = -1.18$, $p > .05$, $r = .19$ for high intensity pleasure.

Table 4. *Correlations between imitation on mouth modelling and sound modelling tasks (imitators =1, non-imitators =0)*

	Imitation Mouth model	Imitation Sound model	Activity Level	Vocal Reactivity	High Intensity Pleasure
Imitation Mouth model	1	.16	-.03	.19	.30
Imitation Sound model	.16	1	.16	.36 *	.41**
Activity level	-.03	.16	1	.63**	.09
Vocal reactivity	.19	.36*	.63**	1	.41*
High Intensity Pleasure	.30	.41**	.09	.41*	1

* = significance level 0.05 (2-tailed)
** = significance level 0.01 (2-tailed)

2.5. Discussion

The current study set out to assess to what extent learning theories of imitation, nativist theories of imitation and our own suggestion of a third way for imitation combining innate preferences and early learning, could each explain early imitative behaviours and individual variability. In order to do so we set out to answer three questions: Can we observe early imitation at the group level? Can we observe individual differences in early imitation? And are these individual differences related to infants' attentional preferences? Infants were tested in a longitudinal study on two early imitation tasks known to have previously found evidence for early imitation. In addition infants' behavioural arousal was assessed to examine the alternative explanation for early imitative behaviours proposed by learning theories. Several temperament scales of the IBQ-R were also included to check whether individual differences in early imitative behaviours could be related to infants' attentional preferences.

2.5.1. Early imitation

Can we observe early imitation? The results of both the mouth modelling task and the sound modelling task revealed no significant evidence for early imitation at the group level. This result is different from many previous studies who have found evidence for early imitation (e.g. Meltzoff & Moore, 1983; Chen, Striano & Rakoczy). In the current study no infants were excluded from analyses, which is a major difference compared to previous studies which did report early imitation at the group level. These studies of early imitation often excluded large numbers of subjects, resulting in less variability and a selective group of subjects. This difference can account for the aberrant finding in the current study. By

including every infant in our sample, however, we believe our results reflect a more accurate representation of the general population.

2.5.2. Individual variability

Can we observe individual differences in early imitation? At the individual level infants did display early imitative behaviours. Over half of the sample demonstrated consistent or increased imitative behaviour over time. Moreover these behaviours were not the result of increased arousal as measured both by behavioural arousal during testing and the *activity level* scale on the IBQ. Bothe measures, assess arousal in different ways: behavioural arousal during testing was assessed as the observed motor movement during an imitation eliciting task, while *activity level* of the IBQ measures a general level of arousal during daily activities. The finding that when using 2 very different measures of arousal no significant relation was found with either measure, strengthens our result.

Are individual differences related to infants' attentional preferences? Results revealed individual variability was related to infant characteristics. More specifically results revealed that imitators on the sound modelling task had higher scores on both the *vocal reactivity* scale and the *high intensity pleasure* scale compared to non-imitators, while no significant differences were found for imitators and non-imitators on the mouth modelling task. This result indicates a specific relation between a preference for vocal and high intensity stimuli and performance on an imitation eliciting task of a vocal nature.

2.5.3. Assessing all three accounts

As noted in the introduction nativist theories predicted we would observe imitation at the group level. For both imitation tasks no significant imitation at the group level was found. In addition nativist theories predict a relation between imitation on the mouth modelling task

with imitation in the sound modelling task. The lack of a significant relation between the two imitation tasks is not supportive of a nativist account.

Learning theories predicted no early imitation would be found. In case some early imitative behaviours should be observed they could be explained as being an increased arousal response. However the present results do not support this idea. At the individual level imitative behaviours were found and the behaviours are not accounted for by an increased arousal response.

The third way for imitation predicted individual variability in imitative behaviours. In addition, this individual variability would be related to differences in attentional preferences as measured by the IBQ-R (Gartstein & Rothbart, 2003). The present findings are consistent with these ideas. Individual differences in imitation were observed and moreover these differences were related to the scores on the *vocal reactivity scale* and the *high intensity pleasure scale*. This result supports our proposal that infants' attentional preferences for certain kinds of stimuli determine whether they are imitating in certain tasks and not in others. The higher scores for imitators of the sound modelling task on the *vocal reactivity* scale indicate both a preference for and subsequent experience with vocalizations and vocal stimulation. This conclusion is strengthened by the finding that imitators and non-imitators in the mouth modelling task did not differ on the *vocal reactivity* scale. In addition imitators in the sound modelling task, thought to be of a higher intensity in comparison with the mouth modelling task, had higher scores on the *high intensity pleasure* scale of the IBQ than non-imitators. This was not the case for imitators in the mouth modelling task, again demonstrating a preference for specific kinds of stimuli. The finding that imitation on one task was not related to imitation in the other also supports of a specific relation between attentional preferences for vocal stimulation and performance on a vocal task and strengthens the idea that infants differ in their attentional preferences.

By focussing on individual variability in early imitation by including every infant in the analyses the current study has demonstrated that the nativist-empiricist debate on imitation has not resulted in theories that sufficiently explain early imitative behaviours and in particular the individual variability observed in early imitative behaviours. The current results, however, do provide strong support that a dynamic interactive approach, combining an innate component with learning through experience, provides a better fit.

An alternative explanation for why no imitation at the group level was observed is that by including every infant we increased the noise or error variance in our study. This goes back to the divide discussed in the introduction between experimentalists who focus on between treatment differences and try to minimize individual variance, and correlational psychologists who focus on the individual variability observed between individuals. Correlational psychologists would not interpret the variance observed as error or noise, while experimentalists do. In the present study we attempted to combine both approaches. It is important, however, that the present results get replicated in future studies. If the same results are observed in different studies with different samples, then that will strengthen the case for individual differences in imitation as meaningful information, for combining both methods and for our third way for imitation. Furthermore, we need to assess possible longitudinal relations between the differences in imitative behaviour and attentional preferences in this study with performance later on in development. Is it advantageous to a child's development to be an imitator on the vocal modelling task? What is the longitudinal gain or loss to have an attentional preference for vocal stimuli. Data to answer this type of questions is available as part of the First Steps project and longitudinal will be conducted in the near future.

The present study demonstrates a first attempt in assessing the predictions of the third way for imitation. In doing so we have tried to combine experimental methods with the study of individual differences. Although we have established that arousal does not account for

early imitative behaviours, that an innate imitation system cannot fully account for the observed variability between infants and tasks and that these findings in combination with the observed relation between differences in temperament and differences in early imitation fit best with the third way for imitation, the proposal for innate preferences that orient the infant's attention to specific stimuli remains to be studied in more detail. For example to study innate attentional preferences one would preferably assess infants even younger than 2 months. It is however vital to include every infant in order to study the predictions of the third way for imitation. Especially with very young infants this will remain a challenge. Furthermore, in the current study we assessed the relation with innate attentional preferences by using temperament measures. Even though not everyone agrees on the exact definition, most researchers agree on temperament emerging early, being relatively stable and biologically rooted (Allport, 1961; Thomas & Chess, 1977), making it a suitable starting point to study the role of child characteristics. The results in the present study demonstrate that these characteristics are related to specific differences in imitative behaviour. However, future studies should attempt to also include alternative methods for studying attentional preferences, preferably one that can separate innate preferences from early experience in a better way.

We have established a relation between preferences in attending to and experience with vocal stimuli and early imitation on a sound modelling task. However, other relations between different imitative behaviours and attentional preferences are expected based on the third way for imitation and these yet remain to be studied. Nevertheless, the results of the current study demonstrate the importance of not being hampered by the polarisation of the nativist-empiricist debate on development when studying early imitation and of taking into account individual differences. Our results support a dynamic interactive approach which

views development as an ongoing interaction between innate aspects and early learning processes.

Chapter 3. The role of spontaneous imitation in imitating actions on objects: A diary study.

3.1. Abstract

Over the past decades experimental studies have considerably increased our knowledge of 'when' and 'what' infants are able to imitate. However, in contrast to elicited imitation, which is readily studied in experimental settings, not much is known about spontaneous imitation because one cannot 'elicit' spontaneous imitation in experimental studies. Therefore, the aim of the present longitudinal study was to assess the role of spontaneous and elicited imitation in the development of object imitation in the home through the use of diary reports at 4- to 6- months and 10- to 12- months of age. According to a unidirectional view of imitation, in which the child is merely a receiver of external inputs, no major role for spontaneous imitation is to be expected; instead one would expect a larger role for imitative instances which are elicited. However, if one assumes a contribution from the child to its own developmental process one would predict an important role for spontaneous imitation in the development of object imitation during the first year of life. Results revealed a significant increase in object imitation from the 4- to 6- month period to the 10- to 12- month period, with the largest increase observed in spontaneous imitation. Furthermore spontaneous imitation, but not elicited imitation, during 4- to 6- months significantly predicted the increase in spontaneous imitation at 10- to 12- months of age. Thus the infants' own initiative in spontaneously imitating actions on objects influences the development of object imitation during the first year of life.

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3.2. Introduction

As mentioned in previous chapters, imitation is an important mechanism, especially in infancy, for acquiring new skills and learning about social roles and rules. As a consequence imitation in infancy has been readily studied using a variety of methods, such as observations, experimental studies and diary reports. Diary studies have formed the basis of some of the earliest studies of imitation. For example, Darwin used his notes on the (imitative) behaviour of his own son in order to study which behaviours were learned and which responses were instinctive (Darwin, 1877; Burkhardt & Smith, 1987). In addition, Piaget (1962) used the diaries he kept of his own children as a basis for his theoretical model on the development of imitation.

From the1970's onwards researchers began to take the findings from early diary studies to the laboratory to study imitation in more controlled experimental settings. Over the past decades these experimental studies have considerably increased our knowledge on 'when' and 'what' infants are able to imitate. For example experimental studies have revealed that contrary to what Piaget believed, infants can imitate facial gestures from very early on in life (Meltzoff & Moore, 1977). However several questions concerning imitation and spontaneous imitation in particular, have remained unanswered. For example in contrast to elicited imitation, which is readily studied in experimental settings, not much is known about the occurrence and development of spontaneous imitation because one cannot 'elicit' spontaneous imitation in experimental studies. Therefore, the aim of the present study was to assess the role of spontaneous and elicited imitation in the development of imitation during the first year of life in a naturalistic setting, namely the home, through the use of diary reports.

Experimental studies of imitation have revealed infants can copy a vast array of gestures, vocalizations, actions and even goals and intentions (Meltzoff and Moore, 1977, 1983; Field, Woodson, Greenberg and Cohen, 1982; Kugiumutzakis, 1999; Chen, Striano & Rakoczy, 2004; Barr, Dowden and Hayne, 1996; Carpenter, Call & Tomasello, 2005; Carpenter, Akhtar & Tomasello, 1998). To account for these findings and especially the finding of early imitative abilities, several theories of imitation were developed over the past decades.

Some of these theories assume an innate system for imitation to account for early imitative behaviours such as the Active Intermodal Mapping system (AIM, Meltzoff & Moore, 1989). AIM proposes an innate system that can detect the equivalent between the perceived act and the produced act and a proprioceptive feedback loop that enables infants to match what they see onto their own body. Other theories propose imitation to be a slow learned process. These models are often based on studies that have failed to find evidence for early imitation or challenge the explanations for the imitative behaviours and conclude that there is no such thing as early imitation (Lewis & Sullivan, 1985; Anisfeld, 1996; Jones 1996; Kokkinaki & Kugiumutzakis, 2000). What both types of theoretical models of imitation have in common, however, is that they advocate a unidirectional view of development in which the child is viewed as merely responding to environmental inputs, irrespective of whether these responses are based on an innate system or on learning processes.

Contrary to the unidirectional view of experimental studies, studies on imitation in naturalistic settings have often taken into account the child's contribution to development. These studies mostly involve observations of mother-infant interactions. Flynn, Masur & Eichorst (2004) for example conducted a study assessing whether the disposition to engage in object-related activities would lead infants and mothers to imitate more actions on objects and whether being highly verbal would lead them to produce more verbal imitations, or whether,

rather than disposition, variation in imitative behaviour depended on the opportunities to imitate provided by the interactional partner. For mothers, opportunity was the strongest predictor for imitation for both object related imitation and verbal imitation. For infants, however, disposition was the strongest predictor of imitation. Infants increased in object and verbal imitation, while the number of opportunities provided by the mothers remained relatively stable and even decreased during some periods. These results emphasize the importance of taking a child's contribution into account when studying imitative development.

Several other studies on mother-infant interactions in more natural settings also demonstrated the interactive nature of development. In addition, these studies emphasize the occurrence of spontaneous imitation and the high variability in the observed frequencies of imitation (Pawlby, 1977; Masur, 1987; Masur & Rodemaker, 1999). Pawlby (1977) studied the natural occurrence of imitative sequences in a sample of eight infants and their mothers from 17 weeks till 43 weeks old by observing them weekly in ten minute observations. She found that imitative sequences occurred frequently, that a wide range of activities were copied including facial gestures, vocalizations and actions on objects, that infants imitated their mothers in about 20% of the total imitative instances and that the frequency of mother's imitation remained stable over time but that infants increased in imitation as they got older. In addition, Masur & Rodemaker (1999) studied the spontaneous occurrence of imitation in mother-infant dyads based on observations during a ten to fifteen minute bath session and a play session in the home, revealing similar results to Pawlby regarding the frequency of occurrence of imitative sequences. In addition they found infants copied actions with objects more than any other behaviour at 10- and 13- months, by 17 months infants' vocal imitations had increased considerably and kept increasing at 21 months. Additionally they found remarkable variation in imitativeness in both infants and mothers at each age. However,

because they had no information about imitation before ten months they were unable to assess the origin of this observed variability (Masur & Rodemaker, 1999). Thus, observational studies in naturalistic settings have contributed to our knowledge on the occurrence of spontaneous imitation of actions and vocalizations by infants and their mothers, and have contributed to an increased awareness of the child's contribution to its own development.

One of the problems regarding the findings of the above mentioned mother-infant interaction observations however, is that they are based on limited hours of video observations. In the studies of Masur and colleagues (Masur, 1987; Masur & Rodemaker, 1999; Flynn, Masur & Eichorst, 2004) infants were observed during a maximum of 15 minutes once every three to four months. In addition, in Pawlby's (1977) study, even though infants were observed weekly, the sessions only lasted 10 minutes and observations were conducted in the lab with the infant in an infant seat and only two toys present, instead of in the home. Additionally these studies did not discriminate whether or not the mother encouraged her child to imitate or whether the infant imitated her acts in a truly spontaneous manner. Furthermore studies have thus far described the observed frequencies of spontaneous imitation but have not addressed the specific role of spontaneous imitation in the development of imitation. Thus questions about the development and role of spontaneous imitation still remain.

One way of overcoming the problem of limited hours of observations in observational studies is assessing behaviours as they happen in the home, by training mothers to record their infant's behaviours in a diary. However, as Bolger, Davis and Rafaeli (2003) point out, one needs to implement several measures to ensure reliability of the collected data. One is providing appropriate training for the participants to minimize the risk of participants selecting certain behaviours and overlooking others. Another problem can be the recall accuracy; to minimize the risk associated with this, one can ask the participants to record the

behaviour immediately after it occurred. Choosing the right design is also vital. Time-based designs require participants to record their experiences or a specified behaviour at predetermined intervals, for example at the same time each day or after receiving a signal. Time-based designs are often used when measuring behaviours that occur relatively frequent and when assessing within-person processes. Event-based designs require the participant to report a behaviour or experience every time it happens. Event-based designs are particularly useful when assessing infrequent behaviours. Another possible disadvantage of diary studies compared to experimental studies is the high level of commitment that is often required. One can reduce the burden for the participant by designing diaries that only take several minutes to complete. The current advantages in technology make this relatively easy to achieve, by using electronic diaries such as a Palm Pilot.

The present study used an electronic diary method to assess both elicited and spontaneous imitation as they occur in the home. To rule out the possible problems with diary methods we used Bolger et al.'s (2003) recommendations and used an electronic diary instead of a pencil and paper version, mothers received training to minimize the risk of participants selecting certain behaviours and overlooking others, and mothers were asked to record the behaviours as soon as possible. To assess the role of spontaneous imitation in the development of imitation and the variability in spontaneous imitation mothers recorded object related imitative behaviours from 4- to 6- months and again from 10- to 12- months indicating whether they were spontaneous or elicited.

There have been a few recent diary studies on imitation. For example Kuczynski, Zahn-Waxler and Radke-Yarrow (1987) assessed the role of imitation in early socialization by asking 24 mothers to record imitative instances of their infants over an 8 month period. They followed two age groups: in one age group infants were between 10- and 15- months at the beginning of the study and the other age group consisted of children aged between 21- and

23- months at the beginning of the study. They found infants decreased in immediate imitation as they got older and increased in deferred imitation with age. Imitations of household tasks, caretaking and self-care tasks also increased with age. However, the large variability in age between infants, even in the same age groups, and the cross-sectional nature of the study make it difficult to draw strong conclusions. In addition, Barr and Hayne (2003) assessed the role of older siblings in imitative learning by asking 300 parents of 12-, 15- and 18- month olds to keep diary records of their infants' imitative behaviours for seven days. They found that infants at each age learned one or two new behaviours per day through imitation and that the type of imitation and what kind of behaviours were imitated varied with age and whether or not infants had an older sibling. In addition they found infant's imitative behaviours at those ages were more often spontaneous compared to elicited. However, again drawing strong conclusions about age related changes is difficult because diaries were only kept for seven days and because of the cross-sectional nature of the study.

The aim of the present study was to assess spontaneous and elicited object imitation in infants in a study designed to overcome the problems of previous diary and observational studies. Therefore the present study assessed object imitation longitudinally using a diary method during two three month periods: starting from when the infants were 4 months until they were 6 months and again when they were 10- to 12- months. More specifically we assessed the occurrence of spontaneous imitation of actions on objects, the role spontaneous imitation plays in the development of object imitation and the similarities and differences between spontaneous and elicited imitation.

Very little is known about both object imitation under 6 months of age and spontaneous imitation in general. We therefore did not have many specific hypotheses. We do know from an earlier performed pilot study that imitation of simple objects can be observed under 6 months of age. In addition, Piaget (1962) describes a few instances of sporadic

imitation involving an object before 6 months, however the vast majority of his descriptions during that stage do not involve objects. Based on the pilot study and the few observations by Piaget we expected to observe imitation on objects during the 4- to 6- month period, but with a low frequency. Furthermore, object imitation was expected to increase over time as has been observed in observational studies such as those of Pawlby (1977) and Masur and Rodemaker (1999).

Concerning the importance of spontaneous imitation for the development of imitation during the first year of life we assessed the predictions made by a unidirectional view of development and that of an interactional view. If one assumes a unidirectional view of imitation in which the child is merely a receiver of external inputs to which it responds then one would not expect a major role for spontaneous imitation in the development of object imitation during the first year of life, instead one would expect a larger role for imitative instances that are encouraged or instructed by their interaction partner, i.e. elicited imitation. However, if one assumes a significant contribution on the part of the child to its own developmental process one would predict an important role for spontaneous imitation in the development of object imitation during the first year of life.

3.3. Method

3.3.1. Participants

Thirty-nine infants and their mothers were recruited to take part in the First Steps longitudinal project. In the current study diary records of 27 infants, made by their mothers during the period infants were between 4- and 6- months old and during the period infants were between 10- and 12- months old, are used. The diary records of eleven infants were excluded from analyses because reliability checks revealed the mothers had not been able to provide reliable information about their infant. One additional infant was excluded because all

object imitation related recordings were made more than one month after the event had occurred.

3.3.2. Apparatus

Diary records were made and kept on a hand-held Palm Pilot (Palm z22). The Palm computer was equipped with Experience Sampling Program (ESP) software developed for recording behavioural data. This software was used to create a standardized questionnaire to record each observed behaviour (see appendix 3 for a flow chart of the questionnaire). The questionnaire was designed in such a way that it captured all necessary detail yet required very little time to fill in. The questionnaire always started with the instruction: 'Describe what happened'. Mothers were required to write down what happened before proceeding to the second question asking them to choose the category of behaviour: motoric behaviour, imitative behaviour or communicative behaviour. They would then go through one of three separate routes which were interlinked at several places in the questionnaire to make sure we would capture behaviours that were for example both motoric and imitative or imitative and communicative. All three routes ended with the question: 'If you would like to change or add anything please note it here', as mothers could not return to earlier questions to change anything. For the data used in the current study mothers would normally go through the 'imitative-object route' (see appendix 4). However, when mothers chose to go through a different route it was still possible to determine whether an object was involved, either through the description for the first instruction, or the answer to the instruction: 'if any objects were involved describe how'. Their answer to the question: 'was this behaviour copied?' was used to determine copying.

In addition mothers were given a folder with detailed instructions on how to record behaviours, including a trouble shooting guide. Furthermore, every three months mothers

were given a “What-to-expect-sheet’, listing and explaining the behaviours they should start to look out for during the coming period to record in their diary.

3.3.3. Procedure and design

Mothers first visited the lab during the final stages of their pregnancy. During this meeting the project was explained, consent was obtained from the mothers and mothers received training in how to use the electronic diary. In addition they were given their first set of What-to-expect-sheets listing behaviours they should look out for during the first three months after birth. Behaviours were explained to them verbally and they were given written descriptions in the What-to-expect-sheets. The diary study used an event-based design and therefore mothers were instructed to record each behaviour three times as they happened or shortly after they happened. In addition, mothers were instructed that some behaviours might either not yet occur, or would have not been recorded three times in the three month period. In this case mothers were instructed to keep looking for the behaviour in the months after the three month period even if they had already received a new list of behaviours to look out for.

After the infants were born mothers visited the lab every month for experimental testing, mother-infant interaction observations and to download the data from their diary onto our central diary database. Each month mothers received written feedback on which behaviours they had recorded, which behaviours they still needed to look out for and, where needed, behaviours were explained to them again. In addition mothers received phone calls in-between visits to provide additional feedback.

3.3.4. Reliability and Coding

Mothers’ reliability of recording was assessed by comparing their recordings on simple motor behaviours with the experimental assessment of these behaviours, conducted as

part of the larger First Steps project. The motor behaviours used to assess this were: Palmar grasp, pincer grip and walking. Palmar grasp was assessed during the 1-month visit to the lab by placing a finger in the infant's palm. Pincer grip was assessed in the lab when infants were 8-, 9- and 10- months old by having the infant pick up two pieces of colourful string from a piece of cardboard. Walking was assessed in the lab every month from when infants were 11 months old by having the infant walk at least two steps towards their mother. To be counted as reliable, mothers should have recorded the motor behaviour in their diary by the time the infant performed the behaviour in the lab. When mothers had failed to record one of the three motor behaviours on time the data was deemed unreliable and excluded from analyses. This was the case for eleven participants.

Object imitation. Next we screened all recordings in the 4- to 6- months period and the 10- to 12- month period for recordings on object imitation. The 4th month started on the day the mothers had received the new What-to-expect-sheet for the 4- to 6- month period to make sure she used the right definition of object imitation. This period ended at the end of the sixth month when she received the sheet for the next three months. The same procedure was followed for defining the 10- to 12- month period. Object imitation was defined as any imitative act involving an object. In a few cases mothers accidentally recorded object imitations under a different category, in that case the mothers' descriptions of what had happened were the main source of information. In addition some motor behaviours that involved an object, such as picking up an object, might have been copied. Even though the mothers would have followed a different route in the questionnaire, these behaviours were included as object imitation as long as they involved an object and were marked as imitated. Combinations of object imitation with vocal imitation, gestural imitation or facial imitation were excluded. Examples of the recorded behaviours are shaking a rattle, pushing a button on

a toy and tapping on a table during the 4-6 month period and brushing hair, sweeping the floor with a broom and brushing teeth during the 10-12 month period.

Spontaneous and elicited imitation. For every recording the mother made in the diary she had to state whether the behaviour was spontaneous or encouraged/instructed, based on the answer given, the object imitations were classed as spontaneous or elicited.

Interrater reliability was assessed by a second coder going through the data of 6 infants (22%) and selecting instances of object imitation, resulting in a Kappa of 0.84.

3.4. Results

3.4.1. Preliminary analyses

Preliminary analyses revealed that the data was positively skewed. A log transformation was used to transform the data which resulted in a normal distribution of the data. However, results of the analyses on the transformed data were highly similar to the results of the untransformed data; therefore results of the untransformed data are reported here.

3.4.2. Main analyses

The first step was to assess the frequency of object imitation during the 4- to 6- month period and during the 10- to 12- month period. Table 1 shows the mean frequencies and standard deviations for object imitation during both periods. Effect sizes are reported using *r*.

Table 1. *Means and standard deviations of the frequency of object imitation*

	Mean	SD
Frequency object imitation 4-6 months	2.56	1.91
Frequency object imitation 10-12 months	9.78	7.64

As can be seen in Table 1 the frequency of object imitation increased considerably over time. A paired-samples *t*-test revealed this increase was significant, $t(26)= -5.28$, $p < .05$, $r= .72$.

Next the frequencies of spontaneous and elicited imitation were calculated. Table 2 shows the means and standard deviations of the frequencies of spontaneous and elicited imitation during both periods.

Table 2. *Means and standard deviations for the frequencies of spontaneous and elicited imitation*

	Mean	SD
Frequency of spontaneous imitation 4-6 months	1.11	1.37
Frequency of elicited imitation 4-6 months	1.37	1.52
Frequency of spontaneous imitation 10-12 months	6.78	6.46
Frequency of elicited imitation 10-12 months	3.00	2.24

Paired-samples *t*-tests comparing the frequency of spontaneous imitation with the frequency of elicited imitation at each age revealed no significant difference at 4- to 6-months, $t(26)= -0.62$, $p > .05$, $r= .12$. However, at 10- to 12- months there was significantly more spontaneous imitation than elicited imitation, $t(26)= -3.31$, $p < .05$, $r= .54$. In addition, a Wilcoxon Signed Ranks test comparing the frequency of spontaneous imitation at 4-6 months with the frequency of spontaneous imitation at 10- to12- months revealed a significant increase in spontaneous imitation over time, $t(26)= -4.99$, $p < .05$, $r= .70$. A similar comparison for the frequency of elicited imitation revealed a significant increase over time in elicited imitation, $t(26)= -2.90$, $p < .05$, $r=.49$ (see also Figure 1).

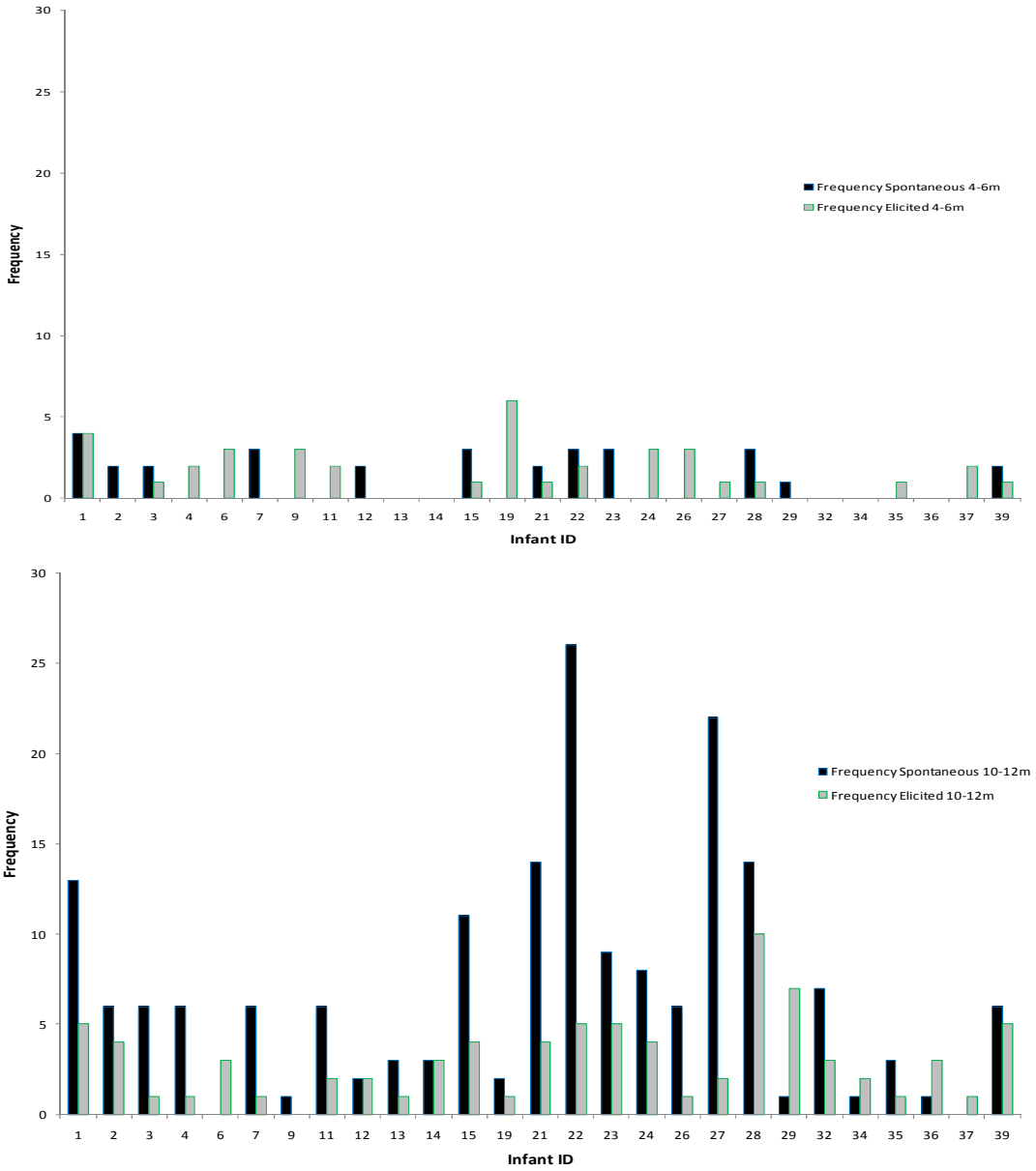

Figure1. Frequencies for each infant of spontaneous (dark) and elicited (grey) imitation during 4- to 6- months (upper graph) and 10-to12- months (lower graph)

To assess the role of spontaneous and elicited imitation in the increase in spontaneous imitation at 10- to 12- months, a Pearson correlation was calculated between spontaneous imitation at 4- to 6- months and spontaneous imitation at 10- to 12- months. A significant positive correlation was found between spontaneous imitation at 4- to 6- months and spontaneous imitation at 10- to 12- months, $r = 0.51$, $p < .05$ (see Figure 2), while no significant relation was found between elicited imitation at 4- to 6- months and spontaneous imitation at 10- to 12- months, $r = .18$, $p > .05$ (see Table 3).

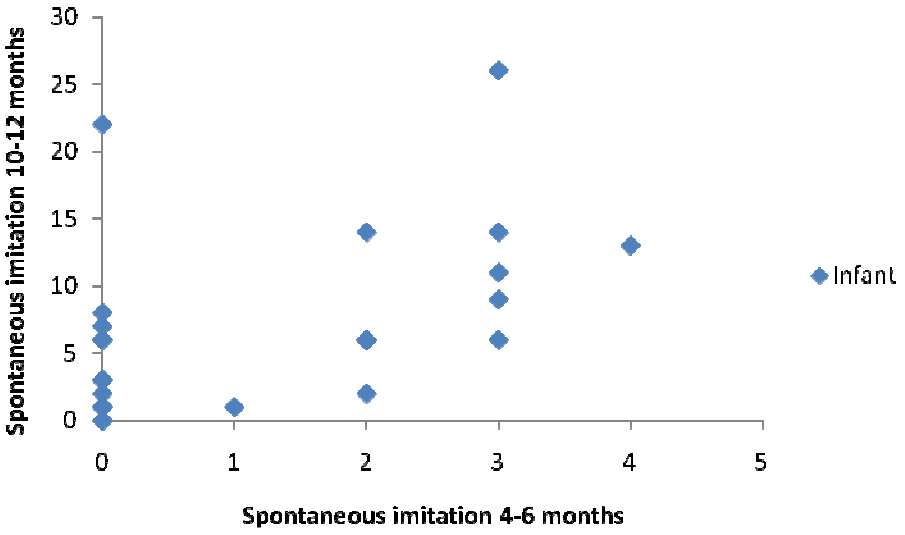

Figure 2. Relation between spontaneous imitation at 4- to 6- months and sponatenous imitation at 10- to 12- months.

Table 3. *Correlations.*

	Frequency spontaneous 4-6	Frequency spontaneous 10-12	Frequency elicited 4-6	Frequency elicited 10-12
Frequency spontaneous 4-6	1	.55**	-.41	.37
Frequency spontaneous 10-12	.55**	1	-.02	.29
Frequency elicited 4-6	-.41	-.02	1	-.31
Frequency elicited 10-12	.37	.29	-.31	1

** significance level 0.01 (2-tailed)

To assess the role of spontaneous imitation in more detail, a multiple regression was carried out to assess a possible predictive relationship between spontaneous imitation and/or elicited imitation at 4- to 6- months and spontaenous imitation at 10- to 12- months. A model was specified with the frequency of spontaneous imitation at 10- to 12- months as the depenent variable and frequency of spontaneous imitation at 4- to 6- months and frequency of

elicited imitation at 4- to 6- months as predictor variables. A backward selection method was used. This revealed that the model with both predictors significantly predicted the frequency of spontaneous imitation at 10- to 12- months and accounted for 26% of the variance, R^2= .26 , F (2,24)= 4.31, p < .05. Beta values of the variables are shown in Table 3. However, when the frequency of elicited imitation at 4- to 6- months was removed, leaving just the frequency of spontaneous imitation at 4- to 6- months as predictor, the model still significantly predicted the frequency of spontaneous object imitation at 10- to 12- months and explained 25% of the variance, R^2= .25, F(1,24)= 8.47, p < .05 (see Table 4). This change in the amount of variance accounted for was not significant, R^2_{change}= -.01, p > .05. Demonstrating that the frequency of spontaneous imitation at 4- to 6- months plays an important role in the sharp increase of sponatenous imitation at 10- to 12- months. In addition, when looking at the beta values in table 3, frequency of sponatneous imitation at 4- to 6- months is the only significant predictor of spontaneous imitation at 10- to 12- months of age.

Table 4. *Beta coeffecients and their significance value of the predictors in both models*

	Predictor	Beta	*p*
Model 1	Frequency of spontaneous imitation 4-6m	.52	< .05
	Frequency of elicited imitation 4-6m	.12	> .05
Model 2	Frequency of Spontaneous imitation 4-6m	.50	< .05

3.5. Discussion

The present study set out to assess the role of spontaneous imitation in object imitation during the first year of life. We therefore collected detailed diary records from 27 mothers and their infants on instances of object imitation during the 4- to 6- month period and again during the 10- to 12- month period. We were specifically interested in the frequency of object imitation in general during the 4- to 6- month period and in spontaneous and elicited imitation during both periods. In addition, we were interested in the possible relations between early object imitation and later object imitation and the specific role of spontaneous and/or elicited imitation.

Analyses revealed that during the 4- to 6- month period object imitations do occur but with a relatively low frequency of an average 2.56 instances during the three month period. In addition a sharp increase in the frequency of object imitation was observed between the 4- to 6- month period and the 10- to 12- month period. With the frequency of object imitation during the 10- to 12- month period averaging around 9.78. This increase in frequency of object imitation over time was significant. The finding of object imitation being present before six months is consistent with our expectation of observing object imitation before six months but with a low frequency. This prediction however, was based on very little evidence as it has proved to be difficult to measure object imitation experimentally before six months. By using a diary method instead of an experimental method to assess object imitation we have demonstrated that infants are imitating actions on objects before six months of age. In addition we expected infants to show an increase in object imitation by the time they are 10- to 12- months of age, this is exactly what was observed in the current study. This finding is

consistent with results of an earlier observational study that also reported an increase in object imitation around this age (Masur & Rodemaker, 1999).

Further analysis revealed similar levels of elicited and spontaneous imitation at 4- to 6- months. However, by the time infants are 10- to 12- months they show significantly more spontaneous imitation. Comparing elicited and spontaneous imitation at 4- to 6- months with elicited and spontaneous imitation at 10- to 12- months revealed both a significant increase in spontaneous imitation over time as well as a significant increase in elicited imitation over time.

Results furthermore revealed an important role for spontaneous imitation. Spontaneous imitation at 4- to 6- months was positively correlated with spontaneous imitation at 10- to 12- months. No significant relation was found for elicited imitation at 4- to 6- months with spontaneous imitation at 10- to 12- months. Furthermore a multiple regression revealed that the model with only the frequency of spontaneous imitation at 4- to 6- months as predictor, as compared to a model including both frequency of spontaneous imitation at 4- to 6- months and frequency of elicited imitation at 4- to 6- months, was the best predictor for the frequency of spontaneous imitation at 10- to 12- months, explaining a quarter of its variance. The finding that spontaneous rather than elicited imitation plays an important role in the development of imitation is an important one. Thus far not much was known about the role of spontaneous imitation because it is difficult to study in an experimental setting.

In contrast a vast amount of research has been concerned with the role of elicited imitation. A theory concerned with the role of explicitly instructing or eliciting learning is the theory of pedagogy (Csibra & Gergely, 2006, 2009). This theory suggests infants are sensitive to ostensive cues that signal a social partner is communicating to them. Such cues include direct eye-gaze and infant directed speech. Csibra and Gergely (2009) suggest that even though infants do learn from adults by observing behaviours that were not meant as a targeted

ostensive demonstration, their learning fundamentally changes when ostensive cues are used. Csibra and Gergely place great importance on instructive learning in infants and young children and on the use of ostensive cues. Even though we do not dismiss the importance of teaching, or pedagogy, the findings of the present study provide a strong indication that it is not the direct demonstrations or mothers' attempts to teach the infant, e.g. elicited imitation, but it is the infants' spontaneous imitations that lead to increased learning at least during the first year of life.

Furthermore, the present results demonstrate the importance of taking into account the child's contribution to its own developmental process. Most theories and studies of development have thus far, directly or indirectly, advocated a unidirectional view of development in which the child simply receives environmental inputs which elicit responses from the child and influences development. The results of the present study demonstrate that the child's own initiative in spontaneously imitating certain acts results in a sharper increase in imitative learning towards the end of the first year of life. Thus a new more interactive model of the development of imitation is needed that takes into account both environmental influences as well as child factors.

Chapter 4. Selective and Faithful Imitation at 12- and 15- Months

4.1. Abstract

Imitation research in infancy has primarily focused on assessing *what* and *when* infants imitate. More recently, however, the question *why* infants imitate has received renewed attention, partly motivated by the finding that infants sometimes selectively imitate the actions of others and sometimes faithfully imitate, or over-imitate, the actions of others. The present study evaluates the hypothesis that this varying imitative behaviour is related to infants' social traits. To do so, we assessed faithful and selective imitation longitudinally at 12- and 15-months, and extraversion at 15 months. Results revealed that 1) at both ages, selective imitation was dependent on the causal structure of the act, 2) faithful imitation increased from 12- to 15- months, while selective imitation decreased, and 3) at 15 months infants high in extraversion were more faithful imitators than infants low in extraversion. These results demonstrate that both selective and faithful imitation begin earlier than previously thought, and support the hypothesis that the shift from selective to faithful imitation is caused by the social motivations of the infant.

4.2. Introduction

Much of the research on imitation has been concerned with *what* and *when* infants and young children are able to imitate. The results of this research indicate that infants are capable of copying facial gestures from birth, vowel sounds from around four months, and simple actions on objects between six and twelve months (Meltzoff & Moore, 1983; Kuhl & Meltzoff, 1996; Barr, Dowden & Hayne, 1996). By comparison few studies have addressed *why* infants imitate. In this paper, we report a longitudinal study investigating the relation between developmental changes in what infants imitate and why infants imitate.

In a seminal paper, Uzgiris (1981) suggested two motivations to imitate: An instrumental motivation to learn new skills, and a social motivation to create and share experience with social partners. She suggested that initially infants imitate for instrumental reasons, and that they begin to imitate for social reasons during the second year of life.

Importantly, the evidence on which Uzgiris based her proposal differed for the two motivations. She reviewed experimental studies illustrating the instrumental motivations, and observational studies of mother-infant interactions illustrating the social motivations. In her review, experimental evidence of social motivation is limited to one study illustrating that the child's understanding of the interpersonal situation changes around 16 months. In that study, Killen and Uzgiris (1981) tested four age groups (7½-, 10-, 16- and 22- months) on imitation of very simple actions on objects, socially appropriate actions on objects and socially inappropriate actions on objects. The youngest age group copied simple actions only, and 10- and 16-month olds copied simple actions and socially appropriate actions. The eldest group, 22-month olds, were the only group that copied all three types of action, including socially inappropriate actions. Killen and Uzgiris (1981) reasoned that if infants copy for purely instrumental motivations, older infants should decrease in copying simple actions and socially

appropriate actions. This was not the case. Uzgiris (1981) concluded that by 22 months, infants understand imitation as a social exchange and are motivated to maintain the social interaction by imitating the actions of the social partner, including the simple actions they already fully understand.

Recently researchers have once more raised the question of *why* infants and children imitate, motivated in part by demonstrations that *how* they imitate varies according to context. On some tasks, infants and children selectively imitate the actions of others. For example, Carpenter, Akhtar, and Tomasello (1998) demonstrated that 12- and 18- month olds imitate selectively, copying intentionally marked actions more than accidentally marked actions. Other evidence also supports the claim that infants and children imitate selectively, copying goals and intentions and omitting other aspects of the model's actions (Bekkering, Wohlschläger & Gattis, 2000; Carpenter, Call & Tomasello, 2005). On other tasks, however, infants and children imitate faithfully, or over-imitate, the actions of others, even to the extent of copying unnecessary steps in an action sequence (Brugger, Lariviere, Mumme & Bushnell, 2007; Horner & Whiten, 2005; Lyons, Young & Keil, 2007; Lyons, Damrosch, Lin, Macris & Keil, 2011; Nielsen, 2006). The contrast between *selective imitation* in some contexts and *faithful imitation* in other contexts has led to renewed interest in why infants imitate. In the present paper we report a longitudinal study, investigating developmental changes in selective and faithful imitation and whether those changes are influenced by the motivation to maintain social interactions.

One proposed explanation for the variable nature of imitation is that, as Uzgiris proposed, humans have two different motivations to imitate, and imitative behaviour varies according to the motivations, which are in turn influenced by context. In some contexts, infants and children use imitation to learn new skills, including how to manage the

affordances and cause-effect relations of objects, while in other contexts, they use imitation to share experience with social partners.

In recent years a few studies have investigated the influence of context in eliciting instrumental motivations. For example, Brugger et al. (2007) investigated whether infants vary their imitative behaviour according to the causal structure of a modelled act by modelling a sequence of two actions in two different causal contexts, and asking whether behaviour differed in those two contexts. In the *necessary condition* the first action was causally necessary in order to produce the second action. In the *unnecessary condition* the first action was unnecessary in order to produce the second action. Fourteen- to 16-month olds were more likely to copy the first action when it was causally necessary than when it was not, demonstrating that infants vary their imitative behaviour depending on the causal structure embedded in the demonstrated actions. Similarly, Lyons and colleagues (2007, 2011) reported a series of studies in which pre-schoolers faithfully imitated actions on a novel object. He concluded that in unfamiliar situations, pre-schoolers use adults' actions to infer the causal structure of an act.

Correspondingly, a few studies have investigated how context elicits social motivations to imitate. These studies have used tasks with similar causal relations, but to a different end. For example, Nielsen (2006) modelled opening a box with a tool, even though it was easier to open with a hand. The social context was manipulated by varying the model's behaviour: half of the participants saw the model acting socially and the other half saw the model acting aloof. Eighteen-month olds were more likely to use the tool in the social condition than in the non-social condition. Twenty-four-month olds were consistent in their tool use in both conditions but were more successful in opening the box when the model acted socially. Nielsen concluded that infants were copying for social reasons: infants persisted longer in the social condition to sustain the social interaction.

In the same study Nielsen also demonstrate age related changes in selective and faithful imitation. In a similar experiment he demonstrated that 12 month olds copied selectively unless they were given a logical reason to copy all actions. Twelve month olds would only use the tool to open the box if they saw a failed hand demonstration followed by a successful opening of the box using the tool. Combined with the results of the other experiments, Nielsen concluded that social context and age both influence social motivations to imitate, with infants becoming more faithful imitators around 18- to 24- months.

Interestingly, Brugger et al. (2007) also demonstrated that social context influences the faithfulness of imitation. In their study, in addition to the causal structure of the act, they also manipulated the social context by varying the model's behaviour: in half of the trials the model would act in a normal social manner while for the other half of the trials the model would act in a non-social manner. Infants were more likely to copy the unnecessary step of an action sequence when the model acted in a natural social manner compared to when the model acted in a non-social manner.

The results of Brugger et al. (2007) and Nielsen (2006) thus demonstrate that instrumental and social motivations to imitate are influenced by context and by age. In particular the evidence suggests a correspondence between selective imitation and an instrumental motivation to imitate, and a correspondence between faithful imitation and a social motivation to imitate. Manipulations of causal relations in a task suggest an instrumental motivation is more likely to lead to selective imitation and manipulations of the social behaviour of the model suggest a social motivation is more likely to lead to faithful imitation. This builds on and goes beyond Uzgiris (1981) because it demonstrates specific links between the type of motivation and the kind of imitative behaviour.

In the current study we examined this correspondence using the imitation paradigm used by Brugger et al. (2007) with one important difference: the way we assessed infants'

motivations to imitate. One problem with interpreting the results of the Brugger et al. study and the Nielsen (2006) study is that when a model is acting aloof, infants, on any task, will almost certainly decrease in performance. Therefore in the present study, instead of manipulating the behaviour of the model, we evaluated infants' broader social motivations by assessing extraversion. Extraversion is a measure of infants' desire to interact with other people (Putnam, Gartstein & Rothbart, 2006). We reasoned that extraversion should correspond to the social motivation to imitate. If the proposed correspondence between the social motivation to imitate and faithful imitation exists, sociable infants, or those high in extraversion, should be more likely to imitate faithfully.

We assessed faithful and selective imitation longitudinally at 12- and 15- months using the Brugger et al (2007) paradigm, consisting of a two-step sequence of which the first action is either causally necessary or unnecessary in order to perform the second action. This paradigm has been proven to detect both selective imitation, when infants perform the first action more often in the necessary condition than the unnecessary condition, and faithful imitation, when infants also copy the first actions in the unnecessary condition. Infants' social motivation was measured using the Early Childhood Behavior Questionnaire developed by Putnam et al. (2006). The factor *surgency* in their measure can be seen as the child equivalent of extraversion and includes measures of sociability, impulsivity and positive anticipation. Based on earlier findings (Brugger et al., 2007; Nielsen, 2006; Uzgiris, 1981) we expected infants who scored high on surgency to demonstrate more faithful imitation than infants who scored low on surgency. We expected this relation to be specific to faithful imitation, and therefore did not expect a similar relation between selective imitation and surgency. In addition we predicted that the tendency to copy faithfully would increase with age.

4.3. Method

4.3.1. Participants

Thirty-seven healthy infants were tested at 12 months (M = 365 days, range = 354 to 371 days) and 15 months (M = 458, range = 446 to 465 days) as part of the First Steps longitudinal study.

4.3.2. Apparatus

Stimuli were adapted from Brugger and colleagues (2007). Four toys were used: Two yellow and red wooden boxes containing a hidden toy and two toy trucks with a toy animal on the front and one on the back of the truck. Pushing the animal in the front seat caused music to play and the wheels to spin (see Figure 1). From each type of toy one was used in the *necessary condition* and one in the *unnecessary condition*. For the box in the *necessary condition* a Velcro strap which was attached to the lid of the box needed to be removed before opening the lid. For the box in the *unnecessary condition* the Velcro strap was attached next to the lid on the other half of the box. Therefore it was unnecessary to remove the strap before opening the lid. For the truck in the *necessary condition* a square cover made of plexi-glass with a knob attached to the top was placed over the animal in the front seat of the truck. Therefore the cover needed to be removed in order to push the animal. In the *unnecessary condition* the cover was placed over the animal in the back of the truck and it was therefore unnecessary to remove the cover before pushing the animal in the front seat. To minimize memory effects the colours were changed for all 4 toys at 15 months.

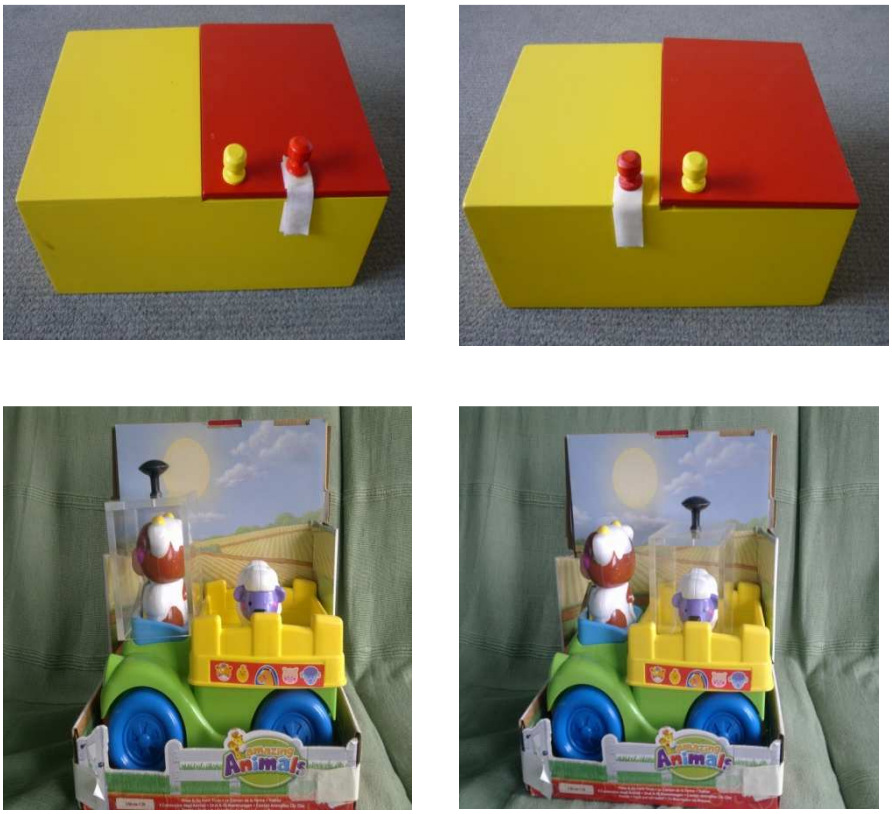

Figure 1. The toys used in the necessary condition (left) and the unnecessary condition (right).

4.3.3. Procedure

Infants were seated on the lap of a secondary experimenter or on their mothers' lap. Mothers were instructed not to speak to their infants or help their infants in any way. The primary experimenter positioned herself at 90° to the infant's right. As soon as the infant was settled the experimenter brought out the first toy from under the table. A two-step sequence was modelled twice followed by a response period. Each modelling sequence started with the experimenter saying: 'Look what I've got! Shall I show you how it works?' followed by the two-step sequence. For the box toy, regardless of condition, the sequence consisted of removing the Velcro strap and opening the lid to reveal the hidden toy. The only difference between conditions was the position of the Velcro strap: either on the lid (necessary) or next to the lid (unnecessary). After the infant's turn the toy was taken away and put out of view of the infant and the next toy was brought out on the table. For the truck, regardless of condition,

the sequence consisted of removing the plastic cover and pushing the animal on the front to make the music play and the wheels spin. The only difference between conditions was whether the cover was placed over the animal in the front (necessary) or over the animal in the back (unnecessary). Infants were shown both types of toys in both conditions in a counterbalanced order. The order of the type of toys was alternated, e.g. truck, box, truck, box.

A parent-report measure of infant temperament was used to measure extraversion. Mothers completed the Early Childhood Behavior Questionnaire (Putnam et al., 2006) at 15 months. In the current study only the scales of the factor surgency were included. Mothers also completed the Infant Behavior Questionnaire-Revised (IBQ-R) (Gartstein & Rothbart, 2003) at 4 months. The IBQ-R is not reported here, but we refer to it in the preliminary analyses below which assessed stability of extraversion/surgency over time.

4.3.4. Coding and analyses

Each testing session was recorded and later coded from video by a trained coder using the Mangold Interact software for coding behavioural data. The coder was blind to the hypotheses but not the condition because the toys were visible in the video. The coder coded the first actions of the sequence: removing the Velcro strap for the boxes and removing the cover for the trucks. A second coder re-coded 25% of the videos to allow assessment of reliability (Kappa = 0.94, $p < .05$ at 12 months and Kappa = 1, $p < .05$ at 15 months).

The critical comparison for the imitation task was between the number of first actions copied in the necessary condition and the number of first actions copied in the unnecessary condition. Selective imitation was operationalized as producing a greater number of first actions in the necessary condition as compared to the unnecessary condition. Faithful

imitation was operationalized as the total number of first actions copied: the higher the number of first actions copied the more faithful the infant's imitative behaviour.

4.4. Results

4.4.1 Preliminary analyses

To assess whether infants were more likely to copy the unnecessary action depending on the order of experimental conditions, a Kruskal-Wallis test was carried out with the four counterbalancing orders as a grouping variable and the first actions copied in the unnecessary condition with each toy as test variables. At 12 months no significant differences were found, $\chi^2(3) = 4.36$, $p > .05$ for first actions with the box in the unnecessary condition and $\chi^2(3) = .60$ $p > .05$ for first actions with the truck in the unnecessary condition. Similarly no significant effects of order were found at 15 months, $\chi^2(3) = 3.34$ $p > .05$ for the box and $\chi^2(3) = 3.44$ $p > .05$ for the truck.

To assess whether surgency was a stable factor in our sample, longitudinal analyses were conducted comparing factor scores on extraversion/surgency from the IBQ-R at 4 months and the ECBQ at 15 months. These analyses demonstrated stability of extraversion/surgency from 4 to 15 months, $r = .43$ $p < .05$. This finding supported our decision to use the factor surgency to assess the relation between social motivations to imitate and faithful imitation.

4.4.2. Main analyses

The first step was to assess whether infants imitated selectively based on the causal structure of the action sequence. Table 1 shows the means and standard deviations for the number of first actions copied in each condition. As the data was not normally distributed, non-parametric tests were used, effect sizes are reported using *r*. Wilcoxon Signed Ranks tests

comparing the number of first actions copied in the necessary condition with the number of first actions copied in the unnecessary condition revealed selective imitation at both ages. At both ages infants were more likely to copy the first action in the necessary condition than in the unnecessary condition, z= -4.54, p< .001, r= -.52; z= -2.83, p<.05, r= -.33.

Table 1. *Means and standard deviations of first actions copied.*

	Month 12		Month 15	
	Mean	SD	Mean	SD
First actions				
Necessary	1.76	0.49	1.62	0.64
First actions unnecessary	0.92	0.64	1.30	0.70

Next we assessed whether selective imitation changed with increasing age. To do so, infants were divided into selective and non-selective imitators. For both ages infants were classed as selective imitators if they copied more first actions in the necessary condition as compared to the unnecessary condition. The other infants were classed as non-selective. A Cochran Q test, which is similar to a Friedman test but can be used with dichotomous data, was used to compare selective imitation at 12 months (M= 0.70) with selective imitation at 15 months (M= 0.30), revealing a significant decrease in selective imitation over time, Q (df=1, n=37) = 8.05, p<.05 (see Figure 2). To assess whether infants change in their amount of faithful imitation during the same period a Wilcoxon Signed Ranks test compared the number of first actions copied in the unnecessary condition at 12 months (M= 0.92) with the number of first actions copied in the unnecessary condition at 15 months (M= 1.30). This analysis

revealed that the number of first actions copied in the unnecessary condition significantly increased from 12 to 15 months, z= -4.24, p< .05, r= -.49.

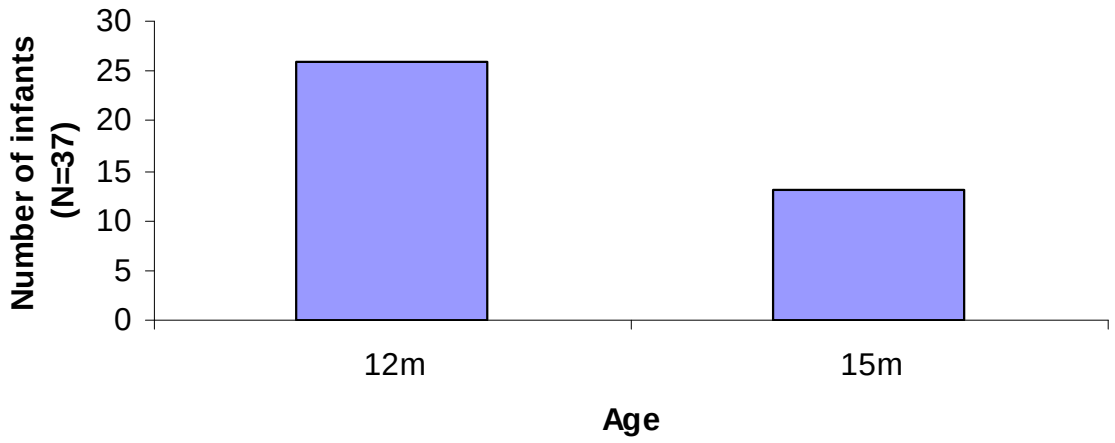

Figure 2. Number of infants copying selectively at 12 months and 15 months.

To assess the hypothesized relation between social traits and faithful imitation, infants were divided into a high and a low surgency group based on a median split on their scores on the surgency scale of the ECBQ (See Figure 3). Next a biserial correlation was calculated between surgency *(*high/low*)* and the total number of first actions copied. This revealed a medium positive relation between surgency and the total number of first actions copied at 15 months, r_b=0.44, p <.05. Thus a higher score on the surgency factor of the ECBQ is related with more first actions copied, i.e. more faithful imitation. No such relation was found at 12 months. In addition a Pearson's chi-square was calculated to assess whether surgency (high/low) was related to selective imitation (yes/no). This revealed no significant relation at either age ($\chi^2(1)$ = .218, p > .05 at 12 months, $\chi^2(1)$ =.83 , p > .05 at 15 months). The phi statistic confirmed there was not a strong association at either age, phi was .08 at 12 months and .15 at 15 months.

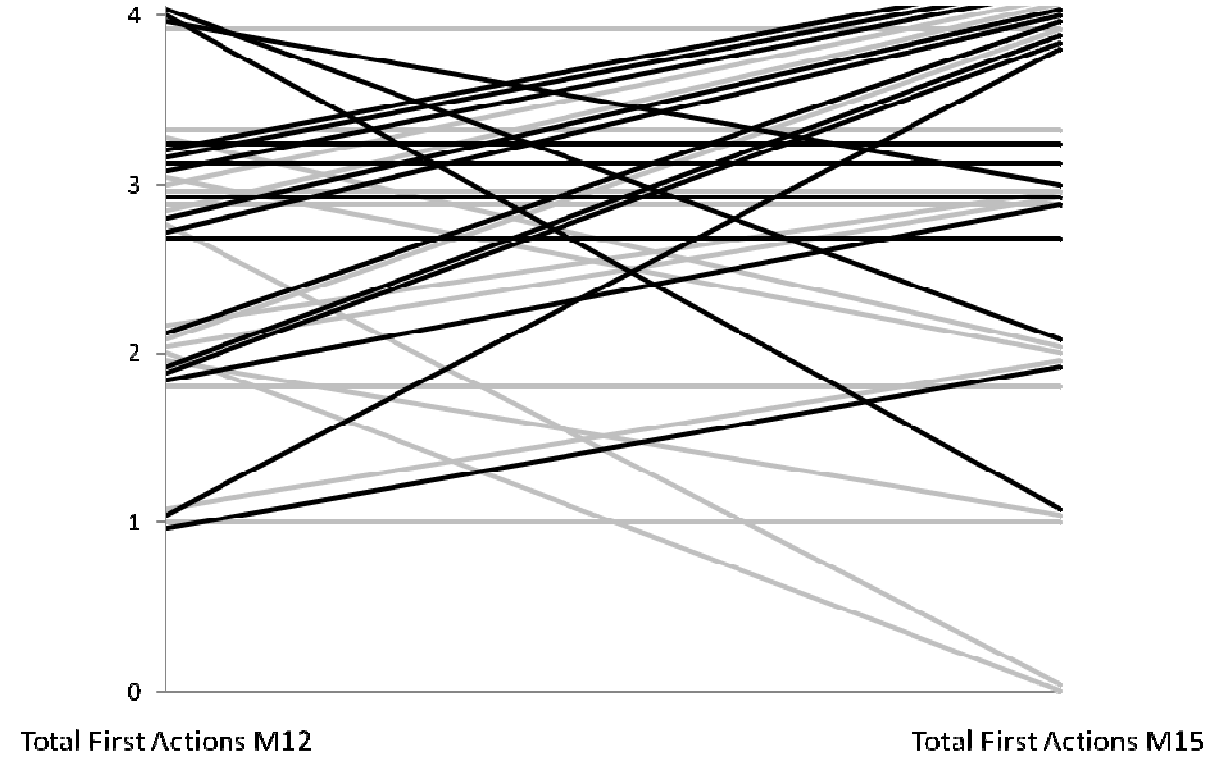

Figure 3. Individual patterns of total first actions copied at 12- and 15 months for high-surgency infants (dark lines) and low-surgency infants (grey lines).

To further investigate the relation between surgency and faithful imitation, a Mann-Whitney test was conducted comparing the number of first actions copied by the low surgency group with the number of first actions copied by the high surgency group. This revealed infants in the high surgency group copied significantly more first actions than infants in the low surgency group, $z = -1.98$, $p < .05$, $r = -.33$ (see Figure 4).

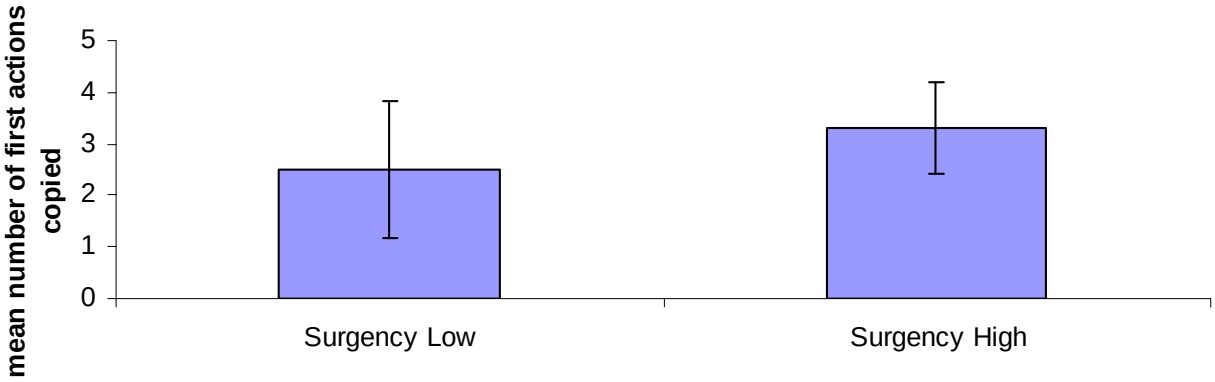

Figure 4. Means and standard deviations for number of first actions copied for the low surgency and high surgency groups.

4.5. Discussion

We conducted a longitudinal study investigating developmental changes in selective and faithful imitation and whether those changes are influenced by the motivation to maintain social interactions. Our aim was to compare selective and faithful imitation in a single experimental task, and to investigate the social motivation to imitate without the inherent confounds of designs using an aloof experimenter. In our study, selective and faithful imitation were measured at 12- and 15- months using an imitation paradigm developed by Brugger et al. (2007) consisting of a two step sequence in which the first action was either a causally necessary or unnecessary step to perform the second action. Social motivation was measured as surgency on the ECBQ (Putnam et al., 2006).

Consistent with previous research, analyses revealed that infants imitate selectively depending on the causal structure of an action sequence. Infants were more likely to copy the first action in the necessary condition compared to the unnecessary condition. In addition to replicating findings from Brugger et al. (2007), who demonstrated that 15-month olds copied selectively depending on the physical properties of the objects, the present study extends these findings to 12-month olds.

Analyses on whether infants changed over time in selective and faithful imitation from 12- to 15- months revealed that infants significantly decreased in selective imitation and increased in faithful imitation. This is consistent with earlier findings by Nielsen (2006) demonstrating that faithful and selective imitation vary with age. Whereas Nielsen reported an increase in faithful imitation from 18 months onwards, however, our results demonstrate that this developmental change begins even earlier, between 12- and 15- months.

Our results indicate that the shift towards faithful imitation begins around the age at which infants also begin to share goals and perspectives with social partners. Tomasello, Carpenter, Call, Behne and Moll (2005) argued in their review that infants have a strong motivation to share emotional states from very early in life but that this motivation becomes more sophisticated as infants get older, with infants becoming able to share goals and perspectives with others from around 12 months onwards. The finding that the shift towards faithful imitation coincides with infants becoming able to share goals and perspectives with others strengthens the idea that infants imitate faithfully because of a motivation to create a shared experience with a social partner.

Comparisons between imitation and social traits provide further evidence supporting the hypothesis that faithful imitation is a consequence of social motivations. Our results indicate that the personality trait surgency, the infant equivalent of extraversion, is related to faithful imitation at 15 months: infants high in surgency were more faithful imitators than infants low in surgency. No such relation was found at 12 months. Importantly, no significant relation was found between selective imitation and surgency either, indicating that surgency is solely related to faithful imitation. These findings indicate that the increase in faithful imitation is a consequence of social motivations: infants are motivated to interact socially with other people and to create shared experiences with other people, leading them to copy the actions of others even when those actions lack functionality.

To summarize, the present results demonstrate that: 1) infant imitation is influenced by causal structure from 12 months onwards; 2) the shift from selective to faithful imitation begins between 12- and 15- months; and 3) this shift is influenced by the social motivation to maintain interactions with partners. Future research should investigate how these important developments in imitation at the beginning of the first year influence imitation at later ages.

5. Conclusions

5.1 Summary of results

The central topic of this thesis is the role of individual differences in the development of imitation and how these individual differences might reflect infants' active involvement in their own developmental process. More specifically, chapter two assessed the specific relations between attentional preferences and individual differences in early imitation of facial and vocal models. To assess this, imitation was measured at 2-, 3- and 4- months of age with a facial modelling paradigm, similar to Meltzoff and Moore (1983), and a vocal modelling paradigm similar to the one used by Chen, Striano & Rakoczy (2004). Possible attentional preferences were measured using three scales of the Infant Behavior Questionnaire-Revised (Gartstein & Rothbart, 2003): vocal reactivity, high intensity pleasure and activity level. In addition infants' behavioural arousal was assessed during the vocal modelling trials at 4 months. Large individual differences in imitation were observed. The observed individual differences in imitation were not explained by arousal and no significant relations between the specific temperament scales and imitation of facial models were found. However, specific relations were present between vocal reactivity and imitation of vocal models and between high intensity pleasure and imitation of vocal models. Infants who were more stable imitators on the vocal modelling task had higher scores on these scales. This led to the conclusion that infants who have an attentional preference for vocal stimuli, and as a consequence have more experience with vocal stimulation, are more likely to demonstrate imitation of vocal models.

Chapter three assessed the role of spontaneous imitation in the development of imitation of actions on objects from 4- to 6-months until 10- to 12-months of age. To assess spontaneous imitation a diary method was used. Mothers made diary recordings of all object related imitation that occurred in the home and marked whether it occurred spontaneously or

whether it was encouraged or instructed. A significant increase was observed in object related imitations from the 4- to 6-month period to the 10- to 12-month period, with the largest increase in spontaneous imitation. This increase in spontaneous imitation was significantly predicted by spontaneous imitation during the 4- to 6-month period and not by elicited imitation. Thus, spontaneous imitation, rather than elicited imitation, seemed to play an important role in the development of imitation of actions on objects during the first year of life.

Finally, the study in chapter four assessed whether individual differences in selective and faithful imitation at 12- and 15- months were related to differences in sociability. Selective and faithful imitation was measured using a paradigm adapted from a study by Brugger, Lariviere, Mumme and Bushnell (2007). Infants saw a two step sequence in two conditions: for half of the trials the first step was causally necessary to be able to produce the second step, for the other half of the trials the first step was not causally necessary in order to produce the second step. Sociability was measured using the surgency scale, the child equivalent of extraversion, of the Early Childhood Behaviour Questionnaire (Putnam, Gartstein & Rothbart, 2006). Results revealed an increase in faithful imitation, i.e. imitation of necessary and unnecessary actions, from 12- to 15-months and a decrease in selective imitation, i.e. only imitating necessary actions, during the same period. Moreover infants who scored high on surgency demonstrated significantly more faithful imitation than infants who scored low on the surgency scale. Thus infants who are motivated to share experiences with a social partner are more likely to copy faithfully the actions of their social partner even if they are unnecessary.

5.2 General discussion

As mentioned in the previous section, the two specific aims of this thesis were to establish the role of individual differences in imitation during the first 15 months of life, and related to this, to establish whether the observed individual differences in imitation reflect infants' active involvement in their developmental process. In the following section I will evaluate the individual differences approach to studying early imitation. Next I will elaborate on the alternative model I proposed in chapter two as an alternative to the two major theoretical accounts, an innate account and a learning account, that have been dominating research on the development of imitation. I will conclude with discussing the limitations of the studies in the present thesis and future directions.

5.2.1. A focus on individual differences

In the present thesis I have adopted a focus on individual differences in order to study imitation during the first year of life. This approach has largely been ignored in the study of imitation in infancy and in research on infant development in general (Siegler, 2002). Instead research has focussed on establishing what an infant is capable of at what age.

One area of infant development where considerable attention has been given to individual differences is the area of motor development where variability is seen as an important part of development (Piek, 2002; Smith & Thelen, 2003). In a recent review on variability in motor development Piek (2002) describes how reduced variability on voluntary motor tasks can be interpreted as increased skill, while reduced variability in spontaneous motor activity early on in life can also lead to less than optimal development. Piek concludes with the suggestion that Dynamic Systems theory is a theory which can account for both these

situations, because it does not just describe variability but also provides explanations for why it is occurring.

Dynamic Systems theory has been proposed by Smith and Thelen (2003), based on studies on motor development. It views development as an ongoing self-organizing process, and views individual variability as an important source of information. More specifically, dynamic systems theory studies the relative stability of behaviour over time in its particular context. Even though Dynamic Systems theory focuses mainly on intra-individual variability there are many similarities with the approach used in the present thesis. Imitation was measured under similar circumstances, in similar contexts at multiple points close in time. However, the individual differences approach used in the present thesis was to divide similarly responding infants into groups to assess what made these groups differ, which could be viewed as an inter-individual variability approach rather than an intra-individual approach (See also Siegler, 2002, on intra- and inter-individual variability). Both approaches place great emphasis, however, on the importance of individual variability in studying early imitation and on the interaction between the child and environmental experience. The present findings of variability in early imitation provide a clear demonstration of the importance of taking into account individual variability and in viewing development as an ongoing interaction between the child and its environment.

Related to the above mentioned importance of the interaction between the chid and its environment is the second aim of this thesis, which was to assess the active involvement of the infant in its own developmental process by using an individual differences approach. As mentioned in earlier chapters, previous theories of early imitation largely ignore a possible active role of the infant in the developmental process. However, in other areas of child development several studies have assessed and demonstrated an active role of the child. For example Goldin-Meadow and Mylander (1990) demonstrate in their review on the child's role

in acquiring language an important role for the child. They review several studies with deaf children who are unable to use spoken language and are not exposed to conventional sign language models. Still, the deaf children demonstrated several structures in their way of communication (gesturing) which are also found in conventional language. In other words, these children are capable of acquiring aspects of conventional language. The authors go on to suggest that these structures or abilities might be innate structures that children bring to the learning situation. Benson and Uzgiris (1986) also demonstrated the role of an infant's own actions. They found that infants were better at retrieving a toy hidden in a hiding box when they self-initiated moving around the hiding box than when they were carried around the box (other-initiated) before being able to retrieve the toy. This led them to conclude that self initiated experience facilitates their understanding of spatial relations.

Both studies suggest an active role for the infant in their own developmental process but in a different way. Goldin-Meadow and Mylander suggest innate structures or abilities in the child as the child's contribution, while Benson and Uzgiris focus on (self-initiated) experience. Both approaches correspond with the findings of the present thesis. In chapter two the child's contribution can be found in the attentional preferences and the interaction between these child characteristics and the child's environment. Furthermore, the findings in chapter three can be seen as an example of self-initiated experience that drives the increase in object imitation, while in the last study child characteristics are demonstrated to influence development of faithful imitation. Together with the findings of previous studies in other areas of development these results demonstrate the importance of viewing development as a bidirectional process of ongoing interactions between the child and its environment. Furthermore, the findings extent the demonstrations of a possible child contribution to development to the field of early imitation.

5.2.2. A Dynamic-Interactive account of imitation

As described in chapter two, the two most dominant theories of early imitation, i.e. the nativist account and learning account, are unable to provide an account of imitation that sufficiently explains the findings of early imitation and the observed variability in early imitation. The same is true for the findings in chapter three and four: Both accounts of imitation do not fit well with the idea of an active involvement of the child in its own developmental process. According to the innate account the infant is equipped at birth with a system that determines the infants' responses to environmental stimulation, while the learning account solely emphasizes the environmental influence of the environment on the child's learning process.

The present findings encourage an alternative approach to studying the development of imitation. They demonstrate that taking into account individual differences as meaningful information is important for assessing how imitation develops. Furthermore, they suggest a dynamic-interactive account of imitation, in which an active role is assumed for both infant characteristics and the social environment, and in which the interaction between the two determines development. Examples of similar approaches can be found in the animal literature: such as Marler's ideas on how birds acquire bird song (Marler, 1991), and in human development research: such as the idea of interactive specialization for the development of the infant social brain described by Johnson (2005), which assumes that innate biases set up the infant to attend to certain social inputs such as faces. Another example is that of the dynamic systems theory, described in the previous section (Smith & Thelen, 2003).

In chapter two I described an alternative account of imitation during the first few months of life, based on the idea of an interaction between the child and its environment. In Figure 1 I have provided a picture of the proposed dynamic-interactive model (DIM). In this account infants have a set of (social) attentional preferences that direct their attention to

certain (social) stimuli in the environment. In other words, these attentional preferences filter the environmental stimulation. These attentional preferences together with what is available in the environment determine infants' experiences and the subsequent learning processes.

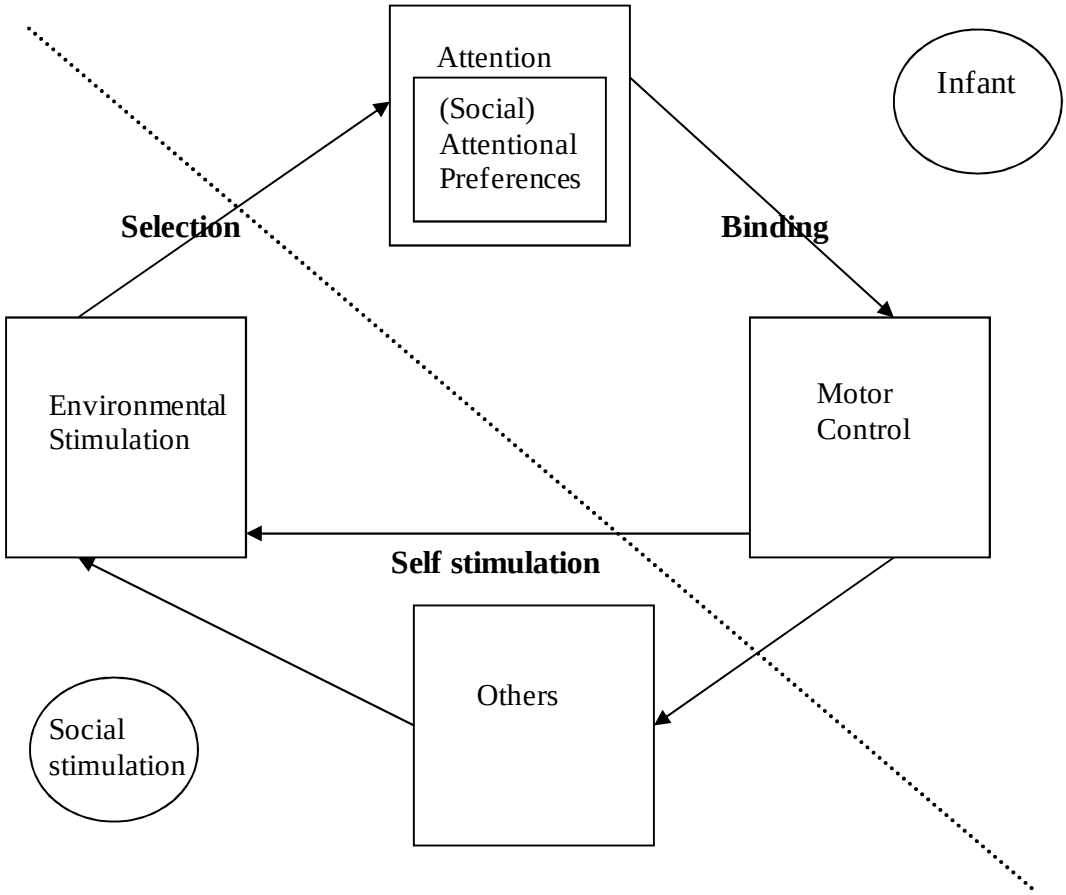

Figure 1. A Dynamic Interactive Model of early imitation.

The DIM model differs from nativists' models such as Meltzoff and Moore's AIM (1989) in that AIM assumes innate machinery that does the binding between perceiving and motor control for the infant. In the DIM model it is the process that does the binding. It is also different from current associative learning models, which assume a direct associative link between environmental stimulation and motor control, in that learning in the DIM model occurs a lot quicker because of the selection function of the (social) attentional preferences.

For this theoretical model to really work, it should also explain the results of chapter three and four. In chapter three the large increase in object imitation mainly consisted of

spontaneous imitation, furthermore, the amount of spontaneous object imitation early on in life predicted the increase in spontaneous imitation. One way this result could fit with the proposed theoretical model is that infants have an attentional preference for objects, or maybe more specifically for manipulating objects. This focus on objects might result in more experience with observing and performing actions on objects, which subsequently influences the learning process, which is demonstrated by an increase in imitation of actions on objects. In this case clear instructions or encouragement is not necessary for an infant to learn to imitate actions on objects.

In chapter four it was demonstrated that the more sociable, i.e. extraverted, infants were more likely to demonstrate faithful imitation than their less sociable counterparts. Surgency is a relatively stable trait, so infants who are more sociable might have attentional preferences from early on in life that focuses them on social interactions. Subsequently these infants gain more experience with social interactions and will learn more about social interactions and what they might involve. This could speed up the learning process concerning sharing experiences with others, especially during the 12- to 15-month period which has been demonstrated to be the period in which infants become able to share goals and perspectives (Tomasello, Carpenter, Call, Behne & Moll, 2005). This experience is then reflected in more faithful imitation at 15 months. Naturally, more research is necessary to further explore both proposals, for example to assess whether some infants might have more of a preference towards objects than others and whether these infants demonstrate a sharper increase than infants who show less of a preference towards objects. Furthermore, one needs to assess whether infants who are rated as more sociable at 15 months are also more sociable or at least more focussed on social interaction earlier on in life.

Based on the results of the present thesis, one could conclude that the proposed attentional preferences are social in nature. Especially when considering that both the vocal

reactivity scale and high intensity pleasure scales are subscales of the surgency factor of the IBQ, which has demonstrated to be a stable factor from 4- to 15- months in the present sample. Whether the attentional preferences are truly limited to social stimuli or social interactions remains to be assessed.

5.2.3. Limitations

The findings in the present thesis highlight the importance of using an individual differences approach and taking into account the infants own contribution to development. However, some limitations of the various methods used in this thesis need to be discussed as it leads to some caution when interpreting the present results.

First, the sample used throughout this thesis is small. As part of the First Steps longitudinal study 39 infants were followed for 18 months. Due to the length of the study and the monthly assessments, time constraints meant that 39 infants was the maximum number to be included in the First Steps study. However, when using naturalistic observations and such extensive longitudinal designs a sample of 39 or sometimes even smaller is relatively common. For example, Killen and Uzgiris (1981) observed 40 infants in a cross-sectional design in mother-infant interactions. Masur and Rodemaker (1999) observed 20 mothers and their infants in a longitudinal study on imitation, consisting of two visits at the ages of 10-, 13-, 17- and 21-months. Kuczynski, Zahn-Waxler and Radke-Yarrow (1987) assessed the role of imitation in early socialization by asking 24 mothers to record imitative instances of their infants over an 8 month period in a diary. Thus even though the sample seems small in comparison to single time point experimental paradigms, it is common practice in longitudinal studies and in studies using more naturalistic methods. Furthermore, these studies have proven to have found reliable results that have been replicated in other studies. The study by

Masur and Rodemaker (1999) for example replicated findings about the frequency of occurrence of imitative instances of an earlier study by Pawlby (1977).

In addition, the findings in the present thesis correspond with findings in others studies. For example in chapter three the frequent occurrence of imitations of actions on objects around the end of the first year is consistent with the findings of Masur and Rodemaker (1999) and Pawlby (1977). Furthermore the results on selective imitation in chapter four are also consistent with previous work such as that of Brugger, Lariviere, Mumme and Bushnell (2007). Although replication of the findings with a larger sample size remains desirable, the correspondence with previous findings supports the idea that our sample size was large enough to find reliable effects.

Another possible limitation of the studies in this thesis is the use of parent report for the measurement of temperament because of concerns of parents' (un-)reliability in reporting. To this end Rothbart (Rothbart, 1981; Gartstein & Rothbart, 2003) designed both temperament questionnaires in such a way that they only ask questions about recent events (in the past week or past two weeks) and avoid asking questions where the parent needs to make a comparison with other children. Even though there are experimental assessments available to establish infant temperament such as the Lab-TAB (see Goldsmith & Rothbart, 1991 for a description), parent report was chosen in the First Steps study to measure temperament in order to minimize the time infants would spent in experimental testing sessions each month. Furthermore, both the IBQ-R and ECBQ have been used extensively in previous research and have demonstrated to be a reliable measure of infant and toddler temperament (Gartstein & Rothbart 2003; Putnam, Gartstein & Rothbart 2006). Both measures also have demonstrated reasonable stability over time, which was especially important for measuring temperament in a longitudinal sample (Rothbart, Ahadi, Hershey, & Fisher, 2001). Therefore, for the studies

in the present thesis and in the First Steps project in general, the IBQ-R and ECBQ were considered the most appropriate methods for assessing temperament.

5.2.4. Future directions

Following from the discussed limitations and the discussion of the DIM model there are several directions for future studies. First, more research is needed to assess the application of the DIM model to other domains than vocal imitation, such as facial imitation and object imitation or for social interaction more generally. Future studies should address whether different types of preferences are related to differences in imitation in these domains and when these preferences can be first observed. Other ways of assessing attentional preferences in addition to temperament measure should be explored.

Secondly, in addition to extending the findings to other domains, replicating the findings with a larger sample size is also desirable. Especially for the study in chapter two which included every infant to study variability in early imitation. Including every infant was a major difference from previous studies which led to different results, replicating these findings, preferably with a larger sample, will strengthen the conclusion that it is important to consider individual differences and will also strengthen the findings on specific attentional preferences.

Thirdly, several interesting questions remain to be studied concerning the diary study on spontaneous imitation. For example one could assess whether there is a difference between elicited imitation and spontaneous imitation in the delay between observing the act and performing it. Furthermore, information about whether infants were rewarded after their spontaneous imitative act, either by their parents or by the action resulting in a fun outcome,

could provide information about the mechanisms underlying this increase in spontaneous imitation.

Finally, future analyses of the longitudinal relations between the data presented in the three separate studies in this thesis should be conducted. It will be interesting to see whether the infants who scored high on vocal reactivity and were classed as vocal imitators in chapter two, are also the infants who have higher surgency scores in the selective and faithful imitation study in chapter four. Conducting longitudinal analyses between several experiments over the full 18 month age range will be the next goal of the First Steps project.

To summarize, the findings in the present thesis indicate the need for a dynamic-interactive approach to study the development of imitation. An infant is clearly not simply the 'receiver' of environmental stimulation, and development is not just the result of the infant reflecting back this environmental stimulation. Neither seems the infant equipped with an innate system to imitate that simply needs to mature. Instead, development seems to be the result of an ongoing interaction between child characteristics and factors in the child's social environment. However, more research is needed to assess the exact role the infant plays in its own development.

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Appendix 1. Infant Behavior Questionnaire - Revised

Infant Behavior Questionnaire - Revised

Subject No. _____ Date of Baby's Birth _____ ____ _____

month. day year

Today's Date _____ Age of Child _____ _____

mos. weeks

Sex of Child _____

INSTRUCTIONS:

Please read carefully before starting:

As you read each description of the baby's behavior below, please indicate how often the baby did this during the LAST WEEK (the past seven days) by circling one of the numbers in the left column. These numbers indicate how often you observed the behavior described during the last week.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(X)
Never	Very Rarely	Less Than Half the Time	About Half the Time	More Than Half the Time	Almost Always	Always	Does Not Apply

The "Does Not Apply" (X) column is used when you did not see the baby in the situation described during the last week. For example, if the situation mentions the baby having to wait for food or liquids and there was no time during the last week when the baby had to wait, circle the (X) column. "Does Not Apply" is different from "Never" (1). "Never" is used when you saw the baby in the situation but the baby never engaged in the behavior listed during the last week. For example, if the baby did have to wait for food or liquids at least once but never cried loudly while waiting, circle the (1) column.

Please be sure to circle a number for <u>every</u> item.

Feeding

<u>During feeding, how often did the baby:</u>

1 2 3 4 5 6 7 X . . . . (1) lie or sit quietly?

1 2 3 4 5 6 7 X . . . . (2) squirm or kick?

1 2 3 4 5 6 7 X . . . . (3) wave arms?

1 2 3 4 5 6 7 X . . . . (4) notice lumpy texture in food (e.g., oatmeal)?

<u>In the last week, while being fed in your lap, how often did the baby:</u>

1 2 3 4 5 6 7 X . . . . (5) seem to enjoy the closeness?

1 2 3 4 5 6 7 X . . . . (6) snuggle even after she was done?

1 2 3 4 5 6 7 X . . . . (7) seem eager to get away as soon as the feeding was over?

<u>How often did your baby make talking sounds:</u>

1 2 3 4 5 6 7 X . . . . (8) while waiting in a high chair for food?

1 2 3 4 5 6 7 X . . . . (9) when s/he was ready for more food?

1 2 3 4 5 6 7 X . . . . (10) when s/he has had enough to eat?

Sleeping

Before falling asleep at night during the last week, how often did the baby:

1 2 3 4 5 6 7 X . . . . (11) show no fussing or crying?

During sleep, how often did the baby:

1 2 3 4 5 6 7 X . . . . (12) toss about in the crib?

1 2 3 4 5 6 7 X . . . . (13) move from the middle to the end of the crib?

1 2 3 4 5 6 7 X . . . . (14) sleep in one position only?

After sleeping, how often did the baby:

1 2 3 4 5 6 7 X . . . . (15) fuss or cry immediately?

1 2 3 4 5 6 7 X . . . . (16) play quietly in the crib?

1 2 3 4 5 6 7 X . . . . (17) cry if someone doesn't come within a few minutes?

How often did the baby:

1 2 3 4 5 6 7 X . . . . (18) seem angry (crying and fussing) when you left her/him in the crib?

1 2 3 4 5 6 7 X . . . . (19) seem contented when left in the crib?

1 2 3 4 5 6 7 X . . . . (20) cry or fuss before going to sleep for naps?

When going to sleep at night, how often did your baby:

1 2 3 4 5 6 7 X . . . . (21) fall asleep within 10 minutes?

1 2 3 4 5 6 7 X . . . . (22) have a hard time settling down to sleep?

1 2 3 4 5 6 7 X . . . . (23) settle down to sleep easily?

When your baby awoke at night, how often did s/he:

1 2 3 4 5 6 7 X . . . . (24) have a hard time going back to sleep?

1 2 3 4 5 6 7 X . . . . (25) go back to sleep immediately?

When put down for a nap, how often did your baby:

1 2 3 4 5 6 7 X . . . . (26) stay awake for a long time?

1 2 3 4 5 6 7 X . . . . (27) go to sleep immediately?

1 2 3 4 5 6 7 X . . . . (28) settle down quickly?

1 2 3 4 5 6 7 X . . . . (29) have a hard time settling down?

When it was time for bed or a nap and your baby did not want to go, how often did s/he:

1 2 3 4 5 6 7 X . . . . (30) whimper or sob?

1 2 3 4 5 6 7 X . . . . (31) become tearful?

Bathing and Dressing

When being dressed or undressed during the last week, how often did the baby:

1 2 3 4 5 6 7 X . . . . (32) wave her/his arms and kick?

1 2 3 4 5 6 7 X . . . . (33) squirm and/or try to roll away?

1 2 3 4 5 6 7 X . . . . (34) smile or laugh?

1 2 3 4 5 6 7 X . . . . (35) coo or vocalize?

When put into the bath water, how often did the baby:

1 2 3 4 5 6 7 X . . . . (36) smile?

1 2 3 4 5 6 7 X . . . . (37) laugh?

1 2 3 4 5 6 7 X . . . . (38) splash or kick?

1 2 3 4 5 6 7 X . . . . (39) turn body and/or squirm?

When face was washed, how often did the baby:

1 2 3 4 5 6 7 X . . . . (40) smile or laugh?

1 2 3 4 5 6 7 X . . . . (41) fuss or cry?

1 2 3 4 5 6 7 X . . . . (42) coo?

When hair was washed, how often did the baby:

1 2 3 4 5 6 7 X . . . . (43) smile?

1 2 3 4 5 6 7 X . . . . (44) fuss or cry?

1 2 3 4 5 6 7 X . . . . (45) vocalize?

Play

How often during the last week did the baby:

1 2 3 4 5 6 7 X . . . . (46) look at pictures in books and/or magazines for 2-5 minutes at a time?

1 2 3 4 5 6 7 X . . . . (47) look at pictures in books and/or magazines for 5 minutes or longer at a time?

1 2 3 4 5 6 7 X . . . . (48) stare at a mobile, crib bumper or picture for 5 minutes or longer?

1 2 3 4 5 6 7 X . . . . (49) play with one toy or object for 5-10 minutes?

1 2 3 4 5 6 7 X . . . . (50) play with one toy or object for 10 minutes or longer?

1 2 3 4 5 6 7 X . . . . (51) spend time just looking at playthings?

1 2 3 4 5 6 7 X . . . . (52) repeat the same sounds over and over again?

1 2 3 4 5 6 7 X . . . . (53) laugh aloud in play?

1 2 3 4 5 6 7 X . . . . (54) repeat the same movement with an object for 2 minutes or longer (e.g., putting a block in a cup, kicking or hitting a mobile)?

1 2 3 4 5 6 7 X . . . . (55) pay attention to your reading during most of the story when looking at picture books?

1 2 3 4 5 6 7 X . . . . (56) smile or laugh after accomplishing something (e.g., stacking blocks, etc.)?

1 2 3 4 5 6 7 X . . . . (57) smile or laugh when given a toy?

1 2 3 4 5 6 7 X . . . . (58) smile or laugh when tickled?

How often during the last week did the baby enjoy:

1 2 3 4 5 6 7 X . . . . (59) being sung to?

1 2 3 4 5 6 7 X . . . . (60) being read to?

1 2 3 4 5 6 7 X . . . . (61) hearing the sound of words, as in nursery rhymes?

1 2 3 4 5 6 7 X . . . . (62) looking at picture books?

1 2 3 4 5 6 7 X . . . . (63) gentle rhythmic activities, such as rocking or swaying?

1 2 3 4 5 6 7 X . . . . (64) lying quietly and examining his/her fingers or toes?

1 2 3 4 5 6 7 X . . . . (65) being tickled by you or someone else in your family?

1 2 3 4 5 6 7 X . . . . (66) being involved in rambunctious play?

1 2 3 4 5 6 7 X . . . . (67) watching while you, or another adult, playfully made faces?

1 2 3 4 5 6 7 X . . . . (68) touching or lying next to stuffed animals?

1 2 3 4 5 6 7 X . . . . (69) the feel of soft blankets ?

1 2 3 4 5 6 7 X . . . . (70) being rolled up in a warm blanket?

1 2 3 4 5 6 7 X . . . . (71) listening to a musical toy in a crib?

When playing quietly with one of her/his favorite toys, how often did your baby:

1 2 3 4 5 6 7 X . . . . (72) show pleasure?

1 2 3 4 5 6 7 X . . . . (73) enjoy lying in the crib for more than 5 minutes?

1 2 3 4 5 6 7 X . . . . (74) enjoy lying in the crib for more than 10 minutes?

When something the baby was playing with had to be removed, how often did s/he:

1 2 3 4 5 6 7 X . . . . (75) cry or show distress for a time?

1 2 3 4 5 6 7 X . . . . (76) seem not bothered?

When tossed around playfully how often did the baby:

1 2 3 4 5 6 7 X . . . . (77) smile?

1 2 3 4 5 6 7 X . . . . (78) laugh?

During a peekaboo game, how often did the baby:

1 2 3 4 5 6 7 X . . . . (79) smile?

1 2 3 4 5 6 7 X . . . . (80) laugh?

How often did your baby enjoy bouncing up and down:

1 2 3 4 5 6 7 X . . . . (81) while on your lap?

1 2 3 4 5 6 7 X . . . . (82) on an object, such as a bed, bouncer chair, or toy?

How often did the infant look up from playing:

1 2 3 4 5 6 7 X . . . . (83) when the telephone rang?

1 2 3 4 5 6 7 X . . . . (84) when s/he heard voices in the next room?

When your baby saw a toy s/he wanted, how often did s/he:

1 2 3 4 5 6 7 X . . . . (85) get very excited about getting it?

1 2 3 4 5 6 7 X . . . . (86) immediately go after it?

When given a new toy, how often did your baby:

1 2 3 4 5 6 7 X . . . . (87) get very excited about getting it?

1 2 3 4 5 6 7 X . . . . (88) immediately go after it?

1 2 3 4 5 6 7 X . . . . (89) seem not to get very excited about it?

Daily Activities

How often during the last week did the baby:

1 2 3 4 5 6 7 X . . . . (90) cry or show distress at a change in parents' appearance, (glasses off, shower cap on, etc.)?

1 2 3 4 5 6 7 X . . . . (91) when in a position to see the television set, look at it for 2 to 5 minutes at a time?

How often during the last week did the baby:

1 2 3 4 5 6 7 X . . . . (92) when in a position to see the television set, look at it for 5 minutes or longer?

1 2 3 4 5 6 7 X . . . . (93) protest being placed in a confining place (infant seat, play pen, car seat, etc)?

1 2 3 4 5 6 7 X . . . . (94) startle at a sudden change in body position (for example, when moved suddenly)?

1 2 3 4 5 6 7 X . . . . (95) appear to listen to even very quiet sounds?

1 2 3 4 5 6 7 X . . . . (96) attend to sights or sounds when outdoors (for example, wind chimes or water sprinklers)?

1 2 3 4 5 6 7 X . . . . (97) move quickly toward new objects?

1 2 3 4 5 6 7 X . . . . (98) show a strong desire for something s/he wanted?

1 2 3 4 5 6 7 X . . . . (99) startle to a loud or sudden noise?

1 2 3 4 5 6 7 X . . . . (100) look at children playing in the park or on the playground for 5 minutes or longer?

1 2 3 4 5 6 7 X . . . . (101) watch adults performing household activities (e.g., cooking, etc.) for more than 5 minutes?

1 2 3 4 5 6 7 X . . . . (102) squeal or shout when excited?

1 2 3 4 5 6 7 X . . . . (103) imitate the sounds you made?

1 2 3 4 5 6 7 X . . . . (104) seem excited when you or other adults acted in an excited manner around him/her?

When being held, how often did the baby:

1 2 3 4 5 6 7 X . . . . (105) pull away or kick?

1 2 3 4 5 6 7 X . . . . (106) seem to enjoy him/herself?

1 2 3 4 5 6 7 X . . . . (107) mold to your body?

1 2 3 4 5 6 7 X . . . . (108) squirm?

When placed on his/her back, how often did the baby:

1 2 3 4 5 6 7 X . . . . (109) fuss or protest?

1 2 3 4 5 6 7 X . . . . (110) smile or laugh?

1 2 3 4 5 6 7 X . . . . (111) wave arms and kick?

1 2 3 4 5 6 7 X . . . . (112) squirm and/or turn body?

When the baby wanted something, how often did s/he:

1 2 3 4 5 6 7 X . . . . (113) become upset when s/he could not get what s/he wanted?

1 2 3 4 5 6 7 X . . . . (114) have tantrums (crying, screaming, face red, etc.) when s/he did not get what s/he wanted?

When placed in an infant seat or car seat, how often did the baby:

1 2 3 4 5 6 7 X . . . . (115) wave arms and kick?

1 2 3 4 5 6 7 X . . . . (116) squirm and turn body?

1 2 3 4 5 6 7 X . . . . (117) lie or sit quietly?

1 2 3 4 5 6 7 X . . . . (118) show distress at first; then quiet down?

When frustrated with something, how often did your baby:

1 2 3 4 5 6 7 X . . . . (119) calm down within 5 minutes?

When your baby was upset about something, how often did s/he:

1 2 3 4 5 6 7 X . . . . (120) stay upset for up to 10 minutes or longer?

1 2 3 4 5 6 7 X . . . . (121) stay upset for up to 20 minutes or longer?

1 2 3 4 5 6 7 X . . . . (122) soothe her/himself with other things (such as a stuffed animal, or blanket)?

When rocked or hugged, in the last week, how often did your baby:

1 2 3 4 5 6 7 X . . . . (123) seem to enjoy her/himself?

1 2 3 4 5 6 7 X . . . . (124) seemed eager to get away?

1 2 3 4 5 6 7 X . . . . (125) make protesting noises?

When reuniting after having been away during the last week how often did the baby:

1 2 3 4 5 6 7 X . . . . (126) seem to enjoy being held?

1 2 3 4 5 6 7 X . . . . (127) show interest in being close, but resisted being held?

1 2 3 4 5 6 7 X . . . . (128) show distress at being held?

When being carried, in the last week, how often did your baby:

1 2 3 4 5 6 7 X . . . . (129) seem to enjoy him/herself?

1 2 3 4 5 6 7 X . . . . (130) push against you until put down?

While sitting in your lap:

1 2 3 4 5 6 7 X . . . . (131) how often did your baby seem to enjoy her/himself?

1 2 3 4 5 6 7 X . . . . (132) how often would the baby not be content without moving around?

How often did your baby notice:

1 2 3 4 5 6 7 X . . . . (133) low-pitched noises, air conditioner, heating system, or refrigerator running or starting up?

1 2 3 4 5 6 7 X . . . . (134) sirens from fire trucks or ambulances at a distance?

1 2 3 4 5 6 7 X . . . . (135) a change in room temperature?

1 2 3 4 5 6 7 X . . . . (136) a change in light when a cloud passed over the sun?

1 2 3 4 5 6 7 X . . . . (137) sound of an airplane passing overhead?

1 2 3 4 5 6 7 X . . . . (138) a bird or a squirrel up in a tree?

1 2 3 4 5 6 7 X . . . . (139) fabrics with scratchy texture (e.g., wool)?

When tired, how often was your baby:

1 2 3 4 5 6 7 X . . . . (140) likely to cry?

1 2 3 4 5 6 7 X . . . . (141) show distress?

At the end of an exciting day, how often did your baby:

1 2 3 4 5 6 7 X . . . . (142) become tearful?

1 2 3 4 5 6 7 X . . . . (143) show distress?

For no apparent reason, how often did your baby:

1 2 3 4 5 6 7 X . . . . (144) appear sad?

1 2 3 4 5 6 7 X . . . . (145) seem unresponsive?

How often did your baby make talking sounds when:

1 2 3 4 5 6 7 X . . . . (146) riding in a car?

1 2 3 4 5 6 7 X . . . . (147) riding in a shopping cart?

1 2 3 4 5 6 7 X . . . . (148) you talked to her/him?

Two Week Time Span

When you returned from having been away and the baby was awake, how often did s/he:

1 2 3 4 5 6 7 X . . . . (149) smile or laugh?

When introduced to an unfamiliar adult, how often did the baby:

1 2 3 4 5 6 7 X . . . . (150) cling to a parent?

1 2 3 4 5 6 7 X . . . . (151) refuse to go to the unfamiliar person?

1 2 3 4 5 6 7 X . . . . (152) hang back from the adult?

1 2 3 4 5 6 7 X . . . . (153) never “warm up” to the unfamiliar adult?

When in the presence of several unfamiliar adults, how often did the baby:

1 2 3 4 5 6 7 X . . . . (154) cling to a parent?

1 2 3 4 5 6 7 X . . . . (155) cry?

1 2 3 4 5 6 7 X . . . . (156) continue to be upset for 10 minutes or longer?

When visiting a new place, how often did the baby:

1 2 3 4 5 6 7 X . . . . (157) show distress for the first few minutes?

1 2 3 4 5 6 7 X . . . . (158) continue to be upset for 10 minutes or more?

1 2 3 4 5 6 7 X . . . . (159) get excited about exploring new surroundings?

1 2 3 4 5 6 7 X . . . . (160) move about actively when s/he is exploring new surroundings?

When your baby was approached by an unfamiliar person when you and s/he were out (for example, shopping), how often did the baby:

1 2 3 4 5 6 7 X . . . . (161) show distress?

1 2 3 4 5 6 7 X . . . . (162) cry?

When an unfamiliar adult came to your home or apartment, how often did your baby:

1 2 3 4 5 6 7 X . . . . (163) allow her/himself to be picked up without protest?

1 2 3 4 5 6 7 X . . . . (164) cry when the visitor attempted to pick her/him up?

When in a crowd of people, how often did the baby:

1 2 3 4 5 6 7 X . . . . (165) seem to enjoy him/herself?

Did the baby seem sad when:

1 2 3 4 5 6 7 X . . . . (166) caregiver is gone for an unusually long period of time?

1 2 3 4 5 6 7 X . . . . (167) left alone/unattended in a crib or a playpen for an extended period of time?

When you were busy with another activity, and your baby was not able to get your attention, how often did s/he:

1 2 3 4 5 6 7 X . . . . (168) become sad?

1 2 3 4 5 6 7 X . . . . (169) cry?

When your baby saw another baby crying, how often did s/he:

1 2 3 4 5 6 7 X . . . . (170) become tearful?

1 2 3 4 5 6 7 X . . . . (171) show distress?

When familiar relatives/friends came to visit, how often did your baby:

1 2 3 4 5 6 7 X . . . . (172) get excited?

1 2 3 4 5 6 7 X . . . . (173) seem indifferent?

Soothing Techniques

Have you tried any of the following soothing techniques in the last two weeks? If so, how quickly did your baby soothe using each of these techniques? Circle (X) if you did not try the technique during the LAST TWO WEEKS.

When rocking your baby, how often did s/he:

1 2 3 4 5 6 7 X . . . . (174) soothe immediately?

1 2 3 4 5 6 7 X . . . . (175) not soothe immediately, but in the first two minutes?

1 2 3 4 5 6 7 X . . . . (176) take more than 10 minutes to soothe?

When singing or talking to your baby, how often did s/he:

1 2 3 4 5 6 7 X . . . . (177) soothe immediately?

1 2 3 4 5 6 7 X . . . . (178) not soothe immediately, but in the first two minutes?

1 2 3 4 5 6 7 X . . . . (179) take more than 10 minutes to soothe?

When walking with the baby, how often did s/he:

1 2 3 4 5 6 7 X . . . . (180) soothe immediately?

1 2 3 4 5 6 7 X . . . . (181) not soothe immediately, but in the first two minutes?

1 2 3 4 5 6 7 X . . . . (182) take more than 10 minutes to soothe?

When giving him/her a toy, how often did the baby:

1 2 3 4 5 6 7 X . . . . (183) soothe immediately?

1 2 3 4 5 6 7 X . . . . (184) not soothe immediately, but in the first two minutes?

1 2 3 4 5 6 7 X . . . . (185) take more than 10 minutes to soothe?

When showing the baby something to look at, how often did s/he:

1 2 3 4 5 6 7 X . . . . (186) soothe immediately?

1 2 3 4 5 6 7 X . . . . (187) not soothe immediately, but in the first two minutes?

1 2 3 4 5 6 7 X . . . . (188) take more than 10 minutes to soothe?

When patting or gently rubbing some part of the baby's body, how often did s/he:

1 2 3 4 5 6 7 X . . . . (189) soothe immediately?

1 2 3 4 5 6 7 X . . . . (190) not soothe immediately, but in the first two minutes?

1 2 3 4 5 6 7 X . . . . (191) take more than 10 minutes to soothe?

Scoring Procedure

INFANT BEHAVIOR QUESTIONNAIRE - REVISED

Scale scores for the Infant Behavior Questionnaire - Revised represent the mean score of all scale items applicable to the child, as judged by the caregiver. Scales' scores are to be computed by the following method:

1. Sum all numerical item responses for a given scale. Note that:

   a) If caregiver omitted an item, that item receives no numerical score;

   b) If caregiver checked the "does not apply" response option for an item, that item receives no numerical score;

   c) Items indicated with an R are reverse items and must be scored in the following way:

7 becomes 1	3 becomes 5
6 becomes 2	2 becomes 6
5 becomes 3	1 becomes 7
4 remains 4	

2. Divide the total by the number of items receiving a numerical response. Do not include items marked "does not apply (N/A)" or items receiving no response in determining the number of items.

   For example, given a sum of 47 for a scale of 12 items, with one item receiving no response, two items marked "does not apply," and 9 items receiving a numerical response, the sum of 47 would be divided by 9 to yield a mean of 5.22 for the scale score.

Maria A. Gartstein, Ph.D.

Infant Behavior Questionnaire - Revised:

Items by Scale

(May 24, 2000)

I. Activity Level (15 items; .82, .70, .78*)

Definition: Baby's gross motor activity, including movement of arms and legs, squirming, and locomotor activity.

Feeding:	During feeding, how often did the baby:
1R	lie or sit quietly?
2	squirm or kick?
3	wave arms?

Sleeping:	During sleep, how often did the baby:
12	toss about in the crib?
13	move from the middle to the end of the crib?
14R	sleep in one position only?

Bathing and	When being dressed or undressed during the last week,
Dressing:	how often did the baby:
32	wave his/her arms and kick?
33	squirm and/or try to roll away?

When put into the bath water, how often did the baby:

38 splash or kick?

39 turn body and/or squirm?

Daily Activities: When placed on his/her back, how often did the baby:

111 wave arms and kick?

112 squirm and/or turn body?

When placed in an infant seat or car seat, how often did the baby:

115 wave arms and kick?

116 squirm and turn body?

117R lie or sit quietly?

* Cronbach's alphas for 3-6, 6-9, and 9-12 months of age groups.

VI. High Pleasure (11 items; .77, .76, .80)

Definition: Amount of pleasure or enjoyment related to high stimulus intensity, rate, complexity, novelty, and incongruity.

Two Week Time Span

Play: How often during the last week did the baby:

58 smile or laugh when tickled?

How often during the last week did your baby enjoy:

65 being tickled by you or someone else in your family?

66 being involved in rambunctious play?

67 watching while you, or another adult, playfully made faces?

When tossed around playfully how often did the baby:

77 smile?

78 laugh?

During a peekaboo game, how often did the baby:

79 smile?

80 laugh?

How often did your baby enjoy bouncing up and down:

81 while on your lap?

82 on an object, such as a bed, bouncer chair, or toy?

When in a crowd of people, how often did the baby:

165 seem to enjoy him/herself?

XIV. Vocal Reactivity (12 items; .82, .73, .78)

Definition: amount of vocalization exhibited by the baby in daily activities.

Feeding: How often did your baby make talking sounds:

8 while waiting in a high chair for food?

9 when s/he was ready for more food?

10 when s/he has had enough food?

Bathing and Dressing:	When being dressed or undressed during the last week, how often did the baby:
35	coo or vocalize?
	When face was washed, how often did the baby:
42	coo?
	When hair was washed, how often did the baby:
45	vocalize?
Play:	How often during the last week did the baby:
52	repeat the same sounds over and over again?
Daily Activities:	How often during the last week did the baby:
102	squeal or shout when excited?
103	imitate the sounds you made?
	How often did your baby make talking sounds when:
146	riding in a car?
147	riding in a shopping cart?
148	you talked to him/her?

Appendix 2. Early Childhood Behavior Questionnaire

Early Childhood Behavior Questionnaire

Child's name: _____ Child's birthdate: Mo:____ Day:____ Yr:____

Today's date: Month:____ Day:____ Yr:____ Child's age: _____Yrs, _____Months

Relation to child: _____ Sex of child (circle one): Male Female

INSTRUCTIONS: **Please read carefully before starting**.

As you read each description of the child's behavior below, please indicate how often the child did this during the last two weeks by circling one of the numbers in the right column. These numbers indicate how often you observed the behavior described during the last two weeks.

		less	about	more			
	very	than half	half	than half	almost		does not
never	rarely	the time	the time	the time	always	always	apply
1	2	3	4	5	6	7	NA

The "Does Not Apply" column (NA) is used when you did not see the child in the situation described during the last two weeks. For example, if the situation mentions the child going to the doctor and there was no time during the last two weeks when the child went to the doctor, circle the (NA) column. "Does Not Apply" (NA) is different from "NEVER" (1). "Never" is used when you saw the child in the situation but the child never engaged in the behavior mentioned in the last two weeks. Please be sure to circle a number or NA for every item.

When told that it was time for bed or a nap, how often did your child

1.	react with anger?	1	2	3	4	5	6	7 NA
2.	get irritable?	1	2	3	4	5	6	7 NA

When approached by an unfamiliar person in a public place (for example, the grocery store), how often did your child

3.	remain calm?	1	2	3	4	5	6	7 NA
4.	pull back and avoid the person?	1	2	3	4	5	6	7 NA
5.	cling to a parent?	1	2	3	4	5	6	7 NA

During everyday activities, how often did your child

6.	startle at loud noises (such as a fire engine siren)?	1	2	3	4	5	6	7 NA
7.	tap or drum with fingers on tables or other objects?	1	2	3	4	5	6	7 NA
8.	get irritated by scratchy sounds?	1	2	3	4	5	6	7 NA
9.	become uncomfortable when his/her socks were not aligned properly on his/her feet?	1	2	3	4	5	6	7 NA

After getting a bump or scrape, how often did your child

10.	forget about it in a few minutes?	1	2	3	4	5	6	7 NA

While playing outdoors, how often did your child

11.	like making lots of noise?	1	2	3	4	5	6	7 NA
12.	enjoy sitting quietly in the sunshine?	1	2	3	4	5	6	7 NA
13.	want to climb to high places (for example, up a tree or on the jungle gym)?	1	2	3	4	5	6	7 NA

When s/he was carried, how often did your child

14.	like to be held?	1	2	3	4	5	6	7 NA
15.	push against you until put down?	1	2	3	4	5	6	7 NA
16.	squirm?	1	2	3	4	5	6	7 NA
17.	struggle to get away?	1	2	3	4	5	6	7 NA
18.	snuggle up next to you?	1	2	3	4	5	6	7 NA

While having trouble completing a task (e.g., building, drawing, dressing), how often did your child

19. get easily irritated?	1	2	3	4	5	6	7 NA
20. become sad?	1	2	3	4	5	6	7 NA

When a familiar child came to your home, how often did your child

21. engage in an activity with the child?	1	2	3	4	5	6	7 NA
22. seek out the company of the child?	1	2	3	4	5	6	7 NA

When offered a choice of activities, how often did your child

23. stop and think before deciding?	1	2	3	4	5	6	7 NA
24. decide what to do very quickly and go after it?	1	2	3	4	5	6	7 NA
25. seem slow and unhurried about what to do next?	1	2	3	4	5	6	7 NA

When asked NOT to, how often did your child

26. run around your house or apartment anyway?	1	2	3	4	5	6	7 NA
27. touch an attractive item (such as an ornament) anyway?	1	2	3	4	5	6	7 NA
28. play with something anyway?	1	2	3	4	5	6	7 NA

During daily or evening quiet time with you and your child, how often did your child

29. enjoy just being quietly sung to?	1	2	3	4	5	6	7 NA
30. smile at the sound of words, as in nursery rhymes?	1	2	3	4	5	6	7 NA
31. enjoy just being talked to?	1	2	3	4	5	6	7 NA
32. enjoy rhythmic activities, such as rocking or swaying?	1	2	3	4	5	6	7 NA

During everyday activities, how often did your child

33. become distressed when his/her hands were dirty and/or sticky?	1	2	3	4	5	6	7 NA
34. notice that material was very soft (cotton) or rough (wool)?	1	2	3	4	5	6	7 NA
35. notice low-pitched noises such as the air-conditioner, heater, or refrigerator running or starting up?	1	2	3	4	5	6	7 NA
36. blink a lot?	1	2	3	4	5	6	7 NA
37. get very enthusiastic about the things s/he was going to do?	1	2	3	4	5	6	7 NA

While at home, how often did your child

38. show fear at a loud sound (blender, vacuum cleaner, etc.)?	1	2	3	4	5	6	7 NA
39. seem afraid of the dark?	1	2	3	4	5	6	7 NA

When visiting the home of a familiar adult, such as a relative or friend, how often did your child

40. want to interact with the adult?	1	2	3	4	5	6	7 NA

While bathing, how often did your child

41. sit quietly?	1	2	3	4	5	6	7 NA
42. splash, kick, or try to jump?	1	2	3	4	5	6	7 NA

While playing outdoors, how often did your child

43. look immediately when you pointed at something?	1	2	3	4	5	6	7 NA
44. choose to take chances for the fun and excitement of it?	1	2	3	4	5	6	7 NA
45. not like going down high slides at the amusement park or playground?	1	2	3	4	5	6	7 NA

When s/he was upset, how often did your child

46. change to feeling better within a few minutes?	1	2	3	4	5	6	7 NA
47. soothe only with difficulty?	1	2	3	4	5	6	7 NA
48. stay upset for 10 minutes or longer?	1	2	3	4	5	6	7 NA

When engaged in play with his/her favorite toy, how often did your child

49. play for 5 minutes or less?	1	2	3	4	5	6	7 NA
50. play for more than 10 minutes?	1	2	3	4	5	6	7 NA
51. continue to play while at the same time responding to your remarks or questions?	1	2	3	4	5	6	7 NA

When approaching unfamiliar children playing, how often did your child

52. watch rather than join?	1	2	3	4	5	6	7 NA
53. approach slowly?	1	2	3	4	5	6	7 NA
54. seem uncomfortable?	1	2	3	4	5	6	7 NA

During everyday activities, how often did your child

55. complain about odors on others, such as perfume?	1	2	3	4	5	6	7 NA
56. seem to be bothered by bright light?	1	2	3	4	5	6	7 NA
57. move quickly from one place to another?	1	2	3	4	5	6	7 NA
58. notice the smoothness or roughness of objects s/he touched?	1	2	3	4	5	6	7 NA
59. become sad or blue for no apparent reason?	1	2	3	4	5	6	7 NA

After having been interrupted, how often did your child

60. return to a previous activity?	1	2	3	4	5	6	7 NA
61. have difficulty returning to the previous activity?	1	2	3	4	5	6	7 NA

While watching TV or hearing a story, how often did your child

62. seem frightened by 'monster' characters?	1	2	3	4	5	6	7 NA

When you suggested an outdoor activity that s/he really likes, how often did your child

63. respond immediately?	1	2	3	4	5	6	7 NA
64. run to the door before getting ready?	1	2	3	4	5	6	7 NA

When told that loved adults would visit, how often did your child

65. get very excited?	1	2	3	4	5	6	7 NA
66. become very happy?	1	2	3	4	5	6	7 NA

When taking a quiet, warm bath, how often did your child

67. seem to relax and enjoy him/herself?	1	2	3	4	5	6	7 NA

When s/he couldn't find something to play with, how often did your child

68. get angry?	1	2	3	4	5	6	7 NA

During sleep, how often did your child

69. toss about in the bed?	1	2	3	4	5	6	7 NA
70. sleep in one position only?	1	2	3	4	5	6	7 NA

During quiet activities, such as reading a story, how often did your child

71. swing or tap his/her foot?	1	2	3	4	5	6	7 NA
72. fiddle with his/her hair, clothing, etc.?	1	2	3	4	5	6	7 NA
73. show repeated movements like squinting, hunching up the shoulders, or twitching the facial muscles?	1	2	3	4	5	6	7 NA

While playing indoors, how often did your child

74. like rough and rowdy games?	1	2	3	4	5	6	7 NA
75. enjoy playing boisterous games like 'chase'?	1	2	3	4	5	6	7 NA
76. enjoy vigorously jumping on the couch or bed?	1	2	3	4	5	6	7 NA

In situations where s/he is meeting new people, how often did your child

77. turn away?	1	2	3	4	5	6	7 NA
78. become quiet?	1	2	3	4	5	6	7 NA
79. seem comfortable?	1	2	3	4	5	6	7 NA

When being gently rocked or hugged, how often did your child

80. seem eager to get away?	1	2	3	4	5	6	7 NA
81. make protesting noises?	1	2	3	4	5	6	7 NA

When encountering a new activity, how often did your child

82. sit on the sidelines and observe before joining in?	1	2	3	4	5	6	7 NA
83. get involved immediately?	1	2	3	4	5	6	7 NA

When visiting the home of a familiar child, how often did your child

84. engage in an activity with the child?	1	2	3	4	5	6	7 NA
85. seek out the company of the child?	1	2	3	4	5	6	7 NA

When another child took away his/her favorite toy, how often did your child

86. scream with anger?	1	2	3	4	5	6	7 NA
87. not become angry?	1	2	3	4	5	6	7 NA
88. sadly cry?	1	2	3	4	5	6	7 NA
89. not react with sadness?	1	2	3	4	5	6	7 NA

When engaged in an activity requiring attention, such as building with blocks, how often did your child

90. move quickly to another activity?	1	2	3	4	5	6	7 NA
91. stay involved for 10 minutes or more?	1	2	3	4	5	6	7 NA
92. tire of the activity relatively quickly?	1	2	3	4	5	6	7 NA

During everyday activities, how often did your child

93. pay attention to you right away when you called to him/her?	1	2	3	4	5	6	7 NA
94. seem to be disturbed by loud sounds?	1	2	3	4	5	6	7 NA
95. stop going after a forbidden object (such as a VCR) when you used a toy to distract her/him?	1	2	3	4	5	6	7 NA
96. notice small things, such as dirt or a stain, on his/her clothes?	1	2	3	4	5	6	7 NA

While in a public place, how often did your child

97. seem uneasy about approaching an elevator or escalator?	1	2	3	4	5	6	7 NA
98. cry or show distress when approached by an unfamiliar animal?	1	2	3	4	5	6	7 NA
99. seem afraid of large, noisy vehicles?	1	2	3	4	5	6	7 NA
100. show fear when the caregiver stepped out of sight?	1	2	3	4	5	6	7 NA

When playing outdoors with other children, how often did your child

101. seem to be one of the most active children?	1	2	3	4	5	6	7 NA
102. sit quietly and watch?	1	2	3	4	5	6	7 NA

During daily or evening quiet time with you and your child, how often did your child

103. want to be cuddled?	1	2	3	4	5	6	7 NA

During everyday activities, how often did your child

104. seem frightened for no apparent reason?	1	2	3	4	5	6	7 NA
105. seem to be irritated by tags in his/her clothes?	1	2	3	4	5	6	7 NA
106. notice when you were wearing new clothing?	1	2	3	4	5	6	7 NA
107. react to beeping sounds (such as when the microwave or oven is done cooking)?	1	2	3	4	5	6	7 NA
108. show repeated movements like squinting, hunching up the shoulders, or twitching the facial muscles?	1	2	3	4	5	6	7 NA

When being dressed or undressed, how often did your child

109. squirm and try to get away?	1	2	3	4	5	6	7 NA
110. stay still?	1	2	3	4	5	6	7 NA

When told "no", how often did your child

111. stop an activity quickly?	1	2	3	4	5	6	7 NA

112. stop the forbidden activity?	1	2	3	4	5	6	7	NA
113. ignore your warning?	1	2	3	4	5	6	7	NA
114. become sadly tearful?	1	2	3	4	5	6	7	NA

Following an exciting activity or event, how often did your child

115. calm down quickly?	1	2	3	4	5	6	7	NA
116. have a hard time settling down?	1	2	3	4	5	6	7	NA
117. seem to feel down or blue?	1	2	3	4	5	6	7	NA
118. become sadly tearful?	1	2	3	4	5	6	7	NA

When given something to eat that s/he didn't like, how often did your child

119. become angry?	1	2	3	4	5	6	7	NA

During everyday activities, how often did your child seem able to

120. easily shift attention from one activity to another?	1	2	3	4	5	6	7	NA
121. do more than one thing at a time (such as playing with a toy while watching TV)?	1	2	3	4	5	6	7	NA

While playing indoors, how often did your child

122. run through the house?	1	2	3	4	5	6	7	NA
123. climb over furniture?	1	2	3	4	5	6	7	NA
124. not care for rough and rowdy games?	1	2	3	4	5	6	7	NA
125. enjoy activities such as being spun, etc.?	1	2	3	4	5	6	7	NA

When playing alone, how often did your child

126. become easily distracted?	1	2	3	4	5	6	7	NA
127. play with a set of objects for 5 minutes or longer at a time?	1	2	3	4	5	6	7	NA
128. scratch him/herself?	1	2	3	4	5	6	7	NA
129. tear materials close at hand?	1	2	3	4	5	6	7	NA

Before an exciting event (such as receiving a new toy), how often did your child

130. get so worked up that s/he had trouble sitting still?	1	2	3	4	5	6	7	NA
131. get very excited about getting it?	1	2	3	4	5	6	7	NA
132. remain pretty calm?	1	2	3	4	5	6	7	NA
133. seem eager to have it right away?	1	2	3	4	5	6	7	NA

When s/he asked for something and you said "no", how often did your child

134. become frustrated?	1	2	3	4	5	6	7	NA
135. protest with anger?	1	2	3	4	5	6	7	NA
136. have a temper tantrum?	1	2	3	4	5	6	7	NA
137. become sad?	1	2	3	4	5	6	7	NA

While playing or walking outdoors, how often did your child

138. notice sights or sounds (for example, wind chimes or water sprinklers)?				1	2	3	4	5	6	7 NA
139. notice flying or crawling insects?	1	2	3	4	5	6	7	NA		

When you gave your child an attractive toy, how often did your child

140. grab the object as soon as it was set down?	1	2	3	4	5	6	7	NA
141. look the object over before touching it?	1	2	3	4	5	6	7	NA

When asked to wait for a desirable item (such as ice cream), how often did your child

142. seem unable to wait for as long as 1 minute?	1	2	3	4	5	6	7	NA
143. go after it anyway?	1	2	3	4	5	6	7	NA
144. wait patiently?	1	2	3	4	5	6	7	NA
145. whimper and cry?	1	2	3	4	5	6	7	NA

When being gently rocked, how often did your child

146. smile?	1	2	3	4	5	6	7	NA
147. make sounds of pleasure?	1	2	3	4	5	6	7	NA

While visiting relatives or adult family friends s/he sees infrequently, how often did your child

148. stay back and avoid eye contact?	1	2	3	4	5	6	7	NA
149. hide his/her face?	1	2	3	4	5	6	7	NA
150. "warm up" to the person within a few minutes?	1	2	3	4	5	6	7	NA

When you removed something s/he should not have been playing with, how often did your child

151. become sad?	1	2	3	4	5	6	7	NA

During everyday activities, how often did your child

152. become bothered by sounds while in noisy environments?	1	2	3	4	5	6	7	NA
153. become bothered by scratchy materials like wool?	1	2	3	4	5	6	7	NA
154. notice changes in your appearance (such as wet hair, a hat, or jewelry)?	1	2	3	4	5	6	7	NA
155. appear to listen to even very quiet sounds?	1	2	3	4	5	6	7	NA
156. seem full of energy, even in the evening?	1	2	3	4	5	6	7	NA

When interrupted during a favorite TV show, how often did your child

157. immediately return to watching the TV program?	1	2	3	4	5	6	7	NA
158. <u>not</u> finish watching the program?	1	2	3	4	5	6	7	NA

While being held on your lap, how often did your child

159. pull away and kick?	1	2	3	4	5	6	7	NA
160. seem to enjoy him/herself?	1	2	3	4	5	6	7	NA
161. mold to your body?	1	2	3	4	5	6	7	NA

162. seek hugs and kisses?	1	2	3	4	5	6	7	NA

While a story was being read to your child, how often did s/he

163. enjoy listening to the story?	1	2	3	4	5	6	7	NA

When hearing about a future family outing (such as a trip to the playground), how often did your child

164. become very enthusiastic?	1	2	3	4	5	6	7	NA
165. look forward to it?	1	2	3	4	5	6	7	NA
166. remain pretty calm?	1	2	3	4	5	6	7	NA

While looking at picture books on his/her own, how often did your child

167. stay interested in the book for 5 minutes or less?	1	2	3	4	5	6	7	NA
168. stay interested in the book for more than 10 minutes at a time?	1	2	3	4	5	6	7	NA
169. become easily distracted?	1	2	3	4	5	6	7	NA
170. enjoy looking at the books?	1	2	3	4	5	6	7	NA

When tired after a long day of activities, how often did your child

171. become easily frustrated?	1	2	3	4	5	6	7	NA

When a familiar adult, such as a relative or friend, visited your home, how often did your child

172. want to interact with the adult?	1	2	3	4	5	6	7	NA

When asked to do so, how often was your child able to

173. stop an ongoing activity?	1	2	3	4	5	6	7	NA
174. lower his or her voice?	1	2	3	4	5	6	7	NA
175. be careful with something breakable?	1	2	3	4	5	6	7	NA

When visiting a new place, how often did your child

176. not want to enter?	1	2	3	4	5	6	7	NA
177. go right in?	1	2	3	4	5	6	7	NA

While you were showing your child how to do something, how often did your child

178. jump into the task before it was fully explained?	1	2	3	4	5	6	7	NA

While you were talking with someone else, how often did your child

179. easily switch attention from speaker to speaker?	1	2	3	4	5	6	7	NA

During everyday activities, how often did your child

180. become irritated when his/her clothes were tight?	1	2	3	4	5	6	7 NA
181. notice smells from cooking?	1	2	3	4	5	6	7 NA
182. rock back and forth while sitting?	1	2	3	4	5	6	7 NA
183. notice sirens from fire trucks or ambulances at a distance?	1	2	3	4	5	6	7 NA

When you mildly criticized or corrected her/his behavior, how often did your child

184. get mad?	1	2	3	4	5	6	7 NA
185. have hurt feelings?	1	2	3	4	5	6	7 NA

When s/he was upset, how often did your child

186. cry for more than 3 minutes, even when being comforted?	1	2	3	4	5	6	7 NA
187. cheer up within a minute or two when being comforted?	1	2	3	4	5	6	7 NA
188. become easily soothed?	1	2	3	4	5	6	7 NA

When you were busy, how often did your child

189. find another activity to do when asked?	1	2	3	4	5	6	7 NA

While playing outdoors, how often did your child

190. want to jump from heights?	1	2	3	4	5	6	7 NA
191. want to go down the slide in unusual ways (for example, head first)?	1	2	3	4	5	6	7 NA
192. enjoy being pushed fast on a wheeled vehicle?	1	2	3	4	5	6	7 NA
193. enjoy sitting down and playing quietly?	1	2	3	4	5	6	7 NA

When playing alone, how often did your child

194. chew his/her lower lip?	1	2	3	4	5	6	7 NA
195. stick out his/her tongue when concentrating?	1	2	3	4	5	6	7 NA
196. move from one task or activity to another without completing any?	1	2	3	4	5	6	7 NA
197. have trouble focusing on a task without guidance?	1	2	3	4	5	6	7 NA

When given a wrapped present, how often did your child

198. become extremely animated?	1	2	3	4	5	6	7 NA

When around large gatherings of familiar adults or children, how often did your child

199. want to be involved in a group activity?	1	2	3	4	5	6	7 NA
200. enjoy playing with a number of different people?	1	2	3	4	5	6	7 NA

When s/he was asked to share his/her toys, how often did your child

201. become sad?	1	2	3	4	5	6	7 NA

Scoring Procedure

Early Childhood Behavior Questionnaire (ECBQ)

Scale scores for the eighteen dimensions represent the mean score of all scale items applicable to the child, as judged by the caregiver. If a caregiver omitted an item, or if the caregiver checked the "Does not apply" response option for an item, the item receives no numerical score and is not factored into the scale score.

Scores are to be computed by the following method:

1) Items indicated with an R on the items-by-scale list below are reverse-scored. Before using them to calculate the scale score, they must be reversed. This is done by subtracting the numerical response given by the caregiver from 8. Thus, a caregiver response of 7 becomes 1, 6 becomes 2, 5 becomes 3, 4 remains 4, 3 becomes 5, 2 becomes 6, and 1 becomes 7.

2) Sum the scores for items receiving a numerical response (do not include items marked "does not apply" or items receiving no response). For example, given a sum of 50 for a scale of 12 items, with one item receiving no response, two items marked "does not apply," and 9 items receiving a numerical response, the sum of 50 would be divided by 9 to yield a mean of 5.56 for the scale score.

Scales included in factor Surgency:

Activity Level/Energy (12 items)

Level (rate and intensity) of gross motor activity, including rate and extent of locomotion.

While bathing, how often did your child

41.R sit quietly?

42. splash, kick, or try to jump?

While participating in daily activities, how often did your child

57. move quickly from one place to another?

156. seem full of energy, even in the evening?

During sleep, how often did your child

69. toss about in the bed?

70.R sleep in one position only?

When playing outdoors with other children, how often did your child

101. seem to be one of the most active children?

102.R sit quietly and watch?

When being dressed or undressed, how often did your child

109. squirm and try to get away?

110.R stay still?

While playing indoors, how often did your child

122. run through the house?

123. climb over furniture?

High Intensity Pleasure (12 items)

Pleasure or enjoyment related to situations involving high stimulus intensity, rate, complexity, novelty and incongruity.

While playing outdoors, how often did your child

11. like making lots of noise?

13. want to climb to high places (for example, up a tree or on the jungle gym)?

44. choose to take chances for the fun and excitement of it?

45.R not like going down high slides at the amusement park or playground?

190. want to jump from heights?

want to go down the slide in unusual ways (for example, head first)?

enjoy being pushed fast on a wheeled vehicle?

While playing indoors, how often did s/he:

like rough and rowdy games?

75. enjoy playing boisterous games like ‘chase’?

76. enjoy vigorously jumping on the couch or bed?

124.R not care for rough and rowdy games?

125. enjoy activities such as being spun, etc.?

Impulsivity (10 items)

Speed of response initiation.

When offered a choice of activities, how often did your child

23.R stop and think before deciding?

24. decide what to do very quickly and go after it?

25.R seem slow and unhurried about what to do next?

When you suggested an outdoor activity that s/he really likes, how often did your child

63. respond immediately?

64. run to the door before getting ready?

When encountering a new activity, how often did your child

82.R sit on the sidelines and observe before joining in?

83. get involved immediately?

When you gave your child an attractive toy, how often did your child

140. grab the object as soon as it was set down?

141.R look the object over before touching it?

While you were showing your child how to do something, how often did your child

178. jump into the task before it was fully explained?

Positive Anticipation (11 items)

Excitement about expected pleasurable activities.

During everyday activities, how often did your child

37. get very enthusiastic about the things s/he was going to do?

When told that loved adults would visit, how often did your child

65. get very excited?

66. become very happy?

Before an exciting event (such as receiving a new toy), how often did your child

130. get so worked up that s/he had trouble sitting still?

131. get very excited about getting it?

132.R remain pretty calm?

133. seem eager to have it right away?

When hearing about a future family outing (such as a trip to the playground), how often did your child

164. become very enthusiastic?

165. look forward to it?

166.R remain pretty calm?

When given a wrapped present, how often did your child

198. become extremely animated?

Sociability (8 items)

Seeking and taking pleasure in interactions with others.

When a familiar child came to your home, how often did your child

21. engage in an activity with the child?

22. seek out the company of the child?

When visiting the home of a familiar adult, such as a relative or friend, how often did your child

40. want to interact with the adult?

When visiting the home of a familiar child, how often did your child

84. engage in an activity with the child?

85. seek out the company of the child?

When a familiar adult, such as a relative or friend, visited your home, how often did your child

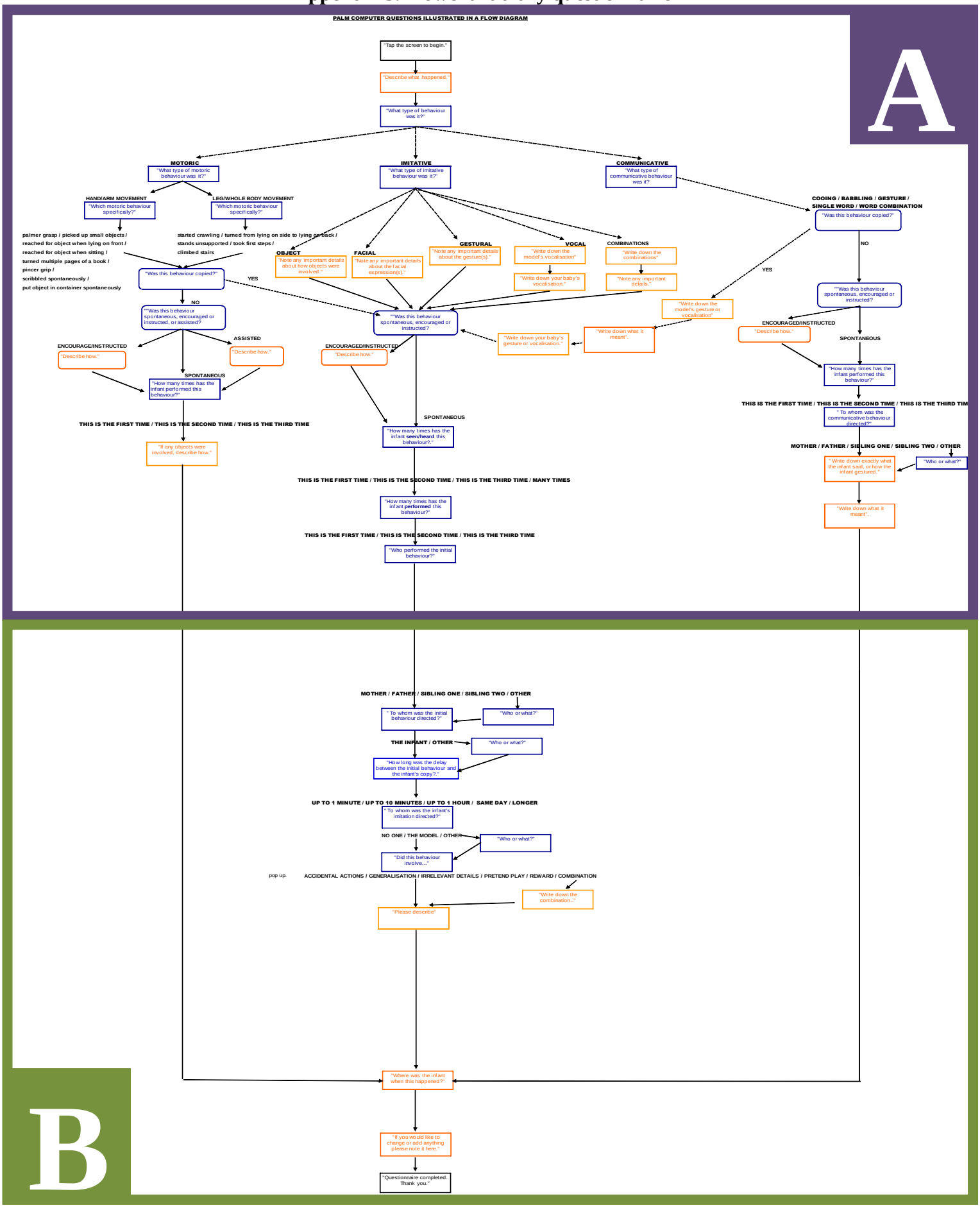
172. want to interact with the adult?

When around large gatherings of familiar adults or children, how often did your child

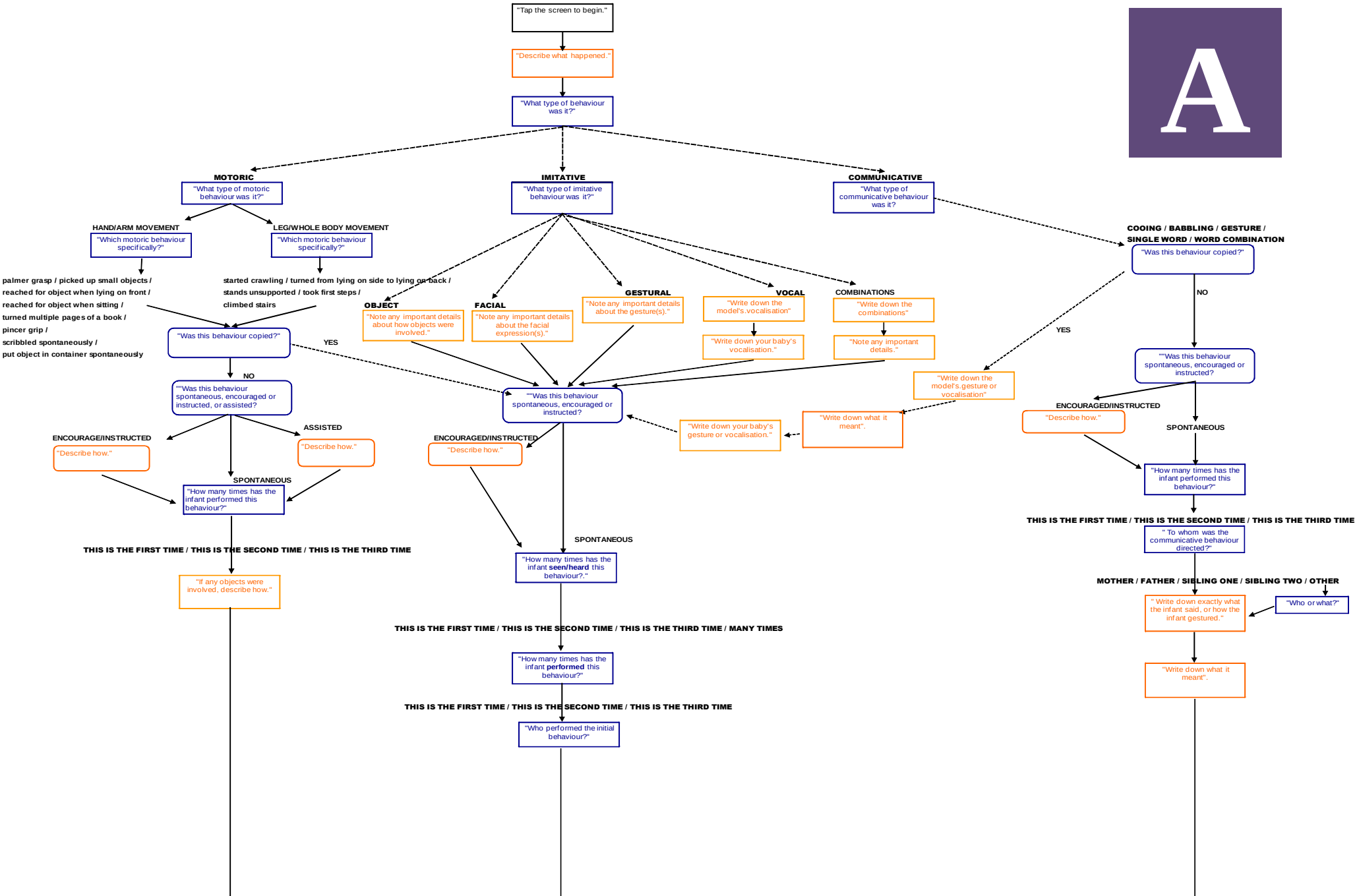
199. want to be involved in a group activity?

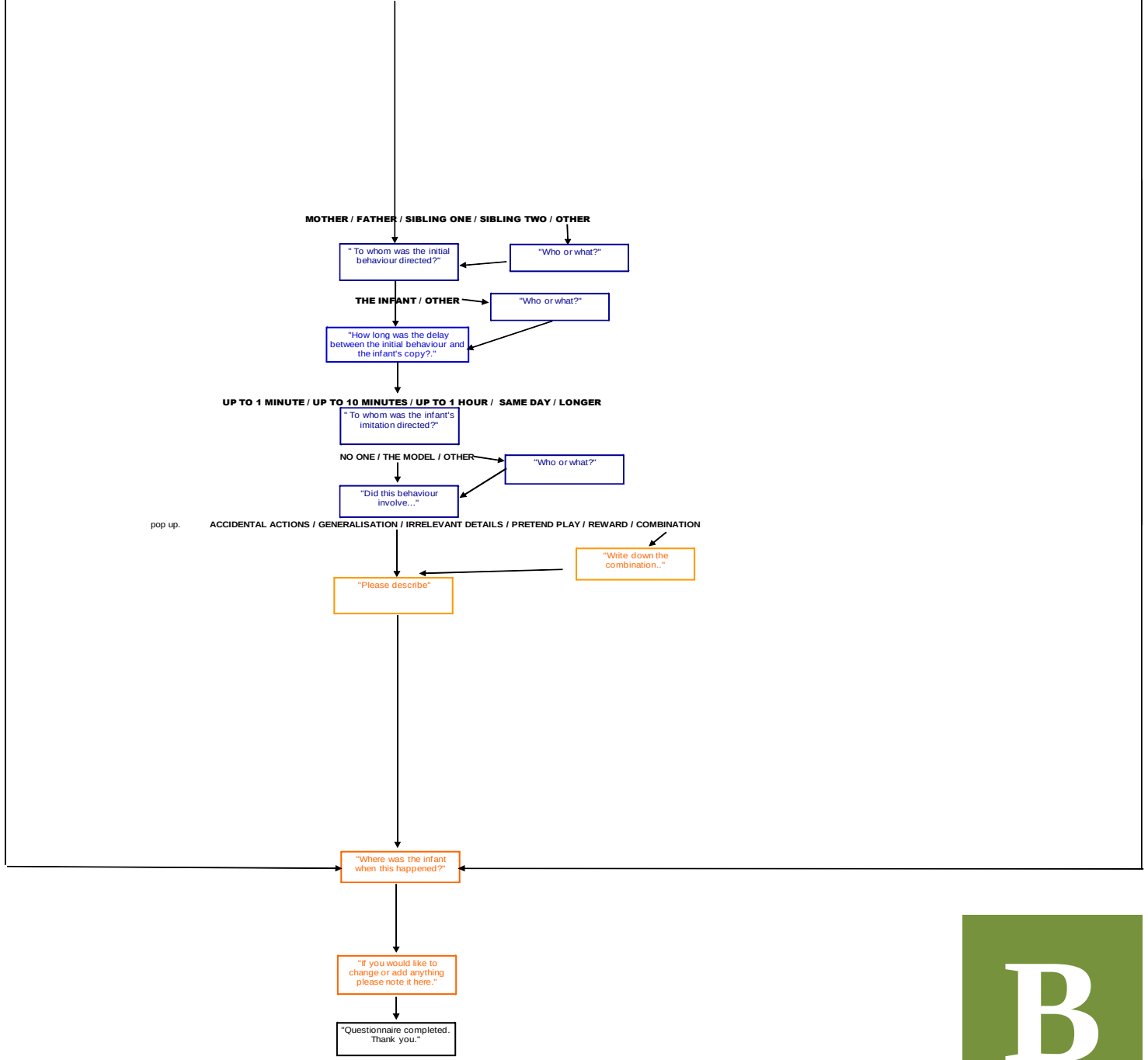
enjoy playing with a number of different people?

Appendix 3. Flowchart diary questionnaire



PALM COMPUTER QUESTIONS ILLUSTRATED IN A FLOW DIAGRAM

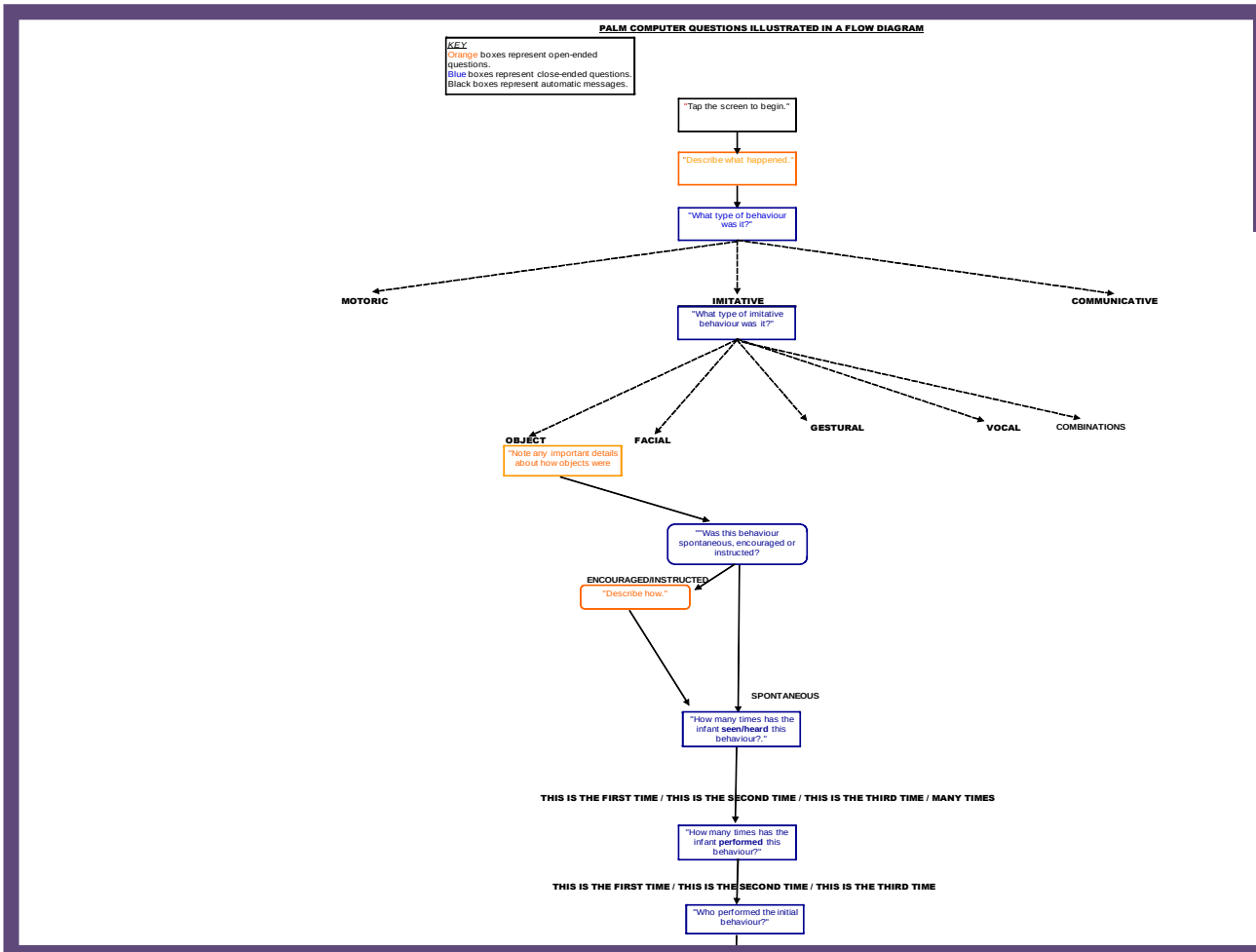



MOTHER / FATHER / SIBLING ONE / SIBLING TWO / OTHER
" To whom was the initial behaviour directed?"
"Who or what?"
THE INFANT / OTHER
"Who or what?"
"How long was the delay between the initial behaviour and the infant's copy?."
UP TO 1 MINUTE / UP TO 10 MINUTES / UP TO 1 HOUR / SAME DAY / LONGER
" To whom was the infant's imitation directed?"
NO ONE / THE MODEL / OTHER
"Who or what?"
"Did this behaviour involve..."
pop up.
ACCIDENTAL ACTIONS / GENERALISATION / IRRELEVANT DETAILS / PRETEND PLAY / REWARD / COMBINATION
"Write down the combination.."
"Please describe"
"Where was the infant when this happened?"
"If you would like to change or add anything please note it here."
"Questionnaire completed. Thank you."

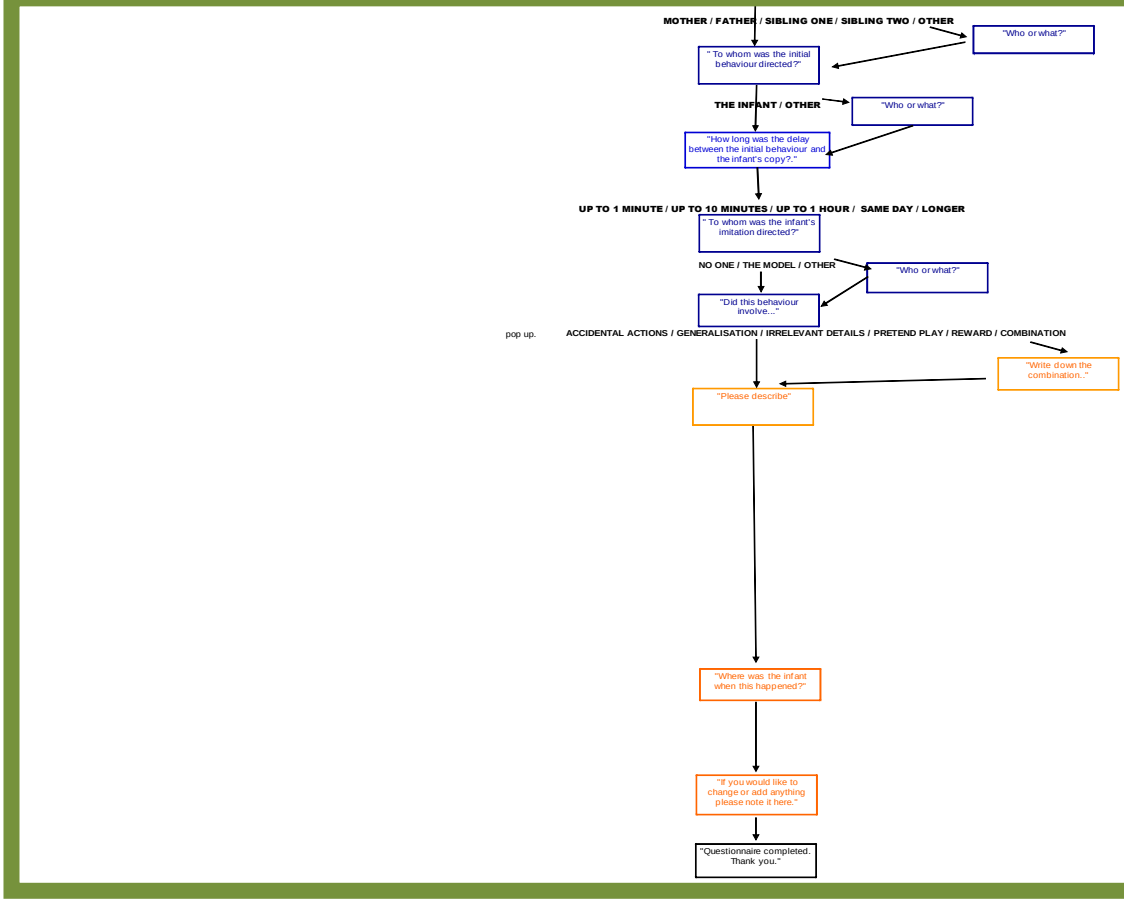
B

Appendix 4. Flowchart (object) imitation

A



B



PALM COMPUTER QUESTIONS ILLUSTRATED IN A FLOW DIAGRAM

KEY
Orange boxes represent open-ended questions.
Blue boxes represent close-ended questions.
Black boxes represent automatic messages.

A

"Tap the screen to begin."

"Describe what happened."

"What type of behaviour was it?"

MOTORIC

IMITATIVE

"What type of imitative behaviour was it?"

COMMUNICATIVE

OBJECT

FACIAL

GESTURAL

VOCAL

COMBINATIONS

"Note any important details about how objects were

""Was this behaviour spontaneous, encouraged or instructed?

ENCOURAGED/INSTRUCTED

"Describe how."

SPONTANEOUS

"How many times has the infant **seen/heard** this behaviour?."

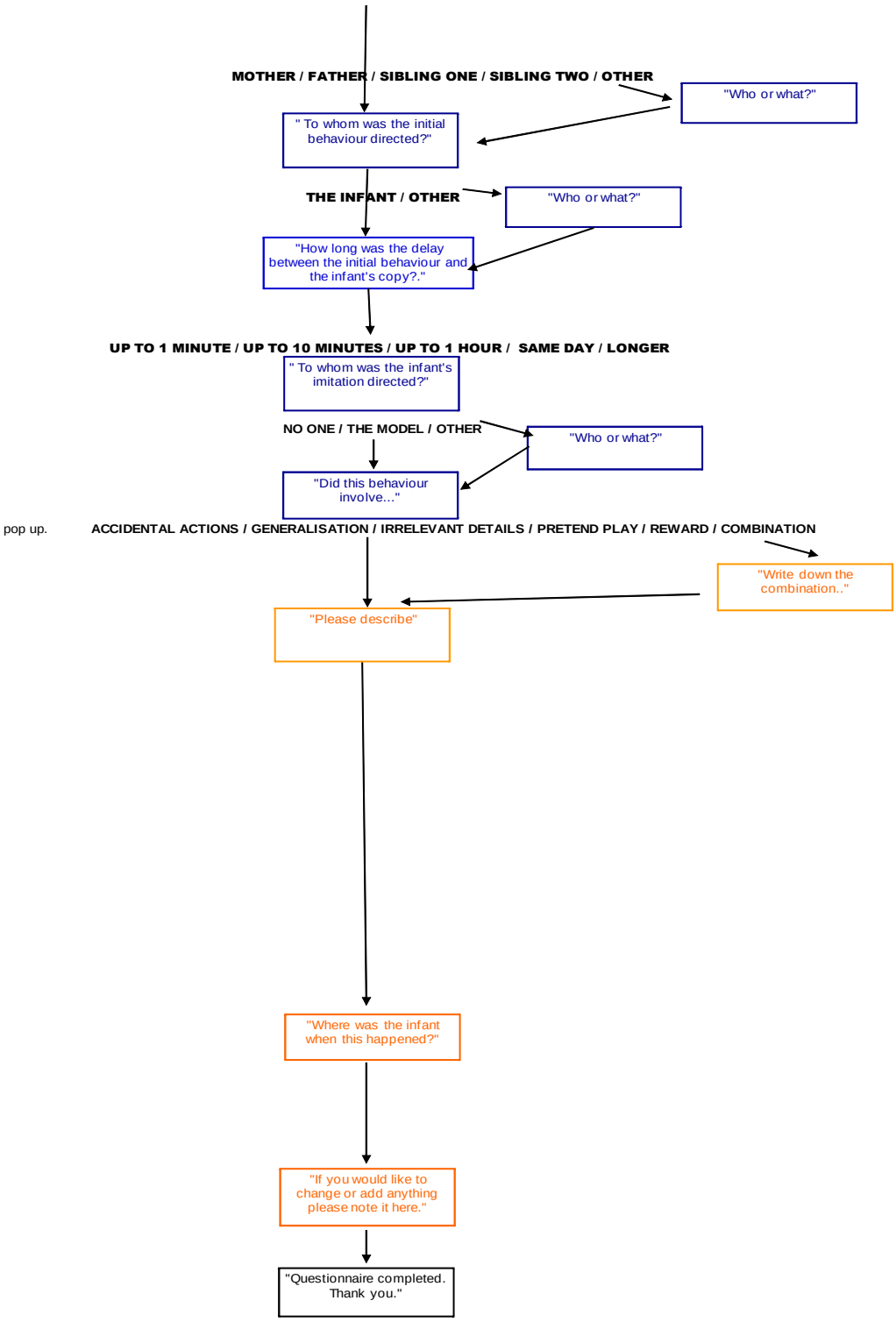
THIS IS THE FIRST TIME / THIS IS THE SECOND TIME / THIS IS THE THIRD TIME / MANY TIMES

"How many times has the infant **performed** this behaviour?"

THIS IS THE FIRST TIME / THIS IS THE SECOND TIME / THIS IS THE THIRD TIME

"Who performed the initial behaviour?"

B


MOTHER / FATHER / SIBLING ONE / SIBLING TWO / OTHER
"Who or what?"
" To whom was the initial behaviour directed?"
THE INFANT / OTHER
"Who or what?"
"How long was the delay between the initial behaviour and the infant's copy?."
UP TO 1 MINUTE / UP TO 10 MINUTES / UP TO 1 HOUR / SAME DAY / LONGER
" To whom was the infant's imitation directed?"
NO ONE / THE MODEL / OTHER
"Who or what?"
"Did this behaviour involve..."
pop up.
ACCIDENTAL ACTIONS / GENERALISATION / IRRELEVANT DETAILS / PRETEND PLAY / REWARD / COMBINATION
"Write down the combination.."
"Please describe"
"Where was the infant when this happened?"
"If you would like to change or add anything please note it here."
"Questionnaire completed. Thank you."